



The 3rd International Workshop on Hospital 4.0 (Hospital)
March 22-25, 2022, Porto, Portugal

Interoperability and Security Issues on Multichannel Interaction In Healthcare Services

Ailton Moreira^{a*}, Tiago Guimarães^a, Ricardo Duarte^a, Maria Manuel Salazar^b,
Manuel Santos^a

^aAlgoritmi Research Center, School of Engineering, University of Minho, Azurém Campus, Guimarães, 4800-058, Portugal

^bCentro Hospitalar Universitário do Porto, Porto, 4099-001, Portugal

Abstract

In recent years, there has been a strong adherence to the digitization, integration, and modernization of health services by care providers. This trend has already demonstrated its potential in several aspects of the health services made available to patients through different interaction channels. Although this practice is full of benefits for the different actors involved, it raises many issues related to the interoperability between the channels and the health services available in them, as well as the security and privacy issues of the data that are transmitted during the interactions between patients and health professionals across multiple channels. With this increasing dependence on technology, healthcare organizations need to look for new solutions capable of solving the enumerated problems. This article intends to study these issues and identify possible solutions that the care provider should adopt to overcome any problems that may arise with the integration of multichannel interaction in health services.

© 2022 The Authors. Published by Elsevier B.V.

This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>)

Peer-review under responsibility of the Conference Program Chairs.

Keywords: Interoperability in Healthcare Services; Multichannel Interaction Interoperability; Security in Multichannel Services

1. Introduction

The digitization of healthcare services has been bringing countless benefits to the sector, but despite the benefits of the digital transformation in healthcare, there are some risks associated with this adoption. We are currently witnessing a rapid and growing adoption of new information and communication technologies in health services,

* Corresponding author.

E-mail address: ailton.moreira@algoritmi.uminho.pt

especially concerning the services that are provided to patients by health professionals who do not require physical contact between these actors (patient and health professionals).

Multichannel interaction in health services is just one of the areas of digitization of health services, which has shown enormous potential in its adoption for both patients and health professionals and the health organization itself. Despite the numerous potentialities of multichannel interaction in health services, it ended up raising more issues related to security and privacy in multichannel interaction in health services. In a multichannel interaction environment, different interaction channels are made available to patients to interact with health professionals, and this also raises issues related to interoperability between these channels and the reliability of patient clinical data available in the different interaction channels. The interoperability of clinical information and different interaction channels is a very important factor that must be considered in multichannel interaction.

Multichannel interaction in health services is still in a very embryonic stage of adoption, so it is necessary to identify the main interoperability and security challenges that must be explored and overcome to promote achieving the fundamental ethical principles of health professionals as well as social expectations.

2. Background

Multichannel interaction in healthcare services is a practice in which healthcare organizations provide certain medical services to patients through different interaction channels (mobile app, web app, email, social media, letter, phone call, TV, Radio) without the need for constant physical contact between the patient and health professionals (1,2). Although this practice in the health area is in an embryonic stage of adoption, there are already some studies carried out on its impact and benefits for patients, health professionals, and care providers (2,3).

The issue of interoperability in healthcare services is a topic that has long been discussed among the community given the vast heterogeneity of hospital systems that need to interact with each other reliably and securely (4). The multichannel interaction in health services has given more emphasis to the issue of interoperability in health services, as well as in the different interaction channels used by patients to interact with health professionals.

Interoperability is the ability of a system or service to communicate clearly and transparently with other systems or services despite their differences without the need for intervention from an outside entity (user)(5). In a very simple and generic way, interoperability is seen as the ability of an independent system to interact with each other and work together to achieve a common goal. In the healthcare area, the issue of interoperability has been increasingly pertinent. In healthcare, interoperability is primarily focused on connecting, integrating different legacy systems and their data to be shared in different environments and distributed to all healthcare professionals wherever and whenever needed (5,6).

To facilitate the process of integration and interoperability between different hospital information systems, a group of researchers from the University of Minho (UM), in partnership with health professionals from the *Centro Hospitalar Universitário do Porto* (CHUP), developed, and proposed a system architecture to create interoperability between the different Hospital Information Systems (HIS) based on intelligent and interoperable agents. Agency for Integration, Dissemination, and Archive (AIDA) is a platform developed to allow the dissemination and integration of information generated in a healthcare environment, including information on Complementary Means of Diagnosis and Therapy (MCDT) (4,6,7). AIDA is characterized by electronic applications that provide intelligent workers, conceived as software agents and with a proactive behavior. They are responsible for tasks such as communicating between different systems; sending and receiving information (e.g., clinical, or medical reports, images, data collection, prescriptions); information management; and responses to requests in a correct and timely manner (4,5,7).

3. Privacy and Security Concerns

Although the advantages of multichannel interaction in healthcare services are numerous, the benefits of this practice must be evaluated and balanced with concerns related to the privacy and security of patients' clinical data. As this data is transmitted over the internet, this adds a risk of compromising data integrity and the consequent security and privacy of patients (8). The channels with bidirectional interaction represent a potential issue, without proper monitoring they can be very easily used to access the network and represent an immense target for attack (9).

Due to the heterogenous channels that patients may use to interact with health professionals, care provider must adopt policies to monitor the use of these channels, log when they were used to access or extract data. The increase in integration of HIS with different channels of interaction increase the healthcare systems vulnerability. This vulnerability is not just from malicious users, but from other threats such as ransomware, malware, spyware and the computer virus (10).

Care Providers must adopt security measures to control access to patient's clinical data in multichannel interaction to ensure that unauthorized users have access to that data. Some of the most common issues related to security breaches in multichannel interaction in healthcare services are (8,11):

- Lack of proper authentication mechanism
- Poor definition access control
- Use of poor encryption algorithms
- Lack of data encryption

These security breaches can lead to unauthorized users having access to patient's clinical data. Lately, there has been much news of security flaws that are discovered and exploited by malicious users who seek to gain access to third-party data through cyberattacks on servers and the consequent disclosure of data gathered online or redemption requests for this data upon payment of large amounts in cryptocurrencies (12–14). In health services, such an occurrence would have a huge impact on the credibility of the care provider, as well as on the services it provides to patients (15). The care provider must always adopt the best practices when providing health services in the different interaction channels to avoid such situations. According to some authors, these are some of the security measures that can prevent such scenarios in multichannel interaction in health services (8,10,16):

- Virtual Privacy Network
- Create Log of Access Control
- Mobile Device, Application, Information Management
- Channel Management
- Data Encryption

In healthcare, privacy is seen as the ability to keep clinical data safe from unauthorized access. This can be achieved by enforcing privacy policies and regulations. Privacy means that only authorized users can access the patient's clinical data and under what circumstances and under what circumstances this data can be accessed, used, and shared with third parties. HIPAA and GDPR manage the regulations on the privacy of clinical data in healthcare (8).

The privacy policies and regulations set by HIPAA and GDPR help the care provider adopt privacy measures that comply with these policies and regulations(17–19). But these measures alone are not enough to guarantee security and privacy in multichannel interactions in healthcare services. In addition to these measures, the care provider must define a set of strategies to be adopted in the multichannel interaction.

4. Interoperability Issue

The variety of interaction channels further emphasizes the issue of interoperability in healthcare services. The care provider must create and adopt interoperability mechanisms to create harmony in the interaction between healthcare professionals and patients through various interaction channels. The care provider needs to adopt interoperability in terms of data, processes, and interaction channels. Data interoperability is related to the correct interpretation and understanding of information exchanged between health systems. Process interoperability ensures continuous communication between different healthcare systems, developing a shared understanding of their process artifacts (20,21). The interoperability of channels in turn ensures communication between the different interaction channels, to present an integrated view of the data processed in the different channels.

The lack of interoperability in multichannel interaction poses a major risk for services that are made available to patients through multichannel interaction environment. Implementing interoperability in different interaction channels is not an easy task due to the complexity and differences between the interaction channels, as well as due to the complexity of HIS. There are several challenges inherent to the issue of interoperability in multichannel interaction in health services, which include technical issues, socio-political and legal issues. Allowing the exchange of clinical information through different interaction channels has implications for clinical and administrative processes, as well as for privacy and confidentiality (21).

AIDA is a system composed of intelligent agents that intends to solve some of the interoperability problems in healthcare, through its intelligent agents. Given the characteristics of AIDA, it intends to solve the problem of interoperability in different HIS, creating an integration layer between these systems and enabling communication and interaction between these hospital systems for the benefit of all stakeholders (5,6). In the model proposed for multichannel interaction in health services (1,2), AIDA ends up playing a crucial role in the integration of data and processes that integrate the proposed model.

Creating an interoperable environment that can be integrated into the different HIS is essential in multichannel interaction services, as this is the only way in which clinical data is transmitted between the different HIS (7) and interaction channels between healthcare professionals and patients. AIDA has the role of processing and managing all the data that is transmitted in the different interaction channels. The adoption of the AIDA platform for the proposed model came to solve one of the interoperability problems in multichannel interaction services in health services.

5. Future Approach

Throughout the literature review presented, some concerns and problems with focus in the health area are explored. When trying to innovate or improve the processes present in the area, some concerns arise that need to be resolved, like, concerns about interoperability between systems, security, and privacy of both patient data and other clinical or administrative data. For a vital area, such as healthcare, being able to guarantee data security while respecting patients' privacy will lead to a more sustainable and true practice.

In this sense, the implementation of 'blockchain' technology emerges as an innovative approach, capable of solving these issues. This implementation provides numerous benefits to the area, managing to improve access control, interoperability between systems, and data provenance and integrity. It's his distributed nature, transparent information structure and immutable records maintained and stored for all users present on the 'blockchain' help ensure data security, integrity, and privacy. With the listed attributes, it becomes possible to attribute the responsibility for improper queries to private or confidential patient data and, due to its immutability characteristic, the data cannot be tampered with or corrupted. In this context, it becomes an adequate solution with the potential to guarantee the security and privacy of data and information as sensitive and critical as those present in the health area.

6. Conclusions

Multichannel interaction in health services has enormous potential to revolutionize the way different users interact with each other, but on the other hand, it has brought to light some issues that are relevant and crucial in health services. This article highlights some of these issues, namely the issue of interoperability and security. In healthcare, there are regulations that health entities must strictly comply with concerning the privacy and security of patients' clinical data. If health entities fail to comply with these rules, they can be severally penalized. In multichannel interaction approach, these are some of many other's problems that it must be considered, and it should guarantee the security and protection of patient data in interactions between patients and health professionals. Interoperability between different legacy systems and new systems is also one of the major challenges that it must be overcome to successfully implement multichannel interaction in health services. In this regard, the AIDA platform already offers a certain level of interoperability between the different HIS used in hospitals.

Furthermore, in this article, it's intended to raise some of the relevant security issues concerning multichannel interaction and the potential risks that are associated with these issues as well as the proposed possibility of using new technologies to investigate the issues raised here. In this way, Blockchain technology appears. It is a technology that is constantly evolving, has contributions in the most diverse areas, and existing documentation continues to grow. Due to the support for smart contracts created in general-purpose programming languages, the learning curve for the integration or implementation of a solution of this nature is reduced, when compared to other existing solutions. So, its implementation becomes an asset for the health area, to solve some existing problems.

Acknowledgements

The work has been supported by FCT – Fundação para a Ciência e Tecnologia within the R&D Units Project Scope: UIDB/00319/2020.

References

- [1] Moreira A, Guimarães T, Santos MF. A Conceptual Model for Multichannel Interaction in Healthcare Services. *Procedia Comput Sci.* 1 de Janeiro de 2020;177:534–9.
- [2] Moreira A, Santos MF. Multichannel Interaction for Healthcare Intelligent Decision Support. *Procedia Comput Sci.* 1 de Janeiro de 2020;170:1053–8.
- [3] Moreira A, Miranda R, Santos MF. Health Professional's Decision-Making Based on Multichannel Interaction Services. *Procedia Comput Sci.* 1 de Janeiro de 2021;184:899–904.
- [4] Neto C, Ferreira D, Abelha A, Machado J. Improving Healthcare Delivery with New Interactive Visualization Methods.
- [5] Cardoso L, Marins F, Portela F, Abelha A, Machado J. Healthcare Interoperability through Intelligent Agent Technology. *Procedia Technol.* 1 de Janeiro de 2014;16:1334–41.
- [6] Cardoso L, Marins F, Portela F, Santos M, Machado J. Interoperability in Health Care.
- [7] Marins F, Cardoso L, Portela F, Santos MF, Abelha A, Machado J. Improving High Availability and Reliability of Health Interoperability Systems. *Adv Intell Syst Comput [Internet].* 2014 [citado 31 de Agosto de 2021];276 VOLUME:207–16. Disponível em: https://link.springer.com/chapter/10.1007/978-3-319-05948-8_20
- [8] Meingast M, Roosta T, Sastry S. Security and privacy issues with health care information technology. Em: *Annual International Conference of the IEEE Engineering in Medicine and Biology - Proceedings.* 2006. p. 5453–8.
- [9] Neslin SA, Shankar V. Key Issues in Multichannel Customer Management: Current Knowledge and Future Directions. *J Interact Mark.* 1 de Fevereiro de 2009;23(1):70–81.
- [10] Hathaliya JJ, Tanwar S. An exhaustive survey on security and privacy issues in Healthcare 4.0 [Internet]. Vol. 153, *Computer Communications.* 2020 [citado 17 de Agosto de 2021]. p. 311–35. Disponível em: https://www.sciencedirect.com/science/article/pii/S0140366419311880?casa_token=iHB6TX37VfWAAAAA:E8uqCo2eQnvJvRWVkJJpdQeuOvCb3UQ4qqaN8v4mOmsqAFvFhWylsdB3zZUmYuDXQ7jVG1du4nGf
- [11] Keshta I, Odeh A. Security and privacy of electronic health records: Concerns and challenges [Internet]. Vol. 22, *Egyptian Informatics Journal.* 2021 [citado 17 de Agosto de 2021]. p. 177–83. Disponível em: <https://www.sciencedirect.com/science/article/pii/S1110866520301365>
- [12] Waldman A. 10 of the biggest cyber attacks of 2020. *electronic article [Internet].* 2021 [citado 2 de Setembro de 2021];1–7. Disponível

- a. em: <https://searchsecurity.techtarget.com/feature/The-biggest-ransomware-attacks-this-year>
- [13] Debolina B. 5 Ransomware Attacks of 2021 That Blew The Internet. Analytics India Magazine [Internet]. 2021 [citado 2 de Setembro de 2021]; Disponível em: <https://analyticsindiamag.com/5-ransomware-attacks-of-2021-that-blew-the-internet/>
- [14] Ransomware: ataques de hackers com pedidos de resgate a empresas crescem no país | [Internet]. Seu Dinheiro. 2021 [citado 2 de Setembro de 2021]. Disponível em: <https://www.seudinheiro.com/2021/empresas/ransomware-ataques-de-hackers-com-pedidos-de-resgate-a-empresas-crescem-no-pais/>
- [15] Scroxton A. Irish health service hit by major ransomware attack [Internet]. Computer Weekly. 2021 [citado 2 de Setembro de 2021]. Disponível em: https://www.computerweekly.com/news/252500777/Irish-health-service-hit-by-major-ransomware-attack?_ga=2.236212164.438580409.1630579618-1372767352.1630579618&_gl=1*15ik39b*_ga*MTM3Mjc2NzM1Mi4xNjMwNTc5NjE4*_ga_TQKE4GS5P9*MTYzMDU3OTYxNy4xLjAuMTYzMDU3OTYxNy4w
- [16] Chacko A, Hayajneh T. Security and Privacy Issues with IoT in Healthcare. EAI Endorsed Trans Pervasive Heal Technol. 2018;4(14).
- [17] Murphy JFA. The General Data Protection Regulation (GDPR). Ir Med J. 1 de Maio de 2018;111(5):747.
- [18] Cohen IG, Mello MM. HIPAA and Protecting Health Information in the 21st Century. JAMA [Internet]. 17 de Julho de 2018 [citado 2 de Setembro de 2021];320(3):231–2. Disponível em: <https://jamanetwork.com/journals/jama/fullarticle/2682916>
- [19] Benitez K, Malin B. Evaluating re-identification risks with respect to the HIPAA privacy rule. J Am Med Informatics Assoc [Internet]. 1 de Março de 2010 [citado 2 de Setembro de 2021];17(2):169–77. Disponível em: <https://academic.oup.com/jamia/article/17/2/169/809345>
- [20] Ali Khan W, Hussain M, Latif K, Afzal M, Ahmad F, Lee S, et al. Process interoperability in healthcare systems with dynamic semantic web services. 2013;95:837–62.
- [21] Weber-Jahnke J, Peyton L, Topaloglou T. EHealth system interoperability [Internet]. Vol. 14, Information Systems Frontiers. 2012 [citado 25 de Agosto de 2021]. p. 1–3. Disponível em: <http://www.som.buffalo.edu/isinterface/ISFrontiers/>