What problems are the next generation of clinical systems going to solve?

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Introduction

Initiatives to develop new IT systems in health care is often characterized by an exaggerated focus on specific technical issues accentuating the magnificent outcomes a specific technology will accomplish. The demanding implementation process and thereby the history of earlier attempts is thus neglected and unexploited as important learning sources. In this paper we provide a brief review of some important episodes in the specifications of future patient/health records.

Present announcements from the dominant vendors

Epic Systems CEO Judy Faulkner announced in September 2017 at the company's user group meeting that the E from electronic health records should be replaced with a C. She claimed that the "E' has to go away now. It's all electronic," - "We have to knock the walls down whether they're the walls of the hospital or the walls of the clinic". The Comprehensive Health Record (CHR) differ from the traditional EHR in three ways: 1) It contains information that is not in the EHR now, such as social determinants, eating and sleeping habits, obesity, and whether they are lonely. 2) care that is not in the hospital i.e. social and community care. 3) information about care that was traditionally managed inside the hospital but is moving outside the hospitals via telehealth apps or otherwise [1].
The Epic rival vendors Cerner, athenahealth and eClinicalWorks followed suit and announced the following week that they are incorporating new data types, such as social determinants, population health and precision medicine to make EHRs more "comprehensive" [2].
Cerner CEO Zane Burke promised to equip next-generation interoperability with the ability for "data to flow freely" between Cerner's own Millennium EHR and other vendors' software. eClinicalWorks' new EHR, version 11, recently released, consists of cloud-based connectivity, interoperability, intelligence with genetic screening for precision medicine, predictive risk models for population health, and patient engagement features including telehealth services [2].

The evolution of patient/health records

Patient records have a very long history. In Denmark patient records can be traced back to King Frederik the 5th (1723-1766) who founded the first hospital in Denmark in 1756 to treat and care free of charge for impoverished patients in Copenhagen. He issued a decreed to the doctors, instructing them to: *keep an orderly diary of the patients' condition, the nature of the disease, any occurrences, and the medicines, which are prescribed to them, and write down these very same occurrences with exceptional accuracy,....the diary is to remain in the hospital when he leaves the service* [3].

Ever since immense number of notes has been stored in paper forms, and the format of these paper records has been developed for more than 250 years. In the mid 60's the first computer systems were developed to store the growing number of text notes and numeric lab results. The first systems imitated the paper record structure and very few data elements had a specific generic structure.
In 1991 the American Institute of Medicine published a report from the Committee on Improving the Patient Record: The Computer Based Patient Record. An Essential Technology for Health Care [4]. The committee identified five objectives for future patient record systems:

1. Must support patient care and improve its quality
2. Enhance the productivity of health care professionals and reduce the administrative and labor cost associated with health care delivery and finance.
3. Must support clinical and health services research.
4. Must be able to accommodate future developments in health care technology, policy, management, and finance.
5. Patient confidentiality must be maintained while these objectives are being met.

Due to a high, persisting demand of the original report a revised version of the report was published in 1997. A new preface, and two commentaries that report on the state of CPRs anno 1997 was added [5]. New trends in health care delivery, management, and research were appraised to broaden the vision of CPRs in two areas: population-based management of health through computer-based population records and citizen-based management of health through another variant of the CPR, the computer-based personal health record.
Since the statements in the IOM report Electronic Health Records (EHR) has become synonym with computer-based systems that perform a broad range of functions related to documenting and managing patient care. In 2015 the American College of Physicians published a policy position paper [6]. A number of policy recommendations for clinical documentation is presented in the paper.
where they outline 5 recommendations for EHR system design to support 21st-Century clinical documentation:

1. EHR developers need to optimize EHR systems to facilitate longitudinal care delivery as well as care that involves teams of clinicians and patients that are managed over time.
2. Clinical documentation in EHR systems must support clinicians' cognitive processes during the documentation process.
3. EHRs must support "write once, reuse many times" and embed tags to identify the original source of information when used subsequent to its first creation.
4. Wherever possible, EHR systems should not require users to check a box or otherwise indicate that an observation has been made or an action has been taken if the data documented in the patient record already substantiate the action(s).
5. EHR systems must facilitate the integration of patient-generated data and must maintain the identity of the source.

Information from vendor web pages claim that most if not all these functionalities and facilities is present in their product. However, it is not possible to find extensive evidence from systematic evaluation research that confirm this. On the contrary, extensive complaints from clinical users claim that the EHR systems they use in hospitals are far from ideal. A

profusion of unintended consequences [7][8] specifically egregious medical errors resulting from design glitches [9], templates filled with meaningless boilerplate resulting in pasting old notes [10], and excessive warnings and alerts causing fatigues [11]. Promises of increased productivity has been a motivating factor in implementing, however EHR is also suffering the IT productivity paradox as pointed out by Spencer S. Jones et al [12]. A frequent observation is the common work task to order a medication that took seconds using pen and paper (or dictation) can take much longer using the computer [13].

The Need for a Socio-technical Approach

Comparing the visionary predictions and the studies of present health IT systems indicates that the future seems never to arrive. Much of the functionality and requirements touted as novelty, are in fact often a repacking of long known needs. An important element in the interpretation of the contradiction between the idealistic predictions and the counter final outcome of the clinical use is the different ways of interpreting clinical work, which in hospitals, is fundamentally interpretative, interruptive, multitasking, collaborative, distributed, opportunistic, and reactive. Whereas the model for designing EHR systems is objective, rationalized, linear, normative, localized (in the clinician's mind), solitary, and single-minded [14] [15]. To overcome this contradiction the design of the next generation of EHR systems should emphasize the problems and work tasks that have to be solved to produce a comprehensive, safe and sustainable health service.

Being overly focused on the application of specific technological advancements, risks yielding an incomprehensible list of detailed specification requirements, thus losing sight of the tangible clinical problem. E.g., all parties would benefit from adopting a more fluid design, implementation, and operational collaboration model where vendors and providers work towards building solutions for open-ended clinical problems and continue to do so until all stakeholders are content. Such a partnership requires a different approach to defining contractual constraints. Perhaps we are already gradually observing this shift as the recent EHR tender from the Region of Southern Denmark lists a number of strategic, tactical, and operational collaborative principles [16]. Similarly, the collaboration between CSC and the NHS Trafford Clinical Commissioning Group to establish the Trafford Coordination Centre, is an example of an alternative approach to health information systems development [17].

In summary

As always, the future appears promising to technologists. However, to exemplify our discussion in this paper, future work on next generation EHRs could be offset in the following relevant problems:

- *Cognitive load of information systems*: As hospitals seek to shorten length of admissions across most specialties, next generation systems need stronger alignment with the actual clinical reality, way of thinking, and collaboration as staff needs to familiarize themselves faster with more patients. E.g., improving the situational awareness of staff on general and acute wards where identifying risk patients is difficult due to the diversity of patients and colleagues alike, and the utilization of support systems are often low.
- *Multifaceted health markets:* Addressing the tension facing suppliers, providers, and consumers when seeking to establish EHR solutions spanning two-sided health markets [18]. Expanding the settings will further confound the delivery of high utility information systems as problems are blurred even more.

- *Division of clinical work:* Accommodating for the effects of shifts in division of work between physicians and nurses, and between clinicians and computer supported decision making.
- *Embedding research*: As researchers, one of our key challenges in this new landscape is to convince decision makers to embed objective knowledge dissemination activities directly into the provider-vendor partnership.

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