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CONSTRUCTION OF THE IMMUNIZATION COMPONENT OF THE BRAZILIAN IPS - (INTERNATIONAL PATIENT SUMMARY): MAPPING OF LOCAL VACCINES TERMINOLOGIES TO SNOMED-IPS

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Corresponding Author:	Fabiane Raquel Motter, PhD Syrian-Lebanese Hospital BRAZIL
First Author:	Beatriz de Faria Leao, PhD
Order of Authors:	Beatriz de Faria Leao, PhD
	Monalisa de Assis Molla
	Italo Macedo do Amaral Costa
	Joice Machado
	Aline Rodrigues Zamarro
	Fabiane Raquel Motter, PhD
	Gabriel Gausmann Oliveira
	Sabrina Dalbosco Gadenz, PhD
	Karla L de A Calvette Costa
	Elivan Silva Souza
	Blanda Helena de Mello
	Gabriella Nunes Neves
	Robson Matos
	Paula Xavier dos Santos
Abstract:	<p>The International Patient Summary (IPS) is an electronic health record extract that contains sections with essential health information for continuity of care. IPS is intended to be used in unscheduled and cross-border care settings. It can also be used nationally as the main continuity of care record. This study describes the mapping of the Brazilian immunobiological registry list to the SNOMED IPS terminology for completing the Immunization Section of IPS. Methods: The Brazilian immunobiological registry list, as well as SNOMED IPS were uploaded to an open-source terminology server (Open Concept Lab-OCL). The ISO TR-12300 - Health informatics — Principles of mapping between terminological systems (2) standard was followed by creating mapping tables in Excel that express the direction, cardinality, and degree of equivalence of the mapping. Results: Before carrying out the mappings, it was observed that from the 103 terms in the Brazilian dictionary, four were duplicates and 12 were vaccine diluents that could be mapped to SNOMED GPS. In 40% of the mappings, the Brazilian term was more specific than the SNOMED IPS concept. In 23% of the cases the mapping was not possible either because the term was not on IPS refset (11 terms) or not even on SNOMED-CT Core (10 terms), mostly for antivenoms. Conclusion: SNOMED-CT by providing the IPS refset is allowing for the sharing of relevant clinical information necessary for the continuity of care. It is, however, mandatory that the terms already identified by the international community of implementers of IPS that are not present today in the IPS refset, but only in SNOMED CT core are made available on the IPS. Also, terms that are not on SNOMED Core should be added and also made available to the IPS refset. For countries that do not</p>

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Suggested Reviewers:	Heimar de Fatima Marin heimarfm@gmail.com
	Marco Antonio Guitierrez marco.gutierrez@incor.usp.br

CONSTRUCTION OF THE IMMUNIZATION COMPONENT OF THE BRAZILIAN IPS - (INTERNATIONAL PATIENT SUMMARY): MAPPING OF LOCAL VACCINE TERMINOLOGIES TO SNOMED-IPS

Beatriz de Faria Leao¹ (beatriz.leao@hsl.org.br)
Monalisa de Assis Molla¹ (monalisa.aassis@hsl.org.br)
Italo Macedo¹ (italo.costa@slserv.com.br)
Joice Machado¹ (joyce.machado@lsti.com.br)
Aline Rodrigues Zamarro¹ (aline.zamarro@hsl.org.br)
Gabriel Gausmann Oliveira¹ (gabriel.gaoliveira@hsl.org.br)
Fabiane Raquel Motter¹ (Fabiane.motter@hsl.org.br)
Sabrina Dalbosco Gadenz¹ (sabrina.dgadenz@hsl.org.br)
Karla L de A Calvette Costa² (karla.calvette@saude.gov.br)
Elivan Silva Souza³ (elivan.silva@saude.gov.br)
Blanda Helena de Mello³ (blanda.mello@saude.gov.br)
Gabriella Nunes Neves³ (gabriella.neves@saude.gov.br)
Robson Matos³ (robson.matos@saude.gov.br)
Paula Xavier dos Santos³ (paula.xavier@saude.gov.br)

¹ Digital Portfolio, Diretoria de Compromisso Social, Hospital Sirio-Libanês, São Paulo SP, Brazil

² National Immunization Program, MOH Brazil, Brasilia DF, Brazil

³ Innovation and Health Informatics Coordination, Digital Health Secretary, MOH Brazil, Brasilia DF, Brazil

* *Corresponding author*

Fabiane Raquel Motter

Fabiane.motter@hsl.org.br; fabianemotter@gmail.com

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ABSTRACT

The International Patient Summary (IPS) is an electronic health record extract that contains sections with essential health information for continuity of care. IPS is intended to be used in unscheduled and cross-border care settings. It can also be used nationally as the main continuity of care record. This study describes the mapping of the Brazilian immunobiological registry list to the SNOMED IPS terminology for completing the Immunization Section of IPS. **Methods:** The Brazilian immunobiological registry list, as well as SNOMED IPS were uploaded to an open-source terminology server (Open Concept Lab-OCL). The ISO TR-12300 - Health informatics — Principles of mapping between terminological systems (2) standard was followed by creating mapping tables in Excel that express the direction, cardinality, and degree of equivalence of the mapping. **Results:** Before carrying out the mappings, it was observed that from the 103 terms in the Brazilian dictionary, four were duplicates and 12 were vaccine diluents that could be mapped to SNOMED GPS. In 40% of the mappings, the Brazilian term was more specific than the SNOMED IPS concept. In 23% of the cases the mapping was not possible either because the term was not on IPS refset (11 terms) or not even on SNOMED-CT Core (10 terms), mostly for antivenoms. **Conclusion:** SNOMED-CT by providing the IPS refset is allowing for the sharing of relevant clinical information necessary for the continuity of care. It is, however, mandatory that the terms already identified by the international community of implementers of IPS that are not present today in the IPS refset, but only in SNOMED CT core are made available on the IPS. Also, terms that are not on SNOMED Core should be added and also made available to the IPS refset. For countries that do not have a SNOMED subscription as Brazil, this imposes an additional challenge.

1. INTRODUCTION

Interoperability is one of the pillars of digital transformation in healthcare systems. The use of international standards and terminologies can make electronic health records interoperable, enabling the reliable communication of medical information and enhancing the quality of patient care [1]. The International Patient Summary (IPS) is an electronic health record that contains essential health information intended for use in unscheduled and cross-border care settings to ensure that patient data travels with them everywhere, thereby ensuring continuity of care. It enables the reliable communication of medical information using international standards and terminologies. Thus, the IPS can be electronically accessed during planned and unplanned care transitions and has the potential to improve the healthcare quality, promote patient safety, and result in cost savings by avoiding readmissions and emergency appointments, reducing unnecessary laboratory and imaging tests, and preventing adverse drug reactions[2].

Terminological standardization is a fundamental process to enable the sharing of health information in IPS since the mapping between local terms to SNOMED IPS guarantees the most desired semantic interoperability. To ensure the semantic interoperability of information collected by different countries, the largest and most widely used clinical terminology available SNOMED-CT offers a subset of about 30,000 concepts free to use for the community of developers of the IPS standard: SNOMED-CT IPS [3] .

Brazil has implemented a National Immunization Program in 1975 to coordinate the vaccination activities carried out routinely in the public network and became a fundamental part of the Unified Health System (SUS), established by the 1988 Constitution. The program defines the demands for immunobiological preparations

considering compliance with the National Vaccination Calendar. Brazil has experience in experience in producing vaccines by two organizations: PNI was launched in 1975 to coordinate the vaccination activities carried out routinely in the public network and became a fundamental part of the Unified Health System (SUS), established by the 1988 Constitution. The program defines the demands for immunobiologics considering compliance with the National Vaccination Calendar[4]. Brazil has also a long tradition in producing its own immunobiologics. Since 1901, Institute Butanta in São Paulo besides antitoxic and antivenom serums also produces influenza vaccines (influenza vaccine – fragmented and inactivated); DTP (diphtheria, tetanus, and pertussis vaccine adsorbed); hepatitis B (adsorbed hepatitis B vaccine – recombinant); rabies in Vero cell culture (rabies vaccine – inactivated) and more recently the Sinovac-CoronaVac COVID-19 vaccine [5]. Institute Bio-Manguinhos in Rio de Janeiro produces yellow fever, 10-valent pneumococcal, inactivated polio, oral polio, rotavirus, triple viral (measles, mumps, and rubella), and tetravalent viral (measles, mumps, rubella and chickenpox) and AstraZeneca COVID-19 vaccines. It is not uncommon that Brazil sends its antivenoms for other countries in LAC whenever needed [6, 7].

Brazil has a national eHealth Strategy published in 2020[8]. The National Health Data Network (RNDS) is the national platform for connecting all health actors. RNDS is the national platform for innovation and health services. (<https://rndsguia.prod.saude.gov.br>) RNDS Repository actual figures (Sept/23): 1.4 billion vaccine registries, 71 million results of COVID19 lab tests and > 120 thousand outpatient encounters (just started its sending to RNDS).

This study describes the mapping from the Brazilian immunobiologics list to SNOMED IPS.

2. METHODS

The Department of Immunization and Vaccine-preventable Diseases from the Secretary of Environmental and Health Surveillance of the Brazilian MOH is responsible for the coordination of National Immunization Program (NIP). There are 103 vaccines listed in the NIP. This list was obtained from the Simplifier page of the Brazilian RNDS program: <https://simplifier.net/redenacionaldedadosemsaude/imunobiologico>. The list was downloaded and converted to the CVS format and imported to the terminology server.

The SNOMED IPS terminology was downloaded from the SNOMED site - <https://www.snomed.org/international-patient-summary-terminology>. The IPS version download is based on SNOMED-CT July 2022 International Release.

The terminology server used to upload the Brazilian Vaccine List and SNOMED IPS as CodeSystems, according to the FHIR standard, was OCL-Open Concept Lab Software, an open-source community-based developed terminology server. OCL software is distributed under the terms of the Mozilla Public License, v. 2.0 [9].

The mapping from the Brazilian list of vaccines to SNOMED IPS was done in two phases. In the first phase, one physician and one pharmacist from the Hospital Sírio Libanes IPS team, both with more than 5 years of experience working with health terminologies, mapped the Brazilian list of 103 vaccines to SNOMED IPS terminology. The mapping process was initially done in an Excel spreadsheet depicting the direction (from the Brazilian list to SNOMED IPS), cardinality, degree of equivalence of the mapping following the ISO-12300 - Health informatics — Principles of Mapping Between Terminological Systems: (1) Equivalence of meaning; lexical as well as conceptual; (2) Equivalence of meaning, but with synonymy; (3) Source concept is broader, and has a

less specific meaning than the target concept/term; (4) Source concept is narrower, and has a more specific meaning than the target concept/term and (5) 5 No map is possible. No concept was found in the target with some degree of equivalence (as measured by any of the other 4 ratings). Whenever the mapping to SNOMED IPS was not possible a search on SNOMED-CT Core was done. The result of whether the mapping was found on SNOMED-CT core or not was noted in the spreadsheet.

The second phase consisted of the validation of the mapping by one expert from the Department of Immunization and Vaccine-preventable Diseases from the Secretary of Environmental and Health Surveillance of the Brazilian MOH and one pharmacist from the Innovation and Health Informatics Coordination, Digital Health Secretary, MOH Brazil, Brasilia DF, Brazil. Finally, the validated and revised results from the spreadsheet were exported to CSV and bulk-imported to OCL.

3. RESULTS

The Brazilian vaccines list has 103 terms. Before carrying out the mappings, it was observed that from the 103 terms, one was duplicated and 12 were vaccine diluents that could be mapped to SNOMED IPS: 74626007-Drug Diluent with an equivalence of 4, meaning that the Brazilian terms were more specific since they specified the diluent for each vaccine. From the remaining 90 terms left, 11 terms were not present in SNOMED IPS but could be found on SNOMED CT Core. Table 1 depicts these concepts, with the Portuguese translation to English of the Brazilian term, the SNOMED CT Core mapping, and their respective equivalence scales. Ten terms could not be found in SNOMED CT Core, most of them antivenoms, as depicted in Table 2.

In total, 69 terms were mapped to SNOMED IPS terms. Table 3 depicts these totals and shows the mapping scale of equivalence. 42% of the terms could be mapped preserving

the semantics (equivalence 1 or 2); In 34% of the mappings the Brazilian term was more specific than the SNOMED IPS concept (equivalence 4), since the local term included in most COVID-19 vaccines the manufacturer name.

4. DISCUSSION

Using SNOMED IPS we were able to map 77% of the Brazilian Immunobiologics list to SNOMED IPS in order to develop the immunization section of Brasil-IPS. Brazil has one of the most successful vaccination programs in the world and certainly one of the largest immunization registries – today with more than 1.4 billions records and growing since we are now vaccinating for COVID boosters and influenza. The data was sent to the RNDS automatically from the provider administering the vaccines Citizens can verify their immunization records via a mobile application a few days after the vaccines administration.

By having a patient summary in the international standard we will be able to provide for Brazilian citizens the capability to share their relevant health data no matter where they will be in the country or abroad. SNOMED-CT by providing the IPS refset is allowing for the sharing of relevant clinical information necessary for the continuity of care. It is, however, mandatory that the terms already identified by the international community of implementers of IPS that are not present today in the IPS refset, but only in SNOMED CT core are made available on the IPS subset. In addition to that, terms that are used in specific contexts in countries and cannot be found in SNOMED today should also be included. If SNOMED intends to be the international language for clinical interoperability it is necessary to accommodate these needs. The 10 terms that are missing from SNOMED CT Core are mostly antivenoms fabricated in Brazil and very important from the public health perspective. Snake bites have been recognized by WHO as a major public health

problem: there are 81 000 –138 000 000 global deaths due to snakebite, annually according to WHO. Most deaths occur in South Asia and Africa. In 2017, the WHO added snakebite to its list of neglected tropical diseases (NTD). Therefore, it is important that SNOMED CT acknowledges that this is a public health issue and SNOMED CT and now IPS should have concepts for these antivenoms, no matter where they are fabricated[10]. This study focuses on mapping Brazilian immunobiologics registry codes to International Patient Summary SNOMED. This scope may limit the generalizability of the findings to other healthcare terminologies and systems used in different countries. Even with successful mapping, achieving true interoperability in healthcare systems involves addressing technical, organizational, and policy challenges, which are not discussed in this study. In addition, integrating Snomed CT into existing healthcare systems can be time-consuming and may require significant changes to electronic health records (EHRs) and other health information systems.

Although the IPS implementation is costly, there is increasing evidence that the benefits of exchanging and sharing patient data outweigh the costs. This exchange has the potential to diminish redundant healthcare services and expenditures, while simultaneously enhancing patient outcomes [11].

Therefore, as advancements continue to be made toward standardizing terminologies, it is critical that healthcare organizations and regulators work together to overcome these challenges and ensure the success of the International Patient Summary implementations worldwide.

AUTHORS' CONTRIBUTIONS

BFL, SDG and PXS participated in the conception and design of the study. BFL, MAM, IM, JM, ARZ and GGO contributed to acquisition of data, analysis and interpretation of

data. FRM, SDG, KLAC, ESS, BHM, GNN RM and PXS revised the article critically. All authors participated in the preparation of the manuscript and agreed to the submitted version of the paper.

STATEMENT ON CONFLICTS OF INTEREST

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

SUMMARY TABLE

What was already known on the topic?

- The use of international standards and terminologies can make electronic health records interoperable, enabling the reliable communication of medical information and enhancing the quality of patient care
- Terminological standardization is a fundamental process to enable the sharing of health information in IPS since the mapping between local terms to SNOMED IPS guarantees the most desired semantic interoperability.

What this study added to our knowledge?

- Using SNOMED IPS we were able to map 77% of the Brazilian Immunobiologics list to SNOMED IPS in order to develop the immunization section of Brasil-IPS.
- Terms that are used in specific contexts in countries and cannot be found in SNOMED today should also be included.

REFERENCES

- [1] M. Lehne, J. Sass, A. Essenwanger, J. Schepers, S. Thun, Why digital medicine depends on interoperability, NPJ Digit Med, 2 (2019) 79. <https://doi.org/10.1038/s41746-019-0158-1>
- [2] S. Kay, G. Cangioli, M. Nusbaum, The International Patient Summary Standard and the Extensibility Requirement, Stud Health Technol Inform, 273 (2020) 54-62. <https://doi.org/10.3233/SHTI200615>
- [3] S. International, The International Patient Summary Terminology, SNOMED CT Document Library, 2022.
- [4] C. Domingues, A.G.K. Maranhao, A.M. Teixeira, F.F.S. Fantinato, R.A.S. Domingues, The Brazilian National Immunization Program: 46 years of achievements and challenges, Cad Saude Publica, 36Suppl 2 (2020) e00222919. <https://doi.org/10.1590/0102-311X00222919>
- [5] R. Isaias, Developing Countries Can Innovate and Produce Vaccines: The Case of Butantan in Brazil, in: K. Vijay (Ed.) Vaccines, IntechOpen, Rijeka, 2019, pp. Ch. 2.
- [6] E. Ortiz-Prado, N. Kyriakidis, A. López-Cortés, J. Vásconez, Vaccine market and production capabilities in the Americas, Tropical Diseases Travel Medicine and Vaccines, 7 (2021). <https://doi.org/10.1186/s40794-021-00135-5>
- [7] R. Guimarães, Anti-Covid vaccines: a look from the Collective Health, Cien Saude Colet, 25 (2020) 3579-3585. <https://doi.org/10.1590/1413-81232020259.24542020>
- [8] M.o. Health, Brazilian National Digital Health Strategy 2020-2028, in: E.S.S.C. Department., B.N.D.H. Strategy (Eds.), Ministry of Health, Brasilia, 2020.
- [9] Open Concept Lab software. <https://openconceptlab.org/>

[10] S. Bhaumik, A.B. Zwi, R. Norton, J. Jagnoor, How and why snakebite became a global health priority: a policy analysis, *BMJ Glob Health*, 8 (2023).

<https://doi.org/10.1136/bmjgh-2023-011923>

[11] P. Poba-Nzaou, S. Uwizeyemungu, M. Dakouo, A. Tchibozo, B. Mboup, Patterns of health information exchange strategies underlying health information technologies capabilities building, *Health Syst (Basingstoke)*, 11 (2022) 211-231.

<https://doi.org/10.1080/20476965.2021.1952113>

Table 1. List of Brazilian Immunobiologics only present on SNOMED CT CORE

Brazilian Immunobiologics List Code	Brazilian Immunobiologics List - translated	SNOMED CT Core concept ID	SNOMED CT Core concept ID	Mapping equivalence
2	tetanus antitoxin	384706007	Product containing tetanus antitoxin (medicinal product)	1
16	anticrotalic serum	777252008	Product containing only polyvalent crotalidae antivenom (medicinal product)oduct containing only polyvalent crotalidae antivenom (medicinal product)	1
18	Rabies vaccine Chicken embryo	871726005	Vaccine product containing only Rabies lyssavirus antigen (medicinal product)	4
19	Anti-varicella human immunoglobulin	710704003	Vaccine Immunoglobulin M antibody to Varicella zoster virus (substance)product containing only Human alphaherpesvirus 3 recombinant surface glycoprotein E antigen (medicinal product)	3
20	Anti-hepatitis B human immunoglobulin	122450004	Antibody to hepatitis B virus (substance)	4
26	Pneumococcal 10-valent conjugate vaccine	1052330009	Vaccine product containing only Streptococcus pneumoniae Danish serotype 1, 4, 5, 6B, 7F, 9V, 14, 18C, 19F, and 23F capsular polysaccharide antigens conjugated (medicinal product)	2
27	Latrodectus antivenom	5720001	Product containing Latrodectus mactans antivenom (medicinal product)	1
36	Measles and rubella vaccine	871817003	Vaccine product containing only Measles morbillivirus and Rubella virus antigens (medicinal product)	2
38	Antibotulinum serum (trivalent)	774893001	Product containing only botulinum antitoxin (medicinal product)	4
69	AB antibotulinum serum (bivalent)	774893001	Product containing only botulinum antitoxin (medicinal product)	4
101	Herpes-Zoster vaccine, recombinant	1156183006	Vaccine product containing only Human alphaherpesvirus 3 recombinant surface glycoprotein E antigen (medicinal product)	1

Table 2. Brazilian Immunobiologics list not present in SNOMED CT Core

Brazilian Immunobiologics List Code	Brazilian Immunobiologics List - translated	Observation
3	arachnid antivenom	774371002- Product containing only Latrodectus mactans antivenom (medicinal product) Obs: This product is just for one type os Spider
4	scorpion antivenom	
6	antielapidic antivenom	Obs: SNOMED CORE has: 303306002 - Elapid venom but not the antivenom
7	anti-rabies serum	
8	(pentavalent) antibothropic serum	
11	(pentavalent) antivenom for Bothrops and Crotalus snake	
12	pentavalent antivenom for antilachetic snakes	
31	trivalent antivenom for Loxosceles spiders	
32	antivenom for Lonomia Obliqua	
100	Variola vaccine	
		Obs - SNOMED CORE has 713631008 - Antigen of Variola virus (substance), but no vaccine.

Table 3. Equivalence degree of the mappings of Brazilian immunobiologics to SNOMED IPS

Mapping Equivalence Degrees	Total	%
1	10	11,11%
2	28	30,77%
3	0	0,00%
4	31	34,07%
5	21	23,08%
Total	90	100,00%

Declaration of interests

☒The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

☐The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

November, 06th 2023.

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Sincerely,

Fabiane Raquel Motter
Corresponding author