Appendix: Content Summaries of Selected Best Papers for the IMIA Yearbook 2018 Section "Clinical Information Systems"

Olchanski N, Dziadzko MA, Tiong IC, Daniels CE, Peters SG, O'Horo JC, Gong MN

Can a Novel ICU Data Display Positively Affect Patient Outcomes and Save Lives?

J Med Syst 2017;41:171

The reduction of medical errors, the reduction of cost, and/or the increase in outcome quality are amongst others important expectations regarding the introduction of Healthcare Information Technologies (HIT) such as Medical Records. While initial findings support these ideas at least partly, there are other specific examples that put this into question. The respective paper deals with the specific domain of intensive care units (ICUs) where delayed or poorly presented/contextualized information together with other factors often cause failure of HIT.

In the current study, the impact of the Patient-Centered Cloud-based Electronic System: Ambient Warning and Response Evaluation (ProCCESs AWARE), which was developed at the Mayo Clinic, Rochester, MN, is evaluated regarding care process and patient health outcome metrics. AWARE contains built-in tools for error prevention, practice surveillance, decision support, and reporting, built on an advanced understanding of cognitive and organizational ergonomics.

Outcomes before and after implementation were compared using a prospective cohort (856 patients from 2010) and a historical cohort (983 patients from 2014), including all critically ill adult patients (over 18-year old) admitted to four ICUs at the Mayo Clinic. Non-parametric Wilcoxon tests for continuous characteristics and chi-square tests for categorical measures with a significance level of $p = 0.05$ were applied and covariate adjustments were made to control for known biases and confounding. Health outcomes included e.g. overall and ICU length of stay (LOS), inpatient and ICU mortality, central line Infections, etc. The main process outcomes in this study included among others resource utilization in terms of number of days with central line usage, number of days with urinary catheter usage, number of days of antibiotic usage, etc.

Reductions in both hospital and ICU mortality, length of stay, and costs of hospitalization were significant when controlled for patient characteristics and AWARE usage levels. The process measures showed mixed results.

Andersen B, Kasparick M, Ulrich H, Franke S, Schlamelcher J, Rockstroh M, Ingenerf J

Connecting the clinical IT infrastructure to a service-oriented architecture of medical devices

Biomed Tech 2018;63(1):57–68

Currently we can observe a lot of standardization efforts taking place in the domains of medical devices as well as clinical information systems. These efforts are focused on specific challenges ranging from technical to semantic interoperability. What is not yet covered in enough detail is the fact that these domains have to work together in order to allow integrated care scenarios. So it is not enough to tackle the problems of standardization and interoperability within each field. Solutions are needed that bridge the gap between these two fields. On the other hand, it is not only a problem of interoperability but also a question of e.g. guaranteeing security when exchanging data between the domains. The current paper introduces existing standards in the field of medical devices and clinical information systems such as Health Level Seven (HL7), Digital imaging and communications in medicine (DICOM), Fast Healthcare Interoperability Resources (FHIR), etc., and proposes concepts to overcome problems of technical, structural, and semantic interoperability taking the specific requirements of each standard and the context of its use into account. The idea is to allow the transfer of clinical and administrative data to medical devices, physiologic measurements and device parameters to clinical Information Technologies systems, as well as image and multimedia content in both directions. The paper also reports about a prototype implementation and evaluation of the proposed concepts using a service-oriented approach. Finally the approach was reflected with regards to the introduction of the HL7 FHIR approach.

Plastiras P, O'Sullivan DM

Combining Ontologies and Open Standards to Derive a Middle Layer Information Model for Interoperability of Personal and Electronic Health Records

J Med Syst 2017;41:195

Electronic Health Records (EHRs) face widespread adoption in the clinical domain. Often these records are solely focused on health care providers and their information needs. In addition, there are personal health records (PHRs) that – on the opposite – focus on the patients and their needs. It seems evident that an integrated care requires both self-dependent, active patients, and health care providers; the same is true for data. Different scientific publications have identified barriers to the adoption of PHRs such as privacy, interoperability, and integration. The work tackles the problems of integration and interoperability by developing an information model that attempts to overcome inadequacies of existing standards for PHR data such as Continuity of Care Documents (CCDs). The authors present a multilayer architectural model that combines different ontologies to allow a flexible and system-independent transfer of data between EHRs and PHRs in both directions. The idea relies on a set of rules that support the analysis and transformation of information from the different systems based on the mapping of their information model to HL7 RIM classes and the generation of standardized documents that can be exchanged between systems. The evaluation proofed that the system was able to handle various challenges such as how to treat elements from the exporting system that are unsupported by the receiving system; differences in the attributes captured in PHRs and supported by CCD documents, and the semantic interpretation of the expected data.

Nguyen P, Tran T, Wickramasinghe N, Venkatesh S

Deepr: A Convolutional Net for Medical Records

IEEE J Biomed Health Inform
2017;21(1):22–30

When it comes to the extraction of knowledge from medical data, one is faced with a variety of problems. These include, amongst others, that data differ from patient to patient as varying data elements depending, for instance, on the actual patient, collected treatment, or disease characteristics. Also, time and frequency are great challenges for the extraction of knowledge as there are different time gaps between observations or number of observations recorded for a condition which differ between patients. In order to tackle these problems, highly specific feature engineering is necessary, which makes an approach cost-intensive and reduces generalizability. The paper presents a prediction framework called Deepr that does not require manual feature engineering and is based on a multi-layered approach inspired by convolutional neural networks from natural language processing. Deepr is thereby transforming data from electronic medical records to "sentences". Time for example is represented in these sentences by special "words". The basic idea behind the approach is that there exists something like a "health grammar", a clinical pattern that shapes the evolution of one's health over time. Deepr was validated using hospital data to predict unplanned readmission after discharge. The system showed superior results compared to Bag of Words and regularized Logistic Regression. It detected meaningful clinical motifs and uncovered the underlying structure of the disease and intervention space.