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Detection of possible adverse drug events using an Arden-Syntax-based rule engine

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Introduction: The ever increasing number of administered drugs results in an elevated risk for drug-related harm, especially in elderly patients [1,2]. Although many countries have installed a legal commitment to report adverse drug events (ADEs), the number of reported cases—and therefore the efficacy of the reporting systems—remains low. Only about 10–20% of medication errors and 1–13% of detected ADEs are reported [3]. This is because medication errors rarely result in obvious drug-related damages or are seldom considered as primary reasons for disorders [4]. Moreover, ADE detection and reporting is a time-consuming and expensive task. Nevertheless, it is crucial to prevent and mitigate ADEs causing damage to patients [5]. Therefore, hospitals need a more efficient way to quantify the amount and severity of ADEs for pharmacists and physicians to take corrective actions. Several studies have shown that clinical decision support systems can improve quality of care [6] and are appropriate tools to support physicians in their decisions.

Materials and Methods: Within the iMedication project [7], an intelligent ADE cockpit for detecting, monitoring, and reporting ADEs is developed. The core of the software implementation is a decision support system applying a hybrid approach combining the "IHI Global Trigger Tool"-method [5] and Morimoto's classification [8] to detect suspected ADEs. Its knowledge base consists of medical logic modules (MLMs) [9] which encode the medical expert knowledge in Arden Syntax [10] and are executed by an Arden Syntax rule engine residing on a server [11]. The data to be processed come from various sources—the hospital information system, an electronic health record, as well as entered information—and reflects six categories: demographic data, laboratory findings, clinical symptoms, diagnoses, medications, and hospital events. The aggregated information of a single patient is delivered for interpretation to the Arden Syntax server, which returns a detailed interpretation summary for each identified ADE consisting of: (a) an ADE risk score which reflects the degree and severity of the ADE, (b) the institutions which have to be informed according to the severity of the ADE, (c) the triggers having fired, as well as (d) the complete patient information used for interpretation.

Results: Four clinically relevant situations (hyperkalemia, hyponatremia, renal failure, and over-anticoagulation) were selected as exemplary use cases. They represent some of the most relevant ADEs for internal and geriatric medicine wards. Four corresponding knowledge bases, consisting of a total of 33 MLMs covering 51 ADE triggers, were built upon these use cases in Arden Syntax in close cooperation between medical experts and knowledge engineers.

Discussion: Existing approaches for ADE detection use data mining [12], decision trees [13], ontologies [14], or product label parsing [15] to automatically generate ADE detection rules. The approach at hand formalizes operative knowledge of clinical experts into standardized machine-executable Arden Syntax, allowing the formalization of complex rules to identify ADEs. The proposed implementation is suitable for various applications, including quality assurance by retrospective evaluation of clinical data regarding suspected ADEs, active feedback for clinicians during patient treatment, and pharmacovigilance reporting.

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