Key Factors in Achieving Intersectoral Interoperability: A Scoping Review

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Abstract: Intersectoral interoperability is a fundamental basis for effective collaboration and seamless information exchange across various sectors of the healthcare system. This paper presents a scoping review to examine the current state of research into intersectoral interoperability, focusing on the technical, syntactic, semantic, and organizational levels. Key factors identified include the adoption of international standards for data formats, terminologies, and communication protocols, as well as the establishment of trusted governance structures and compliance with ethical and legal requirements. Syntactic interoperability was most frequently addressed, followed by technical and semantic aspects, with organizational factors also playing a significant role.

1 INTRODUCTION

Intersectoral interoperability refers to the ability to seamlessly exchange and use information and data across different sectors or domains to ensure coordinated and effective care or collaboration (Perlin et al., 2016). In healthcare, this particularly means the integration and collaboration between different actors and organizations that provide different services or functions, such as:

- General practitioners and specialists: primary and secondary care sector
- Hospitals: tertiary care sector
- Public health: for population health, with system, political and organizational focus.

In this context, interoperability is crucial to enabling holistic patient care, as it facilitates the exchange of patient records, diagnoses, treatment plans and other relevant information. This can improve the quality of care, reduce redundant examinations and treatments, and optimize coordination between the various players in the healthcare system. Intersectoral interoperability requires consideration of the following four levels of interoperability: (1) technical interoperability to ensure data exchange between systems through technical components; (2) syntactic interoperability to ensure harmonized data formats and information models; (3) semantic interoperability to ensure a common understanding of message content between systems and/or users and (4) organizational interoperability to ensure that the exchange of information is secure, effective, and compliant with legal and data protection requirements (Rezaei et al., 2014).

Despite technological advances and the introduction of numerous IT solutions, the seamless integration of information and processes remains a challenge. This challenge arises from the diversity of the systems involved, the differences in the technologies used, and the varying standards and protocols employed in different sectors.

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The aim of this study is to examine the extent to which intersectoral interoperability is already being addressed in the literature, including which core aspects are particularly emphasized and whether measures necessary for its implementation can be derived. Building on this analysis, the study seeks to develop a comprehensive understanding of the complexity of intersectoral interoperability and to formulate actionable recommendations for more effective integration of the various healthcare sectors.

2 METHODS

To get an overview about current developments, challenges and perspectives of intersectoral interoperability in healthcare, we conducted a scoping review. Our literature search focused on publications describing intersectoral interoperability in the medical field, especially the data exchange and/or collaboration between different sectors of the healthcare system with the aim of providing healthcare.

Table 1: Search strings used for the literature search in PubMed and Web of Science.

Publication database	Search string
PubMed	(medic* OR health*) AND (((intersectoral OR inter sectoral OR inter-sectoral) OR (crosssectoral OR cross-sectoral OR cross sectoral) OR (multisectoral OR multi sectoral OR multi-sectoral)) AND interoperability)
Web of Science	(ALL=(medic*) OR ALL=(health*)) AND (((ALL=(intersectoral) OR ALL=(inter sectoral) OR ALL=(inter-sectoral)) OR (ALL=(crosssectoral) OR ALL=(cross-sectoral) OR ALL=(cross sectoral)) OR (ALL=(multisectoral) OR ALL=(multi sectoral) OR ALL=(multi-sectoral))) AND ALL=(interoperability))

We followed the PRISMA guidelines (Moher et al., 2009) and used two publication databases (i.e. PubMed, and Web of Science) to search for relevant publications until to May 30, 2024 (without starting time limit) written in German or English (Table 1). This review was a two-step process consisting of a title-abstract screening (TAS) and a full-text screening (FTS). Both screening processes used the same exclusion criteria listed in Table 2.

The screening team consisted of four reviewers (FB, EH, MZ, AE). The TAS was carried out by two reviewers (FB, EH) in Rayyan (Ouzzani et al., 2016) blind mode so that each reviewer could label the publication independently. The blind mode was deactivated after all publications had been labeled and the conflicts discussed and resolved. Thereafter, all included publications were loaded as a new project for FTS in Rayyan. The subsequent FTS was conducted by four reviewers (AE, MZ, EH, FB).

Table 2: Exclusion criteria applied.

Description of criterion	Label
Publication does not cover the medical field in the sense of health care.	no_medic
Publication cites medical field as just one potential area of application.	medic_ mentioned
Publication does not deal with intersectoral interoperability; it only considers one sector (e.g. hospitals) or no data exchange with the aim of healthcare provision. This category also includes telemedicine systems that do not focus on combining data from different sectors.	no_intersec_ interop
Publication only mentions (intersectoral) interoperability as a potential field of application.	intersec_ interop_ mentioned
Publication is available in a language other than German or English.	foreign_ language
Publication is only an abstract, a keynote, a letter to the editor or a tutorial.	wrong_publicati ontype
Publication is not accessible or available as full text.	no_fulltext

The FTS was also conducted in blind mode and followed the same review process as the TAS. After the FTS, we extracted the content of all included publications based on the categories listed in Table 3. The extracted content was stored in a table to enable further analyses.

Table 3: Categories for data extraction.

Category	Description
Country	Country of the considered system
Connected healthcare providers	Home, Hospital, General Practice, Public Health Institutions
Level of implementation	Concept, Proof of Concept, Routine
Technical interoperability aspects	How is technical interoperability achieved?
Syntactical interoperability aspects	How is syntactical interoperability achieved?
Semantical interoperability aspects	How is semantical interoperability achieved?
Organizational interoperability aspects	How is organizational interoperability achieved?
Further interoperability categories and aspects	Are there other categories named in publication? (How is interoperability in this category achieved?)

3 RESULTS

The literature search resulted in 113 publications. After removing 17 duplicates, 96 publications were screened during the TAS. By using the exclusion criteria defined in Table 2 29 publications were included for FTS. The screening process and results are detailed shown in Figure 1.

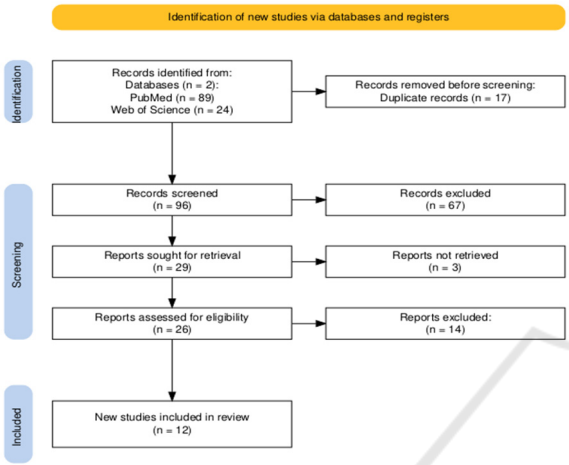

Figure 1: PRISMA flow diagram according to (Haddaway et al., 2022).

Finally, 12 studies were included in this review, which are listed in Table 4 and assigned the sequence numbers 1 to 12 for further analysis. A complete list of the results of the literature search is available on Zenodo (Henke, 2024).

The studies included in this review were published between 2009 and 2021 and considered healthcare providers from the following countries: Denmark, Germany (3), Italy, USA (2), Haiti, Chile, Thailand, Australia and worldwide. Furthermore, the providers involved in intersectoral health care were extracted. In all 12 studies, these were general practices, in 11 studies hospitals, and in 7 studies public health institutions. According to the predefined extraction criteria (Table 3) the level of implementation resulted in 4 concepts, 3 proof of concepts and 5 routine uses.

The following Table 5 shows the methods described in the studies for implementing intersectoral interoperability in accordance with the four previously defined interoperability levels. The numbers 1 to 12 after each method indicate that this method was considered in the respective study. Table 5 thus provides an overview of the various methods for implementing interoperability and the frequency with which these methods are applied.

Table 4: Studies included in this review.

Publication title and reference	Number
A shared electronic health record: lessons from the coalface (Silvester & Carr, 2009)	1
Chile´s National Center for Health Information Systems (Capurro et al., 2017)	2
Cross-enterprise interoperability (Bauer et al., 2020)	3
Fostering global data sharing (Austin et al., 2020)	4
Informatics for public health and health system collaboration (Lenert et al., 2021)	5
Interoperability after deployment (Kierkegaard, 2015)	6
Steps towards a digital health ecostystem (Serbanati et al., 2011)	7
Success factors for implementing and sustaining a mature electronic medical record in a low-resource setting (deRriel et al., 2018)	8
The nephrology eHealth-system of the metropolitan region of Hannover (Pape et al., 2019)	9
The role of Integrating the Healthcare Enterprise (IHE) in telemedicine (Bergh et al., 2015)	10
The Strategic Implementation of Data Interoperability for Better Health Care Services in Thailand (Kawtrakul et al., 2012)	11
Utilizing Standard Data Transactions and Public-Private Partnerships to Support Healthy Weight Within the Community (Mikles et al., 2017)	12

Another additional aspect of interoperability mentioned in three studies is the need to ensure an adequate budget (e.g. for hardware, software, change management, continuous training and ensuring sustainability; 1,8,11). Without sufficient funds, intersectoral interoperability cannot be achieved, making the necessary budget a prerequisite.

On a technical level, web-based services such as centralized databases, platforms and clouds are the most frequently mentioned factors (67% of the studies). International standards such as HL7 or IHE for communication protocols and message formats also play an important role (58%). These aspects make it clear that a stable technological foundation is essential to enable intersectoral exchange.

The semantic layer is heavily influenced by international standards for terminology and classification (67%). These ensure a unified language and a common understanding between the actors involved. The importance of shared repositories for standardizing terms is mentioned less frequently (25%), but it remains a valuable element for improving interoperability.

Table 5: Methods used for implementing intersectoral interoperability.

Interoperability level	Mentioned in study number	Sum* (in %)
Technical interoperability		
web services (centralized databases, platforms, clouds, server, public key infrastructure) for communication	1, 3, 5, 6, 7, 8, 9, 11	8 (67)
international standards for communication and message format (i.e. HL7, IHE, …)	1, 3, 5, 8, 10, 11, 12	7 (58)
Semantic interoperability		
international standards for terminology and organization systems, such as classifications	1, 2, 3, 8, 9, 10, 11, 12	8 (67)
shared repositories to enable standardization of terms and metadata	3, 4, 7	3 (25)
Syntactic interoperability		
international standards for data exchange formats	1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12	11 (92)
Organizational interoperability		
trusted entity/authority for project and system management	1, 2, 6, 11	4 (33)
affinity domains (by IHE, SOA platform, …)	3, 7, 9, 10	4 (33)
guidelines for compliance with local legal and ethical requirements for data processing and storage	1, 4, 11, 12	4 (33)
unique national patient identifier (i.e. master patient index)	3,5,10	3 (25)
technology monitoring procedures and licensing or certification of software	2, 4	2 (17)

* of total 12

With 92% of the studies referring to international standards for data exchange formats, syntactic interoperability is the most widely recognized key factor. This high figure shows how important standardized data formats are for the harmonization of different systems.

At the organizational level, the role of trusted authorities (33%) and guidelines for compliance with legal and ethical requirements (33%) are central. Less frequently mentioned, but still significant, are the introduction of national patient identifiers (25%) and procedures for monitoring and certifying technologies (17%).

4 DISCUSSION

The aim of this study was to examine which key factors are addressed in the literature to ensure intersectoral interoperability. The analysis of the 12 scientific studies highlights central factors that are important for successful intersectoral interoperability. These can be assigned to the four levels of interoperability – semantic, syntactic, technical and organizational. The goal of the research, to capture the key factors for a functioning interoperability, is supported by these results, as they shed light on specific requirements and measures for each level.

Summarizing all but one of the studies mentioned the importance of syntactic standards, followed by semantic standards and components of the infrastructure for communication and technical standards. Factors of organizational interoperability are only found in approximately one-third of the publications considered. Assuming that organizational aspects are absolutely necessary to achieve interoperability, it can be considered the included studies did not report all necessary aspects.

The research only considers scientific literature and disregards national programs, which are often the driving force behind intersectoral interoperability activities. Programs such as national health initiatives or electronic health record projects play a key role in promoting interoperability, but were not analysed. This limitation could affect the comprehensiveness of the identified factors. Nevertheless, the results of the studies provide valuable insight into evidence-based approaches and provide a solid foundation for further research.

In summary, no general statement can be made about the measures necessary to ensure intersectoral interoperability. However, the literature showed that the implementation of intersectoral interoperability requires the consideration of actions at all four levels of interoperability.

5 CONCLUSIONS

The scoping review examined the presence of intersectoral interoperability in the literature. The core aspects and measures for implementing intersectoral interoperability were presented. It was shown that aspects of syntactic interoperability were mentioned most frequently, followed by technical and semantic interoperability. Activities to implement organizational interoperability are reported least.

The identification and presentation of the key factors makes it clear that intersectoral interoperability is based on a combination of technological standards, uniform data formats, terminological systems and organizational structures. Future research should supplement the scientific literature with findings from national programs to obtain a more comprehensive picture of the factors and challenges.

It is evident that further research, incorporating all four levels of intersectoral interoperability is needed to gain a more comprehensive understanding of this subject.

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