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## General Data Protection Regulation (GDPR) in Healthcare: Hot Topics and Research Fronts

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**Abstract.** General Data Protection Regulation came into effect across the European Union in May 2018 but its implications in healthcare are yet to be fully understood. The aim of this study was to identify the fronts and hot topics in research on GDPR in healthcare. We analyzed the relevant records in Scopus through bibliometric and scientometric approach and visualization techniques. A set of 155 records was obtained and processed for co-occurrence analysis of key terms and concept mapping. The number of published papers showed a steep rise in the past two years, mainly by European countries. Analysis of the abstract of the papers showed that data protection, privacy, and big data were the most frequently used terms. Three dominant research fronts of GDPR are 1) general implications of GDPR, 2) technology aspects of GDPR, and 3) GDPR in healthcare service. Blockchain and machine learning are among the remerging topics of GDPR research.

Keywords. GDPR, General Data Protection Regulation, bibliometrics, scientometrics

### 1. Introduction

With the proliferation of invasive digital technologies and the emergence of dataexploiting business practices, it is increasingly difficult for individuals to maintain control over their own personal data. Consequently, this issue of control over personal data has become a significant subject in European privacy law. Compared to earlier regulations, the General Data Protection Regulation (GDPR) explicitly addresses the rights of individuals concerning this issue [1]. This means that organizations are no longer able to use individuals' personal data without their consent. GDPR dictates that entities collecting and processing data related to European Union (EU) residents adhere to GDPR articles regardless of where these entities are located, or where the data is stored. GDPR compliance support the protection of privacy at various levels. Healthcare data breaches not only can affect substantial adverse personal and social impacts on patients, but also suffer a huge cost [2]. Most notably for the healthcare community, GDPR

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explicitly introduces regulations for "data concerning health", "genetic data", and "biometric data" [3].

In spite of the fact that GDPR is a recently developed legal instrument, there have been many research studies on GDPR since its adoption in 2016, such as [4; 5]. Thus, it is important to identify and monitor the research fronts and trends relating to GDPR for better understanding and integration of this regulation with other security, privacy, and technological policies. Research fronts refer to the most dynamic research areas in science and technology that attract the most scientific interest [6] and are the body of articles that researchers actively cite in a short time span [7]. One main characteristic of emerging research fronts is high citation in a short time interval. The objective of distinguishing hot topics within a research front is to identify significant insights that are likely to determine the future direction of research. This study aimed to establish a GDPR research agenda by identifying the current trends, emerging research fronts, and hot topics in research on GDPR in healthcare using a bibliometric analysis approach.

#### 2. Methods

We conducted a bibliometric and scientometric analysis of the papers that have discussed GDPR in healthcare. The data were obtained through an electronic search of Scopus database in October 2019. No limit on year of publication or language was imposed. The results of the electronic search were exported and loaded into Bibliometrix package for R v.3.6.1 and VOSviewer v.1.6.13 for bibliometric and scientometric analyses and visualization. [8; 9]. Research fronts and hot topics were identified by concept mapping of the abstracts as well as co-occurrence analysis of the keywords of each record. We used co-occurrence analysis of keywords to extract the topics of research and find the links between these topics directly from the content of abstracts. Sankey diagram was used to visualize the main items of three fields (i.e. Country, Keywords, Year), and how they are related.

#### 3. Results

The first paper on GDPR in healthcare has published in 2012 and the number of publications was less than 10 per year until 2017, when it shows a radical increase up to 76 papers in 2018 (the year that GDPR was enacted). Germany has published the highest number of papers, followed by the UK and the Netherlands (Figure 1).



**Figure 1.** Countries with more than two papers based on the corresponding author's address. (MCP: Multiple-country publication; SCP: Single-country publication)

A three-field Plot (Sankey diagram) of Country, Keyword, and Year of publication of the cited references was created to depict the proportion of research topics for each country and the recency of the papers that they cited. As shown in Figure 2, the main interests of GDPR researchers in France are big data and data protection. The dominant topic of research in the Netherlands is privacy. Most of the papers that discussed consent have published by Ireland, the Netherlands, and the UK. Research on GDPR and Blockchain, though are few in numbers, are mainly published by USA, Norway, UK, and Netherlands.



**Figure 2.** A three-field Plot (Sankey diagram) of Country, Keyword, and Year of publication of the cited references for the ten most researched topics.

The co-occurrence map of the most frequently used terms in the abstract of the papers was created to reveal the link between the terms and visualize the main clusters of the terms (Figure 3). This map unearthed and visualized three main clusters, namely, legal, technical, and health clusters.



Figure 3. Co-occurrence map of the key terms in Discussion and Conclusions

#### 4. Discussion and conclusions

The enforcement of the GDPR in organizations has dictated the need to comply with GDPR obligations and requirements. As evident in a recent case where a hospital in Portugal was fined  $\notin$ 400,000 for non-compliance, healthcare organizations in particular have to be GDPR compliant in order to avoid sanctions, as supervisory authorities impose sanctions whenever non-compliance is detected [10]. In this study, we identified hot topics and emerging research fronts of GDPR in healthcare. We used keywords, titles, and abstracts of 155 papers that made up our research sample. Our analysis revealed the main topics, their relevant weight in the extant literature, as well as the dominant university affiliations of the authors studying each topic (Figures 1,2).

Moreover, based on a co-occurrence analysis and its subsequent visualization and interpretation (Figure 3), we identified three clusters as emerging fronts in this stream of research, and the terms included in the clusters as hot topics. Table 1 summarizes these research fronts.

Cluster (Color in Figure 3)	<b>Research Front</b>	Hot Topics
Cluster 1: Legal (Red)	General Implications of GDPR	Personal Data, Legal Aspects, Data Protection, Data Subject, Data Subject Rights, Data Access, Genetic Data, and Context-Specific Applications
Cluster 2: Technical (Green)	Technology Aspects of GDPR	Information Systems, Technology Solutions, Risks, Security, Controls, Timeliness of Data
Cluster 3: Health (Blue)	GDPR in Healthcare Practice	Patient, Patient Consent, Hospital Implementation, Health Data, Data Quality, and Use of Data

Table 1. Research fronts and hot topics in GDPR research

Prior evidence tells us that these dynamic research areas that create the greatest interest among the scientific community tend to be the most promising in terms of generating highly cited research, creating attitudinal change among researchers, challenging existing orthodoxies, anticipating possible paradigm shifts, attracting institutional funding, and enhancing the business value of the outcomes [4].

Researchers interested in data protection in healthcare can use our findings to plan for studies on the identified hot topics by observing the research trends, as well as research gaps in this domain. Likewise, journal editorial boards can benchmark their respective journals against these findings and introduce policies for publishing research on the increasingly important topic of personal health data protection. We believe Figure 2, in particular, reveals several opportunities for proposing special issues on important yet understudied topics, such as implications of GDPR for machine learning, Blockchain applications in healthcare, and ethics of collecting and processing personal health data.

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