Translating technology into the clinic

Massachusetts Institute of Technology

A Cautionary Tale

IBM pitched its Watson supercomputer as a revolution in cancer care. It's nowhere close

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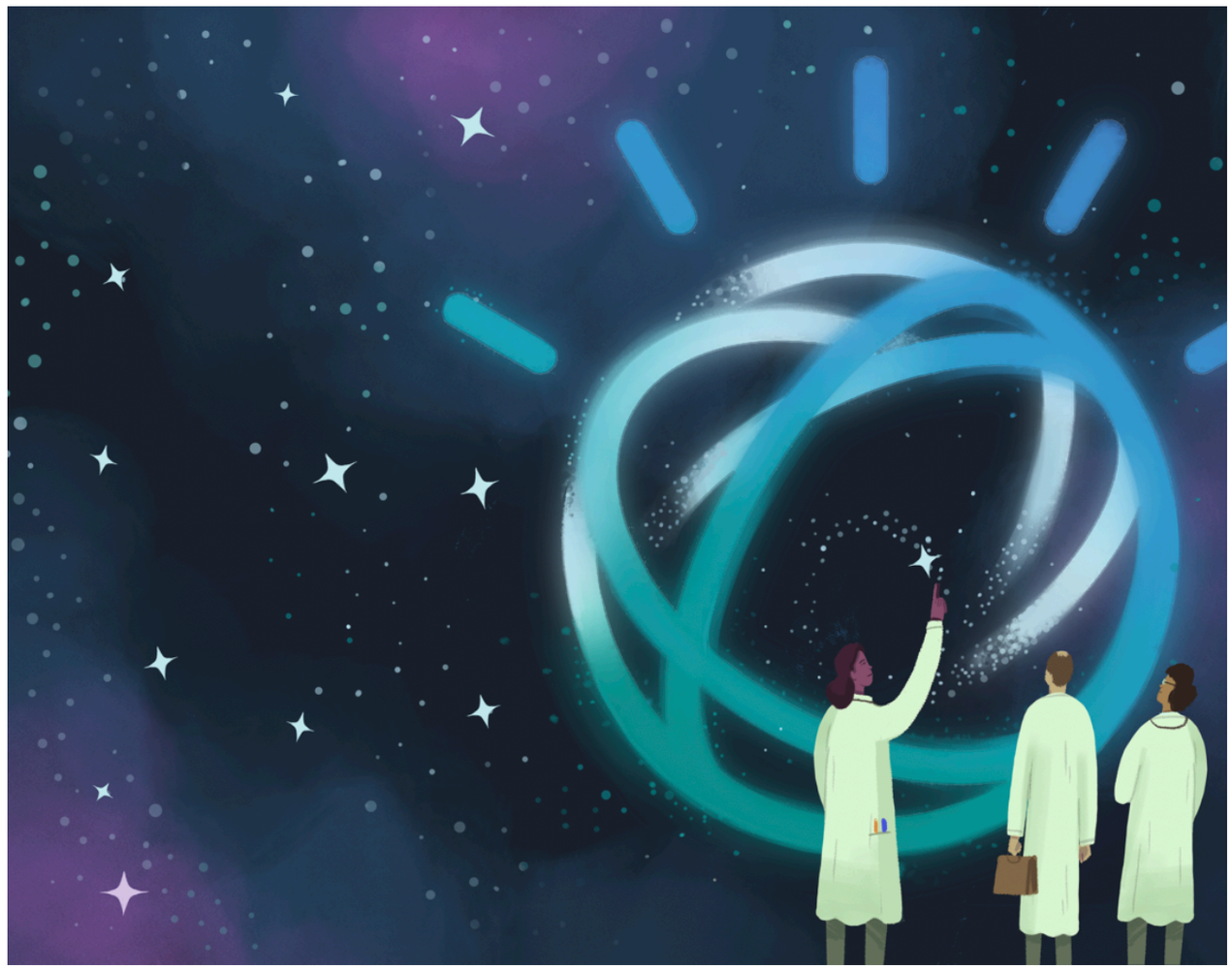
STAT



- Watson for Oncology uses the cloud-based supercomputer to digest massive amounts of data — from doctor's notes to medical studies to clinical guidelines.

https://www.statnews.com/2017/09/05/watson-ibm-cancer/

Watson's problems

- "Breathlessly promoting its signature brand — Watson — IBM sought to capture the world's imagination, and it quickly zeroed in on a high-profile target: cancer.
- … isn't living up to the lofty expectations IBM created
- … still struggling with the basic step of learning about different forms of cancer
- Only a few dozen hospitals have adopted the system
- at foreign hospitals, physicians complained its advice is biased toward American patients and methods of care
- hasn't published any scientific papers demonstrating how the technology affects physicians and patients
- its treatment recommendations … are based exclusively on training by human overseers, who laboriously feed Watson information about how patients with specific characteristics should be treated. … those human operators are a couple dozen physicians at … Memorial Sloan Kettering Cancer Center in New York. **Doctors there are empowered to input their own recommendations into Watson, even when the evidence supporting those recommendations is thin**
- most stunning overreach is … [the] claim that Watson for Oncology, through artificial intelligence, can sift through reams of data to generate new insights and identify … "even new approaches" to cancer care. STAT found that **the system doesn't create new knowledge** and is artificially intelligent only in the most rudimentary sense of the term.

Watson's problems (continued)

- Hospitals pay a per-patient fee … , and ranges between $200 and $1,000 per patient
- **At hospitals that don't link it with their medical records, more time must be spent typing in patient information.** [She] spends about 90 minutes a week feeding data into the machine
- the results for a 73-year-old lung cancer patient were underwhelming: **Watson recommended a chemotherapy regimen the oncologists had already flagged**
- the background information Watson provided, including **medical journal articles, was helpful**, … [b]ut the system did not directly help him make that [treatment] decision, **nor did it tell him anything he didn't already know**
- **IBM has not exposed the product to critical review by outside scientists or conducted clinical trials to assess its effectiveness**

- "Artificial intelligence will be adopted in all medical fields in the future," said Dr. Uhn Lee, who runs the Watson program at Gachon University Gil Medical Center in South Korea. "If that trend, that change is inevitable, then why don't we just start early?"

Watson's MD Anderson experience

- The MD Anderson alliance was essentially the early face of Watson in health care. … But the project disintegrated amid internal allegations of overspending, delays, and mismanagement. In all, MD Anderson spent **more than three years and $60 million** …
- The cancer hospital's first major challenge involved getting the machine to deal with the **idiosyncrasies of medical records**: the acronyms, human errors, shorthand phrases, and different styles of writing. "Teaching a machine to read a record is a lot harder than anyone thought," she said. Her team spent countless hours on that problem, trying to get Watson to extract valuable information from medical records so that it could apply them to its recommendations.
- Chin said her team also wrestled with **deploying the system in clinical practice**. Watson, even if guided by doctors, is as close as medicine has ever gotten to allowing a machine to help decide the treatments delivered to human beings. That carries with it thorny questions, such as how to test the safety of a digital treatment adviser, how to ensure its compliance with regulations, and how to incorporate it into the daily work of doctors and nurses.
- "Importantly," Chin said. "How do we create an environment that can ensure the most important tenet in medicine: **Do no harm**?"
- Finally, the project ran into a bigger obstacle: Even if you can get Watson to understand patient variables and make competent treatment recommendations, how do you get it access to enough patient data, from enough different sources, to derive insights that could **significantly advance the standard of care**? Chin said that was a showstopper.

https://www.statnews.com/2017/09/05/watson-ibm-cancer/

Computerized Physician Order Entry (CPOE)

- A study led by David Bates, MD, Chief of General Medicine at Boston's Brigham and Women's Hospital, demonstrated that **CPOE reduced error rates by 55% —** from 10.7 to 4.9 per 1000 patient-days. Rates of **serious medication errors fell by 88%** in a subsequent study by the same group. The prevention of errors was attributed to the CPOE system's structured orders and medication checks. Another study conducted at LDS Hospital in Salt Lake City by David Classen, MD, demonstrated a **70% reduction in antibiotic-related ADEs** after implementation of decision support for these drugs.
- CPOE has paid other dividends. **Length of stay at Wishard Memorial Hospital in Indianapolis fell by 0.9 days**, and **hospital charges decreased by 13%** after implementation of CPOE. A study at Ohio State University also identified substantial reductions in pharmacy, radiology and laboratory turn-around times, as well as a reduction in length of stay in one of the two hospitals studied.
- Research estimates that implementation of CPOE systems at all non-rural U.S. hospitals **could prevent three million adverse drug events each year.**

https://www.leapfroggroup.org/sites/default/files/Files/2018%20CPOE%20Fact%20Sheet.pdf

CPOE Benefits

- Prompts that warn against the possibility of drug interaction, allergy or overdose;
- Accurate, current information that helps physicians keep up with new drugs as they are introduced into the market;
- Drug-specific information that eliminates confusion among drug names that sound alike;
- Improved communication between physicians and pharmacists; and,
- Reduced long-term healthcare costs.
- — https://www.leapfroggroup.org/sites/default/files/Files/2018%20CPOE%20Fact%20Sheet.pdf

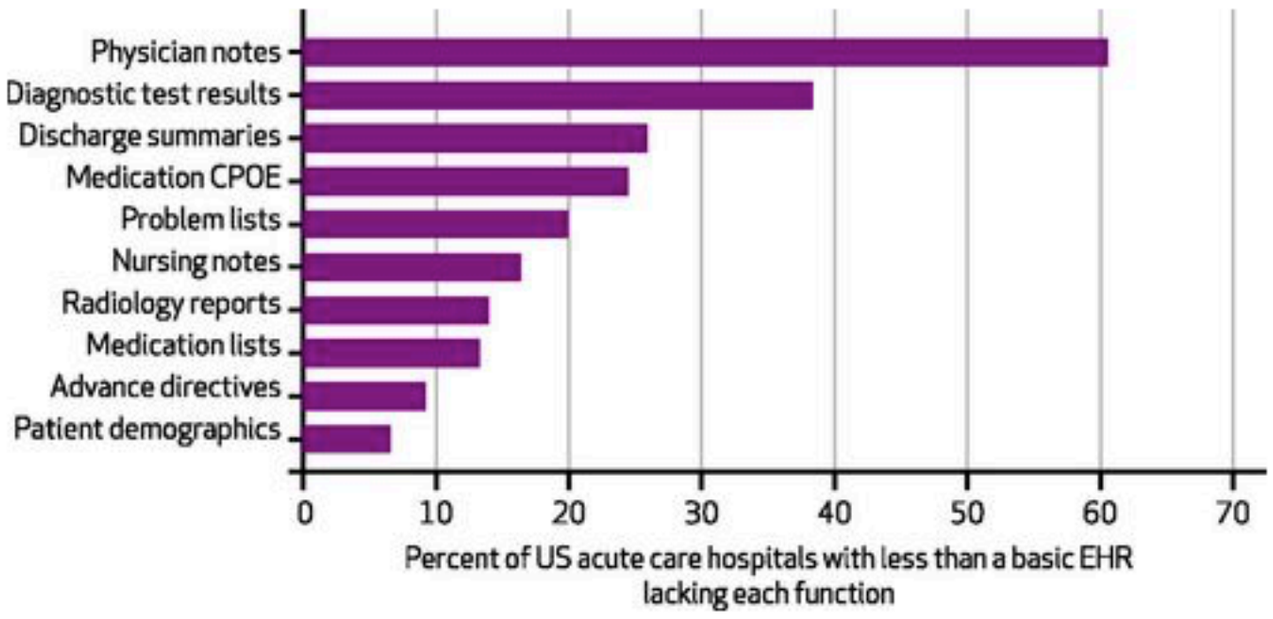
- *Potential future benefits: ML to learn drug-drug interactions*
  - *Identify occurrences in patient notes, reports*
  - *predict from drug class, patient conditions using past data and models*

Adoption of CPOE

- Institute of Medicine (National Academy of Medicine) called for universal adoption of CPOE by 1999.
- "… the CPOE products available as of 2006 represent only a second generation technology', characterized by many limitations. … CPOE adoption in urban hospitals will not reach 80% penetration until 2029."

https://libres.uncg.edu/ir/uncg/f/E_Ford_Predicting_2008.pdf

- **Exhibit 3** Prevalence Of Functions Not Yet Adopted Among Hospitals With Less Than A Basic Electronic Health Record (EHR) System



SOURCE Authors' analysis of American Hospital Association Annual Survey–IT Supplement data, 2014. NOTE CPOE is computerized provider order entry.

CPOE Effect on Pharmacists

- The pharmacists at both the short-term and long-term-CPOE sites spent more time on distributive tasks and less time on clinical tasks … pharmacists at the long-term CPOE site spent a statistically significant less amount of time on clinical tasks
- utilization of CPOE places new burdens and challenges on the pharmacists
- [a] study found that physicians were spending over twice the amount of time on EHR and desk work than on direct clinical face time

Table 3. Average time (min/hr) spent by hospital staff pharmacists on activities

Activity	Mean ± *SD*			*p*-value*
	A: Non-CPOE Hospital	B: Short-term CPOE Hospital	C: Long-term CPOE Hospital	
Clinical[φ]	6.55 ± 6.40	4.95 ± 4.15	3.79 ± 4.91	.0046
Administrative[§]	5.55 ± 6.76	5.59 ± 6.04	8.15 ± 8.31	.0337
Order Entry[&]	29.62 ± 11.24	17.44 ± 10.73	10.27 ± 8.88	< .0001
Order Verification[#]	0.88 ± 1.77	13.93 ± 8.50	16.60 ± 9.63	< .0001
All Other Distributive Tasks[δ]	13.60 ± 10.04	15.86 ± 8.38	19.66 ± 8.42	.0002
Distributive Tasks (Combined)	44.11 ± 9.87	47.23 ± 8.43	46.53 ± 9.17	.0850
Miscellaneous[€]	3.78 ± 4.64	1.54 ± 3.20	2.23 ± 3.51	.0011

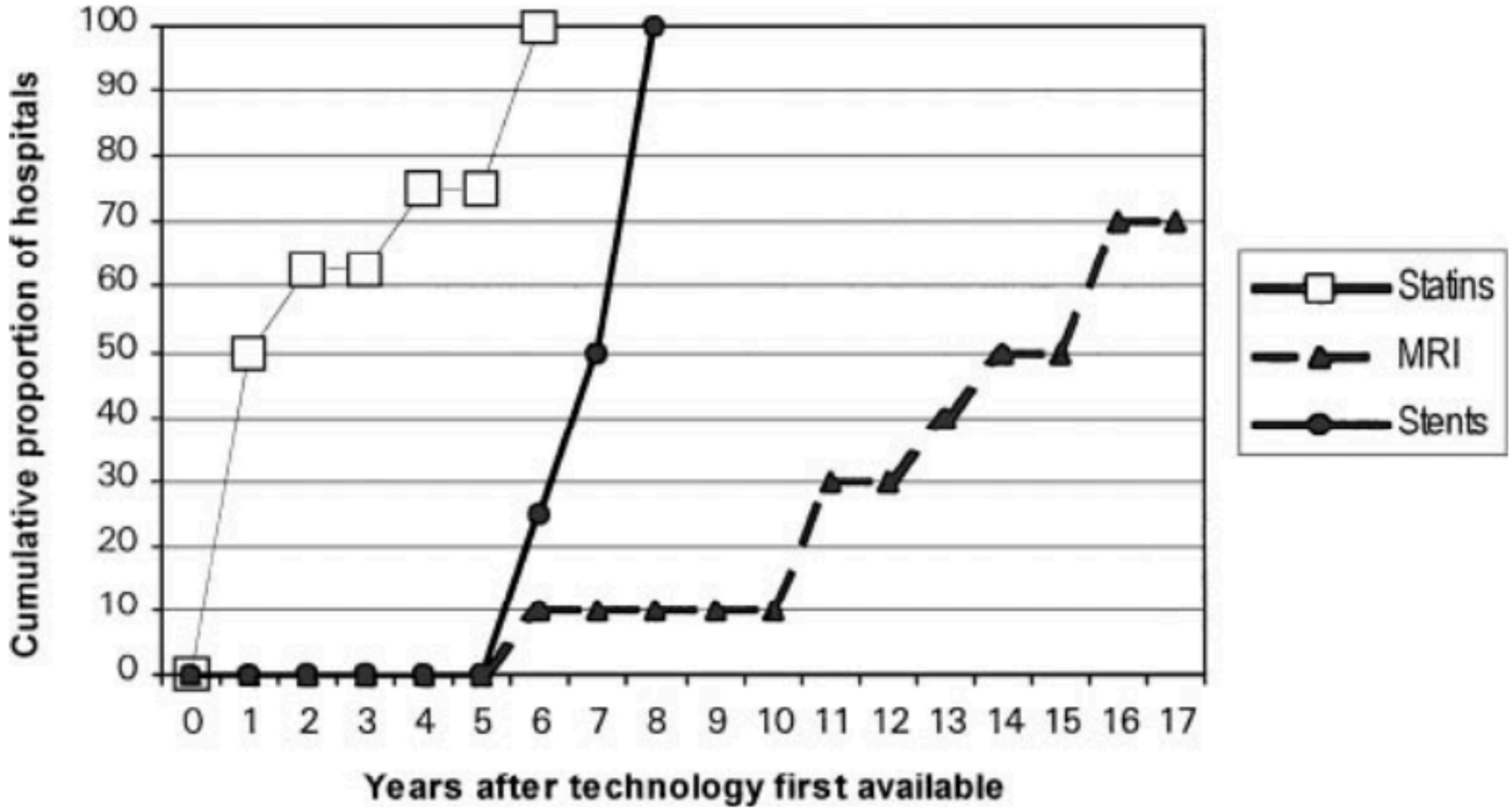
Note. CPOE = computerized provider order entry; Minutes may not equal to exactly 60 due to rounding to second digit after decimal; *p-value calculated by ANOVA - a value of <.05 is considered statistically significant; [Φ] Tukey's test performed to test statistical significance between each site; A to C was significant; [§] Tukey's test performed to test statistical significance between each site; no direct comparisons were significant; [&] Tukey's test performed to test statistical significance between each site; A to B, A to C, and B to C were all significant; [#] Tukey's test performed to test statistical significance between each site; A to B and A to C were significant; [δ] Tukey's test performed to test statistical significance between each site; A to C and B to C was significant; [€] Tukey's test performed to test statistical significance between each site; A to B and A to C was significant

Lewing, B. D., Hatfield, M. D., & Sansgiry, S. S. (2017). Impact of Computerized Provider Order Entry Systems on hospital staff pharmacist workflow productivity: A three site comparative analysis based on level of CPOE implementation. Journal of Hospital Administration, 7(1), 1–8.

Diffusion of New Medical Technologies

- The selected technologies had markedly different diffusion curves.
  - Statins diffused rapidly soon after launch.
  - Coronary stents were initially used 6 years after first availability, but within 2 years all responding hospitals reported using them.
  - MRI scanners were initially purchased 6 years after first availability with a subsequently slow rate of diffusion, and are still absent from some hospitals.
- Influences on the adoption of each technology were different.
  - Commercial marketing was reported as a major influence on the diffusion of statins but not at all on MRIs.
  - Cost impact was a major negative influence on the diffusion of MRI scanners and statins,
  - whereas enthusiastic individuals were key to the diffusion of stents.

Booth-Clibborn, N., Packer, C., & Stevens, A. (2000). HEALTH TECHNOLOGY DIFFUSION RATES. *Intl. J. of Technology Assessment in Health Care*, *16*(3), 781–786.



*Year 0 = year of first availability (England)

How to assure quality?

- Problem of bias in published reports: only successful studies get published
  - Multiple testing by groups unknown to each other will yield *some* positive results

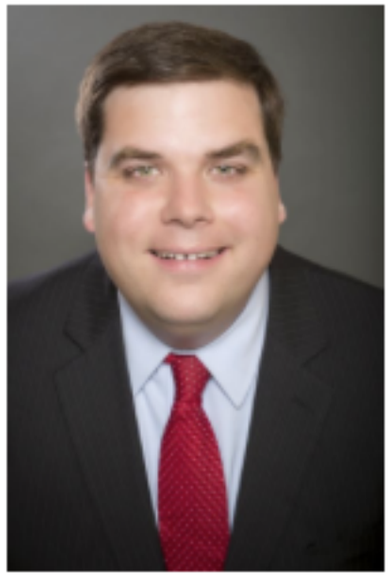
The Importance of Potential Studies That Have Not Existed and Registration of Observational Data Sets

John P. A. Ioannidis, MD, DSc

main analyses would require little time, yet prep

- Well-known inability to replicate large fraction of biomedical (and other) studies
- Require replication of studies in more than one data set—Drazen, NEJM

Ioannidis, J. P. A. (2012). The Importance of Potential Studies That Have Not Existed and Registration of Observational Data Sets. JAMA : the Journal of the American Medical Association, 308(6), 575–576. http://doi.org/10.1001/jama.2012.8144



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http://researchfaculty.brighamandwomens.org/briprofile.aspx?id=807