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# EHR

## Introducing Associative Technology to Electronic Health Records

Atomic Information Systems

# Introducing Associative Technology to EHR

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***Excerpts taken from the American Medical Association in the book "Practical EHR: Electronic Record Solutions for Compliance and Quality Care"***

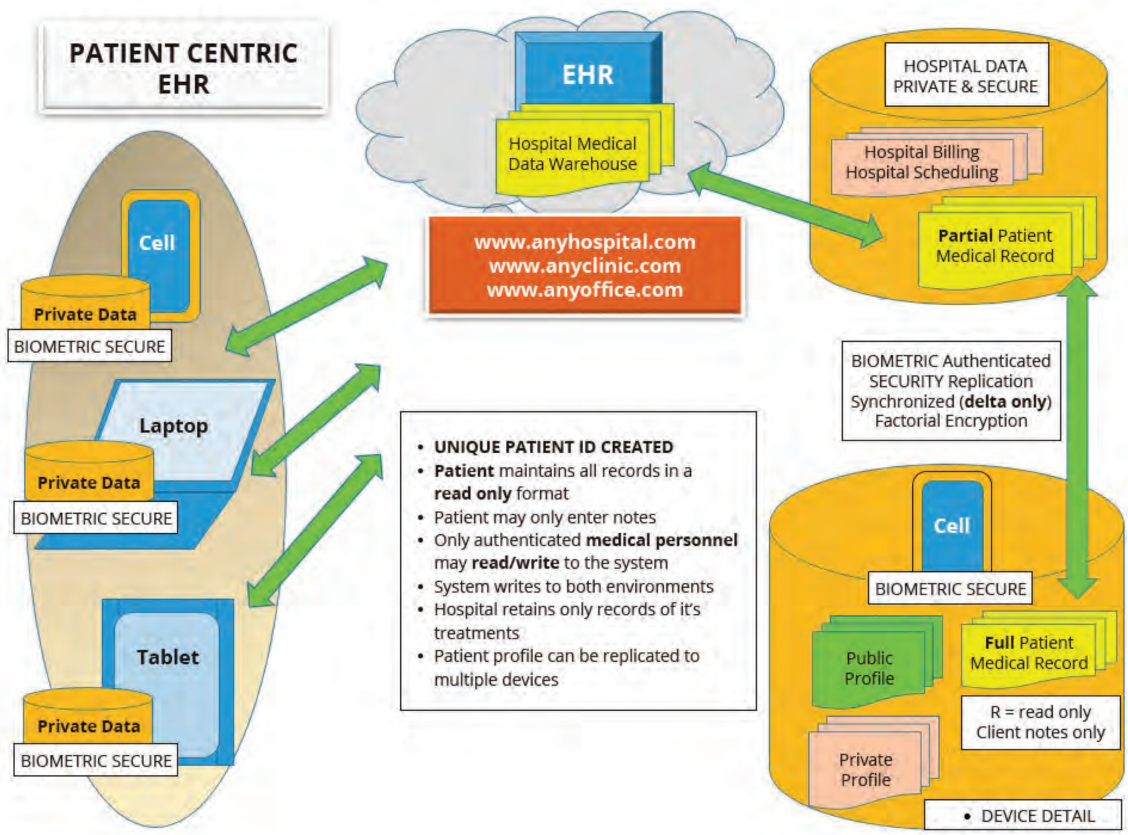
Medical people must deal with continuous and pervasive obstacles as well as challenges from any number of existing electronic health record (EHR) software systems, in hospital, outpatient and remote environments. These burdens arise both from mostly unavailable or unreliable interoperability capabilities and from interface design and functionality issues that fail to meet end user requirements for optimal success and patient care, particularly at the point of care. These clinical requirements, which we generally consider as operability features, may include but not limited to:

- Usability (described as the ability to replicate and facilitate the optimal diagnostic process learned during medical training plus effective documentation of that care);
- Efficiency (described as the ability to perform and accurately document care in a time-effective manner; i.e., at least as timely as a high quality non-electronic system);
- Compliance with all current documentation mandates (described as including not only meaningful use requirements, but also standard documentation and coding guidelines);
- Data integrity (described both as reliable presentation of laboratory and radiology reports and, critically, as easily understood descriptions of individualized patient evaluations and management plans);
- Reliably assisting clinicians in both performing and documenting the optimal diagnostic patient care process;
- Guidance to ensure medically appropriate and indicated levels of care, documentation, and coding in order to achieve appropriately optimized productivity.

Atomic Information Systems Corp has incorporated a revolutionary "Associative" database technology and the most advanced interface designs into it's new EHR program, providing the capability to remedy the interoperability and operability challenges in existing Health Information Technology (HIT) systems. This integrated solution, as described below, presents the practical impact of these programming advances for medical practices and hospitals.

**Interoperability Solution: The Associative Database**

EHR systems available throughout the world uniformly employ conventional "relational database" technology. With this technology, each IT system (including not only EHRs but also all the various other medical and administrative systems to which they should connect) has a complex matrix




of connections unique to its own system. However, establishing EHR interoperability among these various systems (including other EHRs) requires a complex, costly, and time-consuming programming effort in order to connect with each of the disparate systems if it can be done at all.

An insightful analogy results from imagining two large Excel spreadsheets. Programmers must painstakingly establish connections between each box of spreadsheet #1 (e.g., the box at location D-7) to the corresponding box in spreadsheet #2 (e.g., the box at location F-15). This complexity is further compounded by the common occurrence that each box of spreadsheet #1 may require connections to multiple boxes in spreadsheet #2; further, multiple boxes of spreadsheet #1 may need connections to a given box (or boxes) in spreadsheet #2. Complications arise from both missing and incorrect connections; when these common errors occur, they require either costly re-programming or the invention of manual "work-arounds" by users. It is this lack of easy connectivity, which is intrinsic to relational database technology that has made true interoperability unachievable in our current EHR environment.

This barrier is successfully remedied with the introduction of the "associative database." Using this technology, programmers are no longer required to individually seek out the locations of each required connection, as described above. Instead, the associative database identifies the content of each of the boxes in spreadsheet #1 (via language processing) and seeks out any and all boxes in spreadsheet #2 that have similar or related content.

We first replace the data items stored in the tables or tuples with elementary "atoms" of information that reside in a common n-dimensional (n ~ 1 billion) associative vector space of contextual associations among the data attributes. The information atoms are then stored in the physical memory using another organizational vector space with 2120 distinct item locations. In this way, the AtomicDBTM AM tool (Figure 1) provides a unified and compact representation that can accommodate any data type, dynamic or stationary, structured or un-structured, of arbitrary size, origin, and granularity.

The atomic pieces of information are represented as byte arrays of arbitrary siz-es where the maximum size limit is determined by policy or, in its absence, en-forced by the operating system constraints. The associations among the data items are naturally formed based on all the attributes such as the names, counts, hierarchical relationships, and both quantitative and qualitative proper-ties of the items. Of course, these attributes will vary widely among items rep-resenting fundamentally different physical entities such as battery cells and tur-bine blades, but will be typically identical, albeit with different values, for the same entity type. For example, two battery cells may have different voltage specifications but will have exactly the same set of properties like open circuit voltage, maximum current, heat dissipation rate, charge/discharge rate, dimensions, etc. Thus, various instances of identical entity types will lie in the same sub-spaces of the n-dimensional associative vector space, whereas instances of different entities will occupy different sub-spaces therein.

Multiple occurrences of the same entity instance are automatically unified and represented as the same atomic piece of information and the transactional integrity of the relationships of each instance is maintained. The provision to add more attributes, and, thereby increase the dimensionality of the occupying sub-space is always available. Note that the sub-spaces for the different entities may overlap, indicating the presence of common attributes among the entities under consideration. This occurrence builds associative "bridges" at a contextual level enabling automated discovery and correlation. Furthermore, all the items of a particular entity type will be contextually connected to each other, and so are coerced to be physically co-located for access efficiency.

A cluster of related attributes effectively defines a sub-space. Items within a cluster with a high degree of similarity will typically have a high density of inter-relatedness. Items belonging to different clusters may also have some connections between them, but those will be much sparser. These connections are al-ways bi-directional and dynamic enabling the additions of new associations, automatically re-qualifying the sub-space as more data is ingested and models are dataficated.

Mapping of anything to anything in any of a billion associative dimensions is an inherent capability of AtomicDBTM. These dimensions have three distinct forms to discriminate functional perspectives and qualify what can be acted upon and by whom. Specifically, one form is used to model and coordinate record-oriented data sets and data streams, one to segregate the activities of specific users, applications, or CPS system components, and one to model any number of semantic namespaces and / or taxonomies and / or ontologies. This discrimination is valuable when trying to model, map, and coordinate numerous different datasets and data sequences with distributed capabilities, APIs, and processing functions within a CPS system, where tabular and node-graph (tuple-based) systems are inherently inadequate. AtomicDBTM handles this easily.

This functionally rapidly and effectively permits the software to establish a bi-directional information conduit between each appropriate content location in two (or multiple) disparate systems.

The benefits of this advanced technology begin with lower programming cost and much higher reliability for connecting multiple unrelated systems. This technology also provides the ability to store and share significantly more complex information, since it facilitates the sharing of free-text narrative descriptions in addition to check boxes and drop-down "pick lists" in conventional HIT programs. As described in the "Operability Solution" below, this enhanced ability for storing and sharing narrative documentation further provides the ability to create a "common user interface" ("CUI") for the physicians' clinical History and Physical Record; i.e., a common H&P record used by all clinicians in an organization, with the associative database capable of passing this information reliably to any other connected EHR/information technology software systems. In addition to these foundational benefits, the associative database also permits interoperability with older software systems, allowing medical organizations to upgrade their HIT to this new technology without the loss of historical documentation or the need to run parallel systems to have access to legacy information. Other significant advantages of the "associative database" include:

- Zero errors in spelling, mistyping copy, and risk of data loss;
- Reducing requirements for data storage by as much as 75%;
- Ease of data transformation, data correlation, data normalization and overall data management;
- No additional programming, need for users' technical resources, or need for queries to find data;

- Saves valuable time in accessing business critical information;
- Real-time report generation;
- Ability to integrate and utilize all other disparate and legacy systems;
- No further need for costly database system upgrades.

**Usability Solution: The Quality & Compliance-Based Clinical Record Interface**

While EHR systems available throughout the current environment have focused their intellectual and monetary efforts on the "data storage and retrieval" strengths of digital systems, they have consistently failed to invest similar efforts and resources into the designs and functionality of the "data entry" features of the Electronic Health Record: the medical history and physical (H&P) This is the critical component for physicians, because it creates the operational environment for the physician, the patient, and the medical record at the point of care. The H&P interfaces of current systems structure their designs for clinical information in a manner best-suited to fulfilling the demands of relational databases and meeting statistical mandates, rather than meeting clinicians' requirements for usability, efficiency, documentation compliance, and promoting the optimal diagnostic patient care process. The result has been pervasive physician dissatisfaction with the interface designs and functionality of these current systems.

This usability-based medical record interface design comprehensively addresses all of these critical needs for clinicians. Instead of focusing on the restricted design requirements for populating a relational database, this interface is built on the History and Physical methodology and documentation format taught to all medical students as the optimal format for patient care and documentation.[1] This design approach intrinsically ensures the promotion of the optimal patient care process. It also ensures usability because the interface reflects the design of the H&P that clinicians learn to document during their clinical education. Integration with the associative database technology permits this medically-appropriate interface to seamlessly exchange information with HIT devices, including EHRs that are built on relational database architecture.

In addition, this familiar H&P interface appearance is significantly enhanced by design and functionality features that optimize documentation efficiency. These features include use of graphic entry designs where appropriate and compliant (e.g., check boxes for "yes" or "no" responses to pre-entered medical history questions concerning past history, social history, family history, and review of systems), and use of free-text narrative entry where appropriate to describe patient-specific and visit-specific details (e.g., history of present illness, plus details of positive past history, social history, family history, and review of systems responses). Usability and efficiency are further enhanced by appropriate (and compliant) facilitation of preliminary data input by ancillary members of the medical team and by patients themselves. These benefits can be further facilitated by appropriate use of the full spectrum of data entry options, including both voice recognition software and handwriting recognition software (for documentation by check boxes, printing, and legible script handwriting).

Additional benefits of this advanced H&P interface design begin with far easier and quicker training for clinicians. Its content can also be customized to meet the requirements of particular specialties as well as the preferences of individual organizations. The interface also guides and ensures compliance with Evaluation and Management (E/M) Guidelines for documentation and coding, including consideration of medical necessity. This benefit follows logically on the fact that the E/M coding system guidelines are directly derived from the standard reference text most often used to train medical students, and the design and functionality of the usability interface are similarly based on the concepts presented in the same reference text. A further advantage, which will be of particular benefit for hospital-based inpatient care, is the ability to incorporate ICD-10 "Smart Charts" that can quickly guide physicians to appropriately precise ICD-10 codes and the necessary documentation semantics to support them. This feature will assist hospitals in several ways: 1) insuring optimal appropriate diagnostic codes, resulting in optimal DRGs and appropriate payments; 2) reducing CDI requirements and costs; 3) increasing efficiency of revenue cycle management (thereby reducing need for undesirable money factoring/floor planning); 4) providing audit protection for reviews by MACs, RACs, and commercial insurers.

**Summary**

The "U/I Interface" system identifies the core deficiencies in the database technology and interface designs of existing Electronic Health Records and other medical devices integral to the practice of medicine. It provides customizable solutions for these deficiencies, presenting them as an integrated software product capable of operability for clinicians and interoperability with the full spectrum of related Health Information Technology products.

1 This design, and its rationale, have been published by the American Medical Association in the book "Practical EHR: Electronic Record Solutions for Compliance and Quality Care"

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# Transforming care with digital

***Dr. Mahiben Maruthappu, Senior Fellow to the CEO at NHS England, outlines how digitalisation will transform healthcare...***

Digital has transformed almost every aspect of our society, from how we order a taxi, to renting accommodation, to ordering food. It has improved the efficiency of banking transactions 100-fold and saves the airline industry over £2bn a year.

Yet, while the majority of our population owns a smartphone and uses digital, at the moment only a small number use it to interact with the NHS. We speak of sweating our assets in healthcare, but perhaps the most overlooked asset is the smartphone. Tremendously powerful, personalised and connected. At a time when pressures on the NHS couldn't be higher, the need to adopt digital and incorporate smartphones couldn't be greater.

As the NHS seeks to achieve its aims of radically upgrading prevention, better integrating care, and boosting efficiency, digital is the tool that can enable each of these to occur in tandem. From supporting patients in achieving self-care, to diagnostic support to clinicians, to integrated electronic medical records that combine data spanning the health and social care system, while slicing through administrative costs. Digital can and will transform care. The only question is when.

In an effort to embrace and harness digital, we have a launched a number of initiatives to disrupt the system, matched by over £4bn of funding in NHS technology over the coming years:

Prevention: type 2 diabetes costs the NHS around £9bn a year and entails a number of serious complications for patients, including limb amputation – even though the condition is largely preventable through lifestyle modification. To address this, we have launched the world's first Digital Diabetes Prevention Programme, aimed to identify patients at high risk of type 2 diabetes and, using a digital platform, to encourage them to adopt a healthier diet with greater physical activity, to reverse this risk and prevent diabetes from occurring.

Patient empowerment: we have found ways to encourage use of apps in the NHS to allow patients to better manage their own conditions, from chronic obstructive pulmonary disease (COPD) to mental health problems, while knowing that the digital technologies they are using are evidence-based and cost-effective.

Specialist care: a dozen NHS hospital trusts have been selected to serve as digital exemplars. Each hospital is receiving up to £10m, to enable front-line staff to use digital tools and deliver better care. These range from real time video links between ambulances and emergency departments to support better care during journeys to hospital; electronic detection and alerting of patient deteriorations such as sepsis; and online systems able to reduce medication errors by up to half.

Scale: while the NHS has a strong track record when it comes to the discovery and development of innovations, it has struggled to achieve scale. To tackle this head-on, we launched the NHS Innovation Accelerator (NIA) one year ago, designed to spread tried and tested technologies across the health service, including apps and digital social networks. In its first 6 months the NIA benefited over 3 million patients, and within a year over 380 organisations had adopted NIA technologies, demonstrating that the NHS can indeed be disruptive.

These initiatives are part of a comprehensive strategy to digitalise the NHS; empowering patients to better manage their conditions, enabling front-line staff to deliver higher quality care, and boosting system efficiency. The digital revolution has the potential to realise our health, quality and efficiency ambitions; now is the time to embrace it.

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