HiRES and its Application of HL7 Clinical Document Architecture in a Training Context

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***Abstract* — This document presents the HiRES, Health informatics for Research, Education and Service, research project undertaken at the St. Mary's Hospital Research Center, McGill University and its integration of the HL7 Clinical Document Architecture standard for clinical teaching in the virtual environment. The achievement of a meaningful virtual clinical world for teaching, continuing clinical education and the 'mentor' generation patient record requires that clinical information and knowledge be computable and consensus driven. The CDA provides a structure that can be interpreted by an enriched archetype thereby providing a simplified consensus medium that is readily accessible to the clinical community. Curatorship of the knowledge set by cross jurisdictional accreditation entities provides a *de facto* national standard accessible to teachers and vendors.**

***Keywords* — Autonomous Medicine, Decision Support, Teaching, Mentor, Guidelines**

I. INTRODUCTION

HiRES is a research project that intends, over a five year period, to establish a standardized architecture for electronic medical records used in resident and nurse teaching facilities such as family medicine units within hospitals. A specific architecture is considered necessary for this environment as it must provide support for the practice of medicine, the process of teaching the practice of medicine through both real and virtual patient encounters[1] and research into the practice of medicine. At the heart of this research project is the development of a clinical knowledge data bank that will be both human readable and machine inference-able. The project will, with the collaboration of the Canadian College of Family Physicians, the Royal College of Physicians and Surgeons of Canada, the Canadian Nurses Association and l'Ordre des Infirmières et Infirmiers du Québec, curate the best practices of physicians and nurses from across the country through the development and review of enriched archetypes. These enriched archetypes will provide the necessary 'rules of process' to allow the medical record system to 'understand' and 'assist' the physician or nurse in clinical practice as per the Level 5 (mentor) EMR[2].

The HL7 Clinical Document Architecture (CDA) provides HiRES with a framework from which the necessary archetypes can be identified[3]. The CDA also provides the structure and coded information upon which the rules of process will operate[3]. Through extension of the CDA into the medical education domain, it will be possible for the archetypes and hence the rules of process to be automatically updated through the standard process of guideline adoption[4].

In a fully implemented archetype-driven medical record system, the student will be monitored and tutored through his encounters by the system itself drawing on the information collected in the CDA-structured patient file[5]. This environment will allow the quality of care provided to be assessed against the consensus view of correct care and the current applicable guidelines. Entire episodes of care will be extracted and prepared into teaching scenarios that will provide instant feedback to the student as well as report his / her performance to the supervisor.

II. HiRES

HiRES intends to establish a standardized architecture for electronic medical records used in family medicine units within hospitals.

In order that the computer be brought into the examination room as a teacher and mentor in the process of providing care, several knowledge-related hurdles must be overcome. The first hurdle is to render the encounter data intelligible to the machine[6]. This requires the systematic collection of codified information within a standardized structure to provide context[7]. The second hurdle is to provide the machine with the knowledge necessary to understand the data[8]. This requires that all the present and future care-related medical knowledge be structured into a set of unambiguous rules designed to process the contextually

coded information[9]. The final hurdle is to maintain the machine's knowledge current and valid in order that the care specified by the system be of the highest quality available[10]. This will involve the publication of medical guidelines in a form that can be processed by the machine and that will allow the rule base upon which the machine's decisions are made to be updated[9].

A. *HL7 CDA*

The HL7 Clinical Document Architecture, Release Two (CDA R2) provides a strong, standards-based framework from which to address the first hurdle[3]. Indeed with its clear <structuredBody> element and associated <section> element, the CDA R2 provides the context capture environment needed to allow the computer to 'understand' the information that represents the patient's state. The work being done by the HL7 Vocabulary Committee will ensure that the actual codification of the data is sufficiently expressive to hold the nuances of meaning critical to the correct interpretation of this information[11]. These attributes of structure and 'expressive' codification are intended to be exported by the HiRES team and form the link between the encounter data collection and the knowledge base developed to address the second hurdle.

B. *Archetypes*

Archetypes, as implemented by the OpenEHR foundation, provide an efficient mechanism by which a large number of participants can review, comment and correct the information content of knowledge objects such as encounter artefacts[12]. The project team intends to recast the CDA elements related to the patient encounter into archetypes and preserve the contextual and expressive coding attributes as a mean of bridging one structure to the other. In collaboration with the Canadian College of Family Physicians, the Royal College of Physicians and Surgeons of Canada, the Canadian Nurses Association and l'Ordre des Infirmières et Infirmiers du Québec, the HiRES team will collect and curate the best practices of physicians and nurses from across the country through the development and review of the enriched archetypes. These best practices or 'rules of process' will be bound to the archetypes through the use of an 'enriched' constraint language that will allow the computer system to 'understand' and 'assist' the physician or nurse in clinical practice[13].

The constraint language is to be 'enriched' though better visualization techniques intended to facilitate the interpretation and validation of the 'rules of process' by the medical community at large. The current offerings in the field of constraint languages mostly rely on a textual interface which makes the broad base consultation envisioned by the project as a means of establishing best practices for physicians and nurses in family medicine, difficult[14].

With the coding and context models shared between the CDA and the archetypes, the rules of practice will be applicable to the CDA-based record thus creating a producing a 'proof of concept' Level 5EMR[15].

C. *Guidelines*

The curated archetypes will be used to structure the production of practice guidelines in order that future medical practice be available to the computable medical record. These computer-enabled guidelines will also address the perennial problem of disseminating new practice information to physicians and nurses in the field. In its 'mentor' mode the system will provide justifications for its recommendations and practice decisions by displaying the relevant guidelines thus providing the practitioner with a relatively painless means of keeping up to date. Through the integration of new technologies such as IBM's DeepQA[16], the HiRES team will develop a standardized interface between publishing authorities and the knowledge repository [17].

III. ENCOUNTER SIMULATION

In a fully implemented archetype-driven medical record system, the student will be monitored and tutored through his encounters by the system itself drawing on the information collected in the CDA-structured patient file. In the tutored mode, the 'Mentor' will monitor the patient information as it is collected and provide the 'sober second thought' on diagnosis selection and treatment options decided by the student. In the course of the encounter the 'Mentor' will also highlight possible avenues of investigation and enforce minimum levels of record keeping in compliance with both the regulatory requirements and the teaching unit's standards. This same 'tutor' mode could be provided to healthcare practitioners within their day to day practice as a mechanism for regulatory compliance and in the context of continuing medical education and fluency as indicated in the previous section of this paper.

In the monitored mode, the 'Mentor' will monitor the patient information as it is collected and provide a record of the student's thought process[18]. A post-encounter review, augmented by the Mentor's observations, should be available in either a self-assessment mode or 'supervisor-in-the-loop' mode.

Entire episodes of care will be extracted and prepared into teaching scenarios that will provide instant feedback to the student as well as report his / her performance to the supervisor. These scenarios, developed over several encounters, will allow the student to hone his episode of care skills by providing simulated encounters that are compressed in time.

IV. CONCLUSIONS

As the information tsunami of genomics and proteomics descends upon the clinical community, the imperative to teach computational patient record literacy has become acute. The complexity and expense of clinical computational systems is such that the economies of scale can only be achieved through the same collaborative strategies that produce interoperability. As we advance from electric paper to the participant 'mentor', the engagement of the clinical community will be crucial and

can only be guaranteed through laying the foundations of this literacy during training.

The rigor and order that is being applied to our clinical vocabulary and knowledge around the world as a result of the search for the quality goals espoused by the Institute Of Medicine (IOM) of the National Academies and others through the application of computational and systems technologies to clinical care will result in a clinical community that will be comfortable in dialog with machine systems in both the clinical context and the consensus panel. Social media will inevitably provide the venue.

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REFERENCES

[1] R. S. Joe, A. Otto, and E. Borycki, "Designing an electronic medical case simulator for health professional education," *Knowledge Management & E-Learning: An International Journal (KM&EL)*, vol. 3, no. 1, p. 63–71, 2011.

[2] J. H. Jahnke-Weber, M. Price, and G. McCallum, "Making available Clinical Decision Support in Service-Oriented Architectures."

[3] R. H. Dolin et al., "HL7 Clinical Document Architecture, Release 2," *Journal of the American Medical Informatics Association*, vol. 13, no. 1, pp. 30 -39, Jan. 2006.

[4] I. Bilykh, J. H. Jahnke, G. McCallum, and M. Price, "Using the clinical document architecture as open data exchange format for interfacing EMRs with clinical decision support systems," 2006.

[5] V. Alves, J. Neves, L. Nelas, and F. Marreiros, "Web-based medical teaching using a multi-agent system," *Applications and Innovations in Intelligent Systems XIII*, p. 181–194, 2006.

[6] B. Hazlehurst, H. R. Frost, D. F. Sittig, and V. J. Stevens, "MediClass: A system for detecting and classifying encounter-based clinical events in any electronic medical record," *Journal of the American Medical Informatics Association*, vol. 12, no. 5, p. 517, 2005.

[7] J. Eichner and M. Das, "Challenges and Barriers to Clinical Decision Support (CDS) Design and Implementation Experienced in the Agency for Healthcare Research and Quality CDS Demonstrations," 2010.

[8] M. Peleg, S. Keren, and Y. Denekamp, "Mapping computerized clinical guidelines to electronic medical records: Knowledge-data ontological mapper (KDOM)," *Journal of Biomedical Informatics*, vol. 41, no. 1, p. 180–201, 2008.

[9] D. F. Sittig, A. Wright, J. S. Ash, and B. Middleton, "A Set of Preliminary Standards Recommended for Achieving a National Repository of Clinical Decision Support Interventions," vol. 2009, pp. 614-618, 2009.

[10] R. Regier, R. Gurjar, and R. A. Rocha, "A Clinical Rule Editor in an Electronic Medical Record setting: Development, Design, and Implementation," vol. 2009, pp. 537-541, 2009.

[11] "Vocabulary - HL7Wiki," *HL7 Vocabulary TC Infrastructure and Assets*. [Online]. Available: http://wiki.hl7.org/index.php?title=Vocabulary. [Accessed: 12-Apr-2011].

[12] S. Garde, E. Hovenga, J. Buck, and P. Knaup, "Expressing clinical data sets with openEHR archetypes: A solid basis for ubiquitous computing," *International Journal of Medical Informatics*, vol. 76, p. S334-S341, 2007.

[13] M. Marcos and B. Martínez-Salvador, "Towards the Interoperability of Computerised Guidelines and Electronic Health Records: An Experiment with openEHR Archetypes and a Chronic Heart Failure Guideline," *Knowledge Representation for Health-Care*, p. 101–113, 2011.

[14] T. Beal and S. Heard, "Archetype Definition Language ADL2," The OpenEHR Foundation, 2007.

[15] T. Handler, B. Hieb, "The Updated Gartner CPR Generation Criteria," Gartner, 2007

[16] D. Ferrucci et al, "Building Watson: An Overview of the SeepQA Project", *AI Magazine*, vol. 31, no.3, pp. 59-79, 2010

[17] P. Gago and M. F. Santos, "Adaptive knowledge discovery for decision support in intensive care units," *WSEAS Transactions on Computers*, vol. 8, no. 7, p. 1103–1112, 2009.

[18] J. C. Denny, L. Bastarache, E. A. Sastre, and A. Spickard III, "Tracking medical students' clinical experiences using natural language processing," *Journal of Biomedical Informatics*, vol. 42, no. 5, pp. 781-789, Oct. 2009.