“All Quiet on the Western Front” - Clinical Information Systems Research in the Year 2021
An Overview of the CIS Section of the IMIA Yearbook of Medical Informatics

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Summary

Objective: In this synopsis, we give an overview of recent research and propose a selection of best papers published in 2021 in the field of Clinical Information Systems (CIS).

Method: As CIS section editors, we annually apply a systematic process to retrieve articles for the IMIA Yearbook of Medical Informatics. For eight years now, we use the same query to find relevant publications in the CIS field. Each year we retrieve more than 2,400 papers which we categorize in a multi-pass review to distill a preselection of up to 15 candidate papers. External reviewers and yearbook editors then assess the selected candidate papers. Based on the review results, the IMIA Yearbook editorial board chooses up to four best publications for the section at a selection meeting. To get a comprehensive overview of the content of the retrieved articles, we use text mining and term co-occurrence mapping techniques.

Results: We carried out the query in mid-January 2022 and retrieved a deduplicated result set of 2,688 articles from 1,062 different journals. This year, we nominated ten papers as candidates and finally selected two of them as the best papers in the CIS section. As in the previous years, the content analysis of the articles revealed the broad spectrum of topics covered by CIS research, but - on the other side - no real innovations or new upcoming research trends. However, the significant impact of COVID-19 on CIS research was observable also this year.

Conclusions: The trends in CIS research, as seen in recent years, continue to be observable. The content analysis revealed nothing really new in the CIS domain. What was very visible was the impact of the COVID-19 pandemic, which still effects our lives and also CIS.

Keywords
Medical informatics, International Medical Informatics Association, Yearbook, Clinical Information Systems

1 Introduction

For eight years now, we are responsible for the CIS section of the IMIA Yearbook of Medical Informatics. In our search for the best papers in the field, we systematically screen more than 2,400 papers each year, retrieved from PubMed and Web of Science (WoS) using standardized queries. By doing so, we also get a good overview of the research activities in the CIS field in general. Additionally, every edition of the IMIA Yearbook is dedicated to a special topic that is reflected against the background of the retrieved papers.

Last year, the special focus was on “Managing Pandemics with Health Informatics: Successes & Challenges”. We were amazed at the strong influence of COVID-19 on CIS research and the high number of publications that addressed problems of information logistics for the management of the pandemic, some of which offered interesting approaches and solutions [1]. Other trends as observed in previous years continued. Among them patient-centeredness, trans-institutional information sharing, intelligent clinical data analytics capabilities, artificial intelligence, machine learning, and decision support. Telehealth services and networked, integrated care were other vital and rising topics for CIS research in the last years [2–5].

The special topic of the 2022 edition of the IMIA Yearbook of Medical Informatics had been defined as “Inclusive Digital Health: Addressing Bias, Equity, and Literacy to Strengthen Health Systems”. So, we were curious whether this topic was also reflected in the papers found in our selection.

2 About the Paper Selection

The selection process in the CIS section is stable now for eight years. We described it in detail in [2], and the full queries are available upon request.

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Again, most of those papers whose publication records included location information came from the United States (43%, n=591). England was next (30%, n=401), followed from the Netherlands (7%, n=96), Germany (4%, n=54) and Ireland (4%, n=52).

RAYYAN (https://www.rayyan.ai), an online systematic review tool has proven its worth for the multi-stage selection process of the best papers for many years now. We both (WOH, AH) independently reviewed all 2,688 publications and excluded ineligible articles based on their titles and/or abstracts in the first pass (WOH: n=2,616; AH: n=2,647), which resulted in an agreement rate of 96.1 percent (n=2,580 for “exclude”, and n=4 for “not exclude” - i.e., “include”). We included the remaining papers with at least one vote for “include” (n=106) in the next screening round, where we selected 22 papers for full-text review on mutual consent.

This year, we selected ten candidate papers for the CIS 2021 section. For each of these candidate papers, at least six independent reviews were collected. The selection meeting with the IMIA Yearbook editorial board was – as in the two previous years – held as a video conference on April 29, 2022. In this meeting, two papers [6,7] were finally selected as the best papers for the CIS section (Table 2).

### 3 Findings and Trends: Clinical Information Systems Research 2021

Traditionally, we have used text mining and a bibliometric network visualizing approach [8] to summarize the articles’ content and abstracts in our CIS result set. This helps us to put our overview of the section’s content, which we get from screening and evaluating the publications, on a methodologically more stable footing.

Again, we extracted the authors’ keywords (n=16,830) from all articles and presented their frequency in a tag cloud (Figure 1). We found 3,998 different keywords, of which 2,589 were only used once. As in the previous years, the most frequent keyword was “Humans” (n=1,467). “Electronic Health Records” was the second most frequent keyword (n=455), followed by “Female” (n=418), “Male” (n=370), “Adult” (n=275). The next, “Point-of-Care Systems” was defined in 10% of the retrieved papers (n=265).

In contrast to the keyword tag cloud, the bibliometric network can reveal more details on the content of the CIS publications by showing the most relevant terms of titles and abstracts and their association. Figure 2 depicts the resulting co-occurrence map of the top-500 terms (n=507, most relevant 60% of the terms) from the abstracts of the 2,688 papers of the recent CIS result set.

The cluster analysis of titles and summaries did not reveal any significant changes compared to last year’s results. Five clusters emerged that are very similar to those of last year. The red cluster on the left (n=217 entries) and the green cluster

| Rank | Journal | Number of papers |
|------|---------|-----------------|
| 1    | Journal of medical Internet research | 82 |
| 2    | Journal of the American Medical Informatics Association: JAMIA | 70 |
| 3    | PloS one | 61 |
| 4    | Health communication | 48 |
| 5    | BMC medical informatics and decision making | 43 |
| 6    | Applied clinical informatics | 39 |
| 7    | International journal of environmental research and public health | 37 |
| 8    | Computers, informatics, nursing: CIN | 30 |
| 9    | BMC health services research | 28 |
| 10   | Scientific reports | 27 |
| 11   | International journal of medical informatics | 27 |
| 12   | Journal of biomedical informatics | 26 |
| 13   | JAMA network open | 25 |
| 14   | Expert opinion on drug safety | 20 |
| 15   | Sensors (Basel, Switzerland) | 19 |
| 16   | Patient education and counseling | 17 |

Table 2  Best paper selection of articles for the IMIA Yearbook of Medical Informatics 2022 in the section ‘Clinical Information Systems’. The articles are listed in alphabetical order of the first author’s surname.

**Table 1 Number of retrieved articles for top-15 ranked journals (n = 16).**
on the right (n=151 entries) are still the two largest clusters describing contextual factors, objectives and methodological aspects of the studies. The remaining three clusters are again significantly smaller but have increased in size compared to the previous year, while the two large clusters have shrunk a little. The yellow cluster, dedicated to adverse event detection and reporting, grew from n=28 items last year to n=41 this year. In contrast to the last year, the items related to COVID-19 research and scientific response in the CIS field to the pandemic situation (e.g. “coronavirus disease”, “immunization”, “outbreak”, “pandemic”, “sars cov”, “spread”, “vaccination”) are found in the pink cluster (n=32) which traditionally reflects location-based aspects of publications in the result set. The blue cluster (n=66) is also comparable to last year’s, with the exception that the COVID-19 items have been moved to the yellow cluster.

These findings supported the impression we had gained from screening the result set and selecting the paper candidates. Although we found – as every year – an impressive number of good quality publications, we did neither find anything groundbreaking nor could we identify any upcoming new trends in CIS research.

Two papers from our candidate selection convinced all reviewers and therefore made it into the collection of the best papers of the CIS section. The first of the best papers is part of the special topic of this year’s edition of the IMIA Yearbook. Bronwyn Harris and colleagues from the United Kingdom, Nigeria, Bangladesh, Kenya, Tanzania, Pakistan and South Africa present a very interesting mixed-methods study titled “Mobile consulting as an option for delivering healthcare...
In the following, we would like to briefly present them.

Artificial Intelligence (AI) and deep learning are very hot topics in the CIS field. Louis Létinier et al., present an excellent piece of work on the use of AI for coding unstructured adverse drug reporting data [10]. The next candidate paper by Du et al., shows an interesting example of deep learning to predict the risk of severe adverse effects from vaccines based on a retrospective view of adverse event reports [11]. Another interesting contribution using deep learning comes from Saranya Sankaranarayanan et al., who present a methodology for an alert system to flag mortality for COVID-19 positive patients by using laboratory values and electronic health record (EHR) data [12].

Another important aspect in CIS research is to find adequate ways of translating knowledge and sequences of recommended procedures into a computer understandable form, for implementation and quality of care control. Iago Avelino et al., tried to do this and present a process-based modeling language for designing care pathways [13]. Another very technical approach to capture complex, time-varying features of a patient’s EHR data comes from Rui Meng et al., [14].
Admittedly, the majority of reviewers found the content quite difficult to understand and perhaps beyond the interest of most readers. Nevertheless, this work is an interesting approach and perhaps a promising way to create new knowledge from large amount of complex time-series data.

The last three candidate papers come from completely different corners. CIS should primarily contribute to supporting health professionals in providing optimal health care. Keiko et al., present a paper on the topic of smart hospital infrastructure [15]. They evaluated the positioning accuracy of geomagnetic indoor positioning in hospitals. A very practical work that can make us aware that improving positioning accuracy is crucial if we want to reap the benefits of smart hospital technologies. Finally, the last two candidate papers cover important aspects that we must never ignore if we want to live up to the claim of CIS as optimal tools for optimal health care. Joep Tummers et al., compile the most relevant stakeholders, features, and obstacles of health information systems in their systematic literature review [16] and Tania Moerenhout et al., throw light on patients' moral attitudes toward EHR [17].

As every year, at the end of our review of the results and trends of the Clinical Information Systems Section, we would like to recommend reading this year’s survey article of the CIS Section, which is dedicated to the special topic “Inclusive Digital Health”. Understanding the patient experience is important for researching and designing telemedicine and eHealth services to support patient care and wellbeing. Therefore, Johanna Viitanen, Paula Valkonen, Kaisa Savolainen, Nina Karisalmi, Sini Hölsä, Sari Kujala from the Department of Computer Science, Aalto University, Finland present a scoping review of approaches and recent trends of patient experience from an eHealth perspective [18].

4 Conclusions and Outlook

All in all, we could see that not much has really changed in the CIS section this year. Topics and trends in CIS research, as observed in the last few years, can still be observed. The content analysis revealed nothing really new in the CIS section. However, the impact of the COVID-19 pandemic, which is still affecting our lives and also CIS, was clearly visible. That is why we alluded to the novel by Erich Maria Remarque in the title. This is by no means to say that nothing else was going on in the CIS section, that nothing was happening or that there were no high-quality publications. CIS are a vital field, nurtured by hard-working and innovative researchers. After eight years, our query is perhaps a little worn out and a little renewal is needed here too. We will see next year.

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