

Clinical Decision Support Systems: Contributions from 2021

Damian Borbolla¹, Tiago K. Colicchio², Section Editors for the IMIA Yearbook Section on Decision Support Systems

¹ Wolters Kluwer Health and Department of Biomedical Informatics, University of Utah, Salt Lake City, UT, USA

² Informatics Institute, University of Alabama at Birmingham, AL, USA

Summary

Objectives: To summarize significant research contributions published in 2021 in the field of clinical decision support (CDS) systems and select the best papers for the Decision Support section of the International Medical Informatics Association (IMIA) Yearbook.

Methods: The authors searched the MEDLINE® database for papers focused on clinical decision support (CDS) systems. From search results, section editors established a list of candidate best papers, which were then peer-reviewed by at least three external reviewers. The IMIA Yearbook editorial committee selected the best papers on the basis of all reviews including the section editors' evaluation.

Results: A total of 337 articles were retrieved from which 13 candidate papers were identified. Finally, from the candidate papers, the top three papers were selected. The first paper introduces an innovative evaluation approach to CDS systems, the second compares six health institutions on how they are measuring CDS alert fatigue and the last one adds new evidence on how CDS can help to reduce unnecessary interventions.

Keywords

Health informatics; International Medical Informatics Association; yearbook; review; clinical decision support systems

Yearb Med Inform 2022;199-202

<http://dx.doi.org/10.1055/s-0042-1742528>

1 Introduction

This paper serves as the synopsis of the Decision Support section of the International Medical Informatics Association (IMIA) Yearbook. This synopsis complements the review paper authored by Stipelman *et al.*, where the authors performed a literature review to identify studies focusing on the design and implementation of clinician-facing clinical decision support (CDS) tools to improve health care for populations facing disparities [1]. Therefore, the aim of the synopsis is to summarize recent research in the domain of interest and to select the best papers published in this field in 2021. The expansion in the use of Electronic Health Records, and specifically with the implementation of CDS, provides many opportunities to reduce health disparities. This section summarizes the evidence from the literature on the topic, and is organized as follows: first, we summarize the process for selecting the best papers on the decision support topic; next, we present the results of this year's selection process, and then the reviewers' comments on the contributions of the three best papers, as well as noticeable research findings identified during the review process.

2 Methods

We review the literature with a search strategy focused on topics related to CDS to identify candidate best papers in Medline (from the US National Center for Biotech-

nology Information). To define the search queries, we followed the strategy described in the Lamy *et al.*, paper [2]. We targeted papers published in 2021. "Decision Support Systems, Clinical", "Expert systems" AND "Medical Order Entry Systems" Medical Subject Headings (MeSH) terms were used for searching and Boolean operators (AND, OR) were used to specify combinations of search terms. But we also incorporated other narrative terms to the search strategy like "clinical decision support", "Medication Alert Systems", "Computerized Provider Order Entry System", etc. A first review of the retrieved citations was performed by the two section editors who selected 13 candidates' best papers. Following the IMIA Yearbook method [2], these candidates' papers were individually reviewed and rated by both the section editors, the chief editor of the IMIA Decision Support section, and informatics experts from the international Health Informatics community. Each paper was reviewed and scored by at least three reviewers. Based on the reviewers' ratings and comments, the Yearbook editorial committee selected the best papers of the decision support domain.

3 Results

We obtained a total of 337 unique references in the first query. After a first individual screening independently performed by both section editors based on the title of papers, 263 were not retained. Those papers were not retained because the main topics were not fully aligned with our section focus. It

took the section editors several iterations, but we ended up with 74 studies that were then discussed synchronously by the two editors to achieve a final selection of 13 candidates' best papers. Some of the trends identified in our discussion were important number of papers describing CDS interventions to help with the COVID-19 pandemic. Another trend was the increase in studies assessing the negative impact of CDS, e.g., alert fatigue and physician burnout. For the final selection of papers, we balanced the representation of diverse clinical conditions and specialties as well as the location of the authors, but at this stage, all the studies had high scientific standards. After the external review of this final selection, the editorial committee finally selected three of them as the best papers for 2021. Table 1 summarizes 13 papers initially selected by the section editors. These papers represent the best of CDS for 2021 but also appear in a wide range of journals outside of informatics (e.g., *Journal of the American Board of Family Medicine*, *PLoS One*, *JAMA Network Open*, *Surgery*). We are continuing to see more widespread use of CDS tools, and this is very exciting for the field of informatics. The three best papers of 2021 are discussed in the next section.

4 Content of the Best Papers

Table 2 lists the three best papers for the IMIA Yearbook of Medical Informatics in the CDS section. In the first best paper, Austrian *et al.*, [14] describe an innovative testing approach to evaluate the performance of CDS systems, called A/B testing. A/B testing is a method to compare two versions of the same intervention to figure out which one performs better [16]. The authors applied A/B testing principles within a commercial electronic health record (EHR), demonstrating how that this methodology can be used to quickly ascertain the superiority of potential CDS design changes to improve usability, reduce alert fatigue, and promote quality of care. This innovative testing approach demonstrates how multiple versions of alerts in a short period of time can help to improve the acceptance of the

Table 1 List of papers initially selected by section CDS section editors.

Reference	Title
Oluoch et al., [3]	A clinical decision support system is associated with reduced loss to follow-up among patients receiving HIV treatment in Kenya: a cluster randomized trial. <i>BMC Med Inform Decis Mak</i> 2021 Dec 20;21(1):357.
Stephens et al., [4]	Effect of Electronic Health Record Reminders for Routine Immunizations and Immunizations Needed for Chronic Medical Conditions. <i>Appl Clin Inform</i> 2021 Oct;12(5):1101-9.
Solberg et al., [5]	Clinician Perceptions About a Decision Support System to Identify and Manage Opioid Use Disorder. <i>J Am Board Fam Med</i> 2021 Nov-Dec;34(6):1096-102.
Rizk et al., [6]	Development, Validation, and Assessment of Clinical Impact of Real-time Alerts to Detect Inpatient As-Needed Opioid Orders With Duplicate Indications: Prospective Study. <i>J Med Internet Res</i> 2021 Oct 25;23(10):e28235.
Orenstein et al., [7]	Alert burden in pediatric hospitals: a cross-sectional analysis of six academic pediatric health systems using novel metrics. <i>J Am Med Inform Assoc</i> 2021 Nov 25;28(12):2654-26.
Zakim et al., [8]	Computerized history-taking improves data quality for clinical decision-making-Comparison of EHR and computer-acquired history data in patients with chest pain. <i>PLoS One</i> 2021 Sep 27;16(9):e0257677.
Andruchow et al., [9]	Decision support for computed tomography in the emergency department: a multicenter cluster-randomized controlled trial. <i>CJEM</i> 2021 Sep;23(5):631-40.
Seol et al., [10]	Artificial intelligence-assisted clinical decision support for childhood asthma management: A randomized clinical trial. <i>PLoS One</i> 2021 Aug 2;16(8):e0255261.
Orenstein et al., [11]	Evaluation of a Clinical Decision Support Strategy to Increase Seasonal Influenza Vaccination Among Hospitalized Children Before Inpatient Discharge. <i>JAMA Netw Open</i> 2021 Jul 1;4(7):e2117809.
Dente et al., [12]	Predicting the need for massive transfusion: Prospective validation of a smartphone-based clinical decision support tool. <i>Surgery</i> 2021 Nov;170(5):1574-80.
Dutta et al., [13]	Clinical Decision Support Reduces Unnecessary Tetanus Vaccinations in the Emergency Department. <i>Ann Emerg Med</i> 2021 Sep;78(3):370-80.
Austrian et al., [14]	Applying A/B Testing to Clinical Decision Support: Rapid Randomized Controlled Trials. <i>J Med Internet Res</i> 2021 Apr 9;23(4):e16651.
Saegerman et al., [15]	Clinical decision support tool for diagnosis of COVID-19 in hospitals. <i>PLoS One</i> 2021 Mar 11;16(3):e0247773.

Table 2 Best paper selection of articles for the IMIA Yearbook of Medical Informatics 2022 in the section 'Decision Support Systems'. The articles are listed in alphabetical order of the first author's surname.

Section
Decision Support Systems
<ul style="list-style-type: none"> ▪ Austrian J, Mendoza F, Szerency A, Fenelon L, Horwitz LI, Jones S, Kuznetsova M, Mann DM. Applying A/B Testing to Clinical Decision Support: Rapid Randomized Controlled Trials. <i>J Med Internet Res</i> 2021 Apr 9;23(4):e16651 [14]. ▪ Dutta S, McEvoy DS, Stump T, McCabe J, Mahendra-Rajah A, McMurry R, White BA, Rubins D. Clinical Decision Support Reduces Unnecessary Tetanus Vaccinations in the Emergency Department. <i>Ann Emerg Med</i> 2021 Sep;78(3):370-80 [13]. ▪ Orenstein EW, Kandaswamy S, Muthu N, Chaparro JD, Hagedorn PA, Dziorny AC, Moses A, Hernandez S, Khan A, Huth HB, Beus JM, Kirkendall ES. Alert burden in pediatric hospitals: a cross-sectional analysis of six academic pediatric health systems using novel metrics. <i>J Am Med Inform Assoc</i> 2021 Nov 25;28(12):2654-60 [7].

interventions. In the second paper, Dutta *et al.*, [13] described the implementation of a CDS alert in an electronic health record to warn providers about a previously documented tetanus vaccine, when they are ordering a new one. Here, the authors explored the alert efficacy to reduce unnecessary vaccines in the Emergency Department (ED). The study demonstrates a successful implementation of an electronic health record-based reminder system in the ED to decrease an unnecessary preventive intervention. And in our last best study, Orenstein *et al.* [7] analyzed interruptive alert firings at six pediatric health systems for a period of three years. One of the key findings in this paper was the substantial variation across organizations. The authors also highlighted that alert were consistently responsible for the majority of alert burden, this means that individual organization practices and culture for the development of alerts may be a primary driver of alert burden and may present an opportunity to substantially modify alert burden

5 Outlook

As demonstrated by the number and the variety of studies related to decision support, research in the field is very active. This year's selection highlighted innovation in the CDS evaluation process, alert fatigue, and a more traditional approach to measuring the efficacy and efficiency of CDS alerts.

References

1. Stipelman CH, Kukhareva PV, Trepman E, Nguyen Q-T, Valdez L, Kenost C, et al. Electronic Health Record-Integrated Clinical Decision Support for Clinicians Serving Populations Facing Health Care Disparities: Literature Review. *Yearb Med Inform* 2022;184-98.
2. Lamy JB, Séroussi B, Griffon N, Kerdelhué G, Jaulent MC, Bouaud J. Toward a formalization of the process to select IMIA Yearbook best papers. *Methods Inf Med* 2015;54(2):135-44.
3. Oluoch T, Cornet R, Muthusi J, Katana A, Kimanga D, Kwaro D, et al. A clinical decision support system is associated with reduced loss to follow-up among patients receiving HIV treatment in Kenya: a cluster randomized trial. *BMC Med Inform Decis Mak* 2021 Dec 20;21(1):357.
4. Stephens AB, Wynn CS, Hofstetter AM, Kolff C, Pena O, Kahn E, et al. Effect of Electronic Health Record Reminders for Routine Immunizations and Immunizations Needed for Chronic Medical Conditions. *Appl Clin Inform* 2021 Oct;12(5):1101-9.
5. Solberg LI, Hooker SA, Rossom RC, Bergdall A, Crabtree BF. Clinician Perceptions About a Decision Support System to Identify and Manage Opioid Use Disorder. *J Am Board Fam Med* 2021 Nov-Dec;34(6):1096-102.
6. Rizk E, Swan JT. Development, Validation, and Assessment of Clinical Impact of Real-time Alerts to Detect Inpatient As-Needed Opioid Orders With Duplicate Indications: Prospective Study. *J Med Internet Res* 2021 Oct 25;23(10):e28235.
7. Orenstein EW, Kandaswamy S, Muthu N, Chaparro JD, Hagedorn PA, Dziorny AC, et al. Alert burden in pediatric hospitals: a cross-sectional analysis of six academic pediatric health systems using novel metrics. *J Am Med Inform Assoc* 2021 Nov 25;28(12):2654-60.
8. Zakim D, Brandberg H, El Amrani S, Hultgren A, Stathakarou N, Nifakos S, et al. Computerized history-taking improves data quality for clinical decision-making-Comparison of EHR and computer-acquired history data in patients with chest pain. *PLoS One* 2021 Sep 27;16(9):e0257677.
9. Andruchow JE, Grigat D, McRae AD, Innes G, Vatanpour S, Wang D, et al. Decision support for computed tomography in the emergency department: a multicenter cluster-randomized controlled trial. *CJEM* 2021 Sep;23(5):631-40.
10. Seol HY, Shrestha P, Muth JF, Wi CI, Sohn S, Ryu E, et al. Artificial intelligence-assisted clinical decision support for childhood asthma management: A randomized clinical trial. *PLoS One* 2021 Aug 2;16(8):e0255261.
11. Orenstein EW, ElSayed-Ali O, Kandaswamy S, Masterson E, Blanco R, Shah P, Lantis et al. Evaluation of a Clinical Decision Support Strategy to Increase Seasonal Influenza Vaccination Among Hospitalized Children Before Inpatient Discharge. *JAMA Netw Open* 2021 Jul 1;4(7):e2117809.
12. Dente CJ, Mina MJ, Morse BC, Hensman H, Schobel S, Gelbard RB, et al. Predicting the need for massive transfusion: Prospective validation of a smartphone-based clinical decision support tool. *Surgery* 2021 Nov;170(5):1574-80.
13. Dutta S, McEvoy DS, Stump T, McCabe J, Mahendra-Rajah A, McMurry R, et al. Clinical Decision Support Reduces Unnecessary Tetanus Vaccinations in the Emergency Department. *Ann Emerg Med* 2021 Sep;78(3):370-80.
14. Austrian J, Mendoza F, Szerencsy A, Fenelon L, Horwitz LI, Jones S, et al. Applying A/B Testing to Clinical Decision Support: Rapid Randomized Controlled Trials. *J Med Internet Res* 2021 Apr 9;23(4):e16651.
15. Saegerman C, Gilbert A, Donneau AF, Gangolf M, Diep AN, Meex C, et al. Clinical decision support tool for diagnosis of COVID-19 in hospitals. *PLoS One* 2021 Mar 11;16(3):e0247773.
16. Gallo A. A Refresher on A/B Testing. *Harvard Business Review* 2021. Available from: <https://hbr.org/2017/06/a-refresher-on-ab-testing>

Correspondence to:

Damian Borbolla

E-mail: damian.borbolla@utah.edu