Evaluating Online Consumer Medication Information Systems: A Comparative Online Usability Study

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Abstract

Background: Medication is the most common intervention in Health Care and the number of Online Consumer Information Systems (OCMIS) within the pharmaceutical sector are increasing. OCMIS can also prove as a barrier for their users imposing information asymmetry between stakeholders.

Objective: Quantify and compare the usability of OCMIS against a reference implementation based on an interoperable information model for patients, physicians and pharmacists.

Methods: Quantitative and qualitative data were acquired from patients, physicians and pharmacists in this online usability study. We administered three use cases to resolve and a post hoc questionnaire per user. Quantitative usability data like effectiveness (task success), efficiency (task time) and user satisfaction (System Usability Scale) was complemented by qualitative- and demographic data. Users evaluated six existing and one reference implementation of web-based OCMIS.

Results: A total of 137 patients, 81 physicians and 68 pharmacists participated. Task success varied from 84-92% in patients, 66-100% in physicians and 50-91% in pharmacists. Task completion time decreased during the process of the study for all but two OCMIS within the patient group. Due to assumed non-normal distributed SUS-scores, within group comparison was done using the Kruskal-Wallis Test. Patients showed differences in SUS-score (p= .016) and task time (p= .025), and not significant differences for physicians in SUS-score (p= .831) and task time (p= .723).
A significant difference in SUS score (p< .001) and task time (p= .007) for pharmacists was detected.

Conclusions: The vendor neutral reference implementation based on an interoperable information model has proven as a promising approach, not inferior to existing solutions for patients and physicians. For pharmacists it even excels in user satisfaction compared to other OCMIS. This data driven approach based on an interoperable information model, enables the development of more, user tailored views, in order to increase usability. This fosters data democratization and empowers stakeholders within the pharmaceutical sector.

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Introduction

Every health decision is dependent of health information and quality is therefore a key aspect when improving access to health services [1–3]. Medication nonadherence is thereby an important public health consideration, affecting health outcomes and overall healthcare costs [4]. Today more than 60% in Europe, 80% in the US and 85% of the population in low and middle income countries are making use of the internet to search for advice about health, medication or medical conditions, the most frequent activity being searching for medication information [5]. The number of available Online Consumer Medication Information Systems (OCMIS) is increasing. OCMIS gained traction as an information source for patients, prescribers and dispensers in many countries. Nevertheless, OCMIS can also prove as a barrier for users with poor health literacy (HL) [6–8] and information quality may vary [9,10]. Information can sometimes be omitted due to a limited information model, which can generate information asymmetry between stakeholders (e.g. patients, physicians and pharmacists). OCMIS should take preferences, skills, and knowledge of its users into account [11]. Vendor neutral and interoperable data models could mitigate this asymmetry but their interfaces need to prove their fitness for use to its users.

Implementation Research tries to understand how to deliver innovations identifying contextual factors and creating a link between theory and practice in real world settings [12]. This online usability study focused on Chile as an example for an emerging middle-income country in Latin-America [13], where the number of OCMIS increases due to growing digitalization within the pharmaceutical sector [14]. Governmental policies promote a rational use of- and facilitate equal access to medications and related information [15,16], but OCMIS have not been evaluated in this regard.

After evaluating technical aspects and features of OCMIS by a systematic review in a previous study [17] (Appendix 1), this follow-up study seeks to investigate System Usability of existing OCMIS against a self-developed reference implementation of an interoperable information model. The study also considers factors like HL and previous experience of participants.

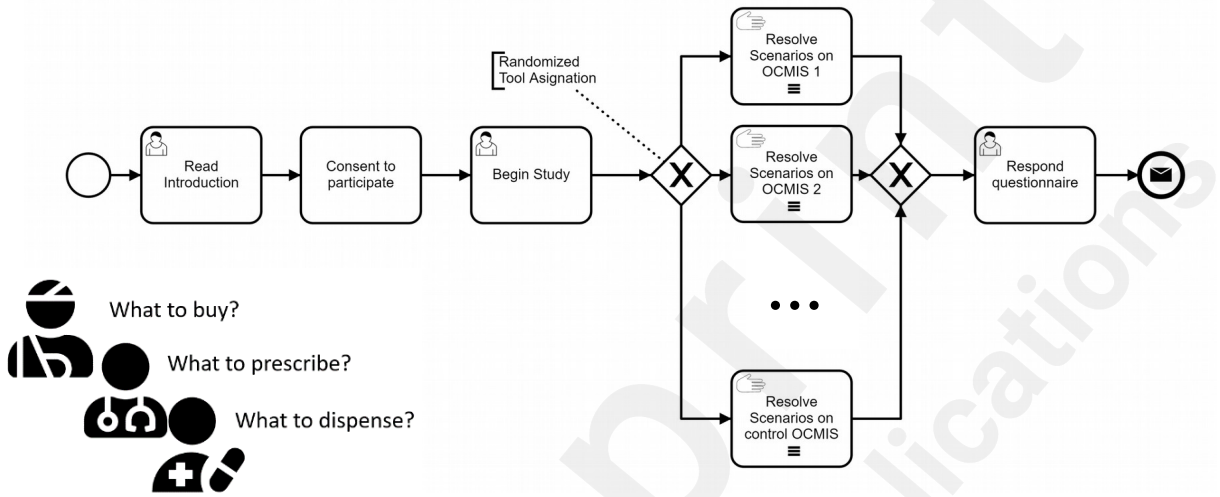
Methods

Study Design

This implementation research study focusses on real world scenarios identifying factors that impact uptake of research findings across multiple levels, including patient, provider, clinic, facility and organizational levels [12]. This study understands OCMIS as socio-technical systems and therefore focusses on the human-computer interaction while including different aforementioned stakeholders.

Two-phased approach to this online usability study was choosen: a pretest-phase and a main-phase. During the pretest-phase, approximately 10% of the expected participants completed the study and provided feedback about clarity and understandability of the study contents to the moderating researchers. Comments about change requests in wording have been recorded and, after a validation with 2 native Spanish speaking representatives from each group, incorporated into the study after discussion [18].

Subsequently, the unmoderated, online-based main-phase was conducted, where participants acted in an in an *in-vivo* setting. After the introduction video (Multimedia Appendix 1), the two-step study process was initiated: first completing three group specific use cases with a randomly assigned OCMIS and secondly completing a questionnaire about the user experience during the study (Figure 1). Contents, like the SUS (Appendix 3) [19] were administered in Spanish, which is the participant's native language. Data about the participants HL [20,21] and OCMIS experience, as well as demographic data, were collected. In addition, quantitative data were collected in parallel during user interaction to evaluate
task success and task completion time.
Figure 1 – A graphical view of the process "Study procedure for the user" is shown in a Business Process Model and Notation (BPMN). After reading the introduction and consent to participate, the



participants are randomly assigned to either the case group, using an Online Consumer Medication Information System (OCMIS 1...n), or the control group, using the reference implementation (Control OCMIS). A post-hoc questionnaire was performed before concluding the study.

Data quality for the study was assured through a token-system embedded in the access to the study material. Pseudonymized tracking of participants, without personal reference, was possible, allowing external users to be recognized. The study was administered to participants via a URL to a self-hosted web page where SurveyJS [22] was used for questionnaire rendering.

Participants of this study had no other incentive than to augment their knowledge about medications and OCMIS. The ethics committee at the Faculty of Medicine of the University of Chile approved this study.

Online Consumer Medication Information Systems

Six web-based OCMIS were identified as relevant in discussion with domain experts from each user group (Figure 2). OCMIS were categorized as online pharmacies (Farmazon [23], Pharol [24]), web presence of a traditional pharmacy (Salcobrand [25]), government driven- (Ministry of Health, MINSAL [26]; Public Health Institute, ISP [27]) and supplier driven (National Health Service System, CENABAST [28]) medication databases. OCMIS were assigned to user groups based on a feature analysis matrix to ensure suitability.
In addition to the aforementioned OCMIS, a reference implementation called TMED [29], based on an interoperable information model *Chilean Pharmaceutical Terminology* [30] (Appendix 2) was part of the test bench for all user groups (Figure 3).

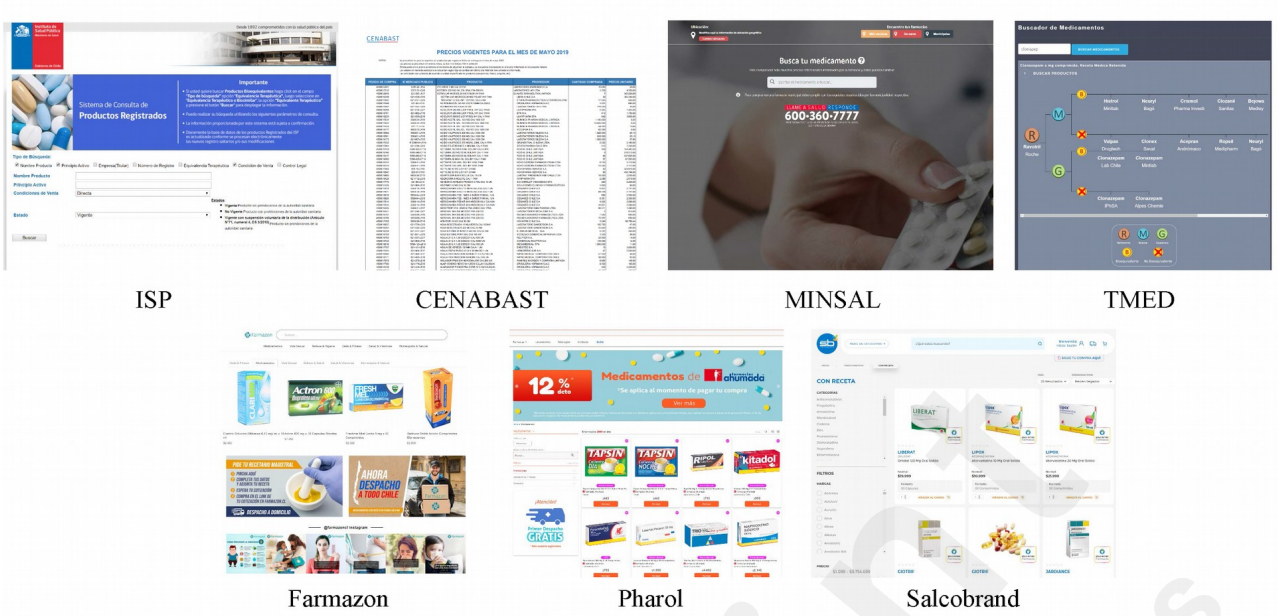


Figure 2 – Screenshots of the OCMIS included in the assessment.

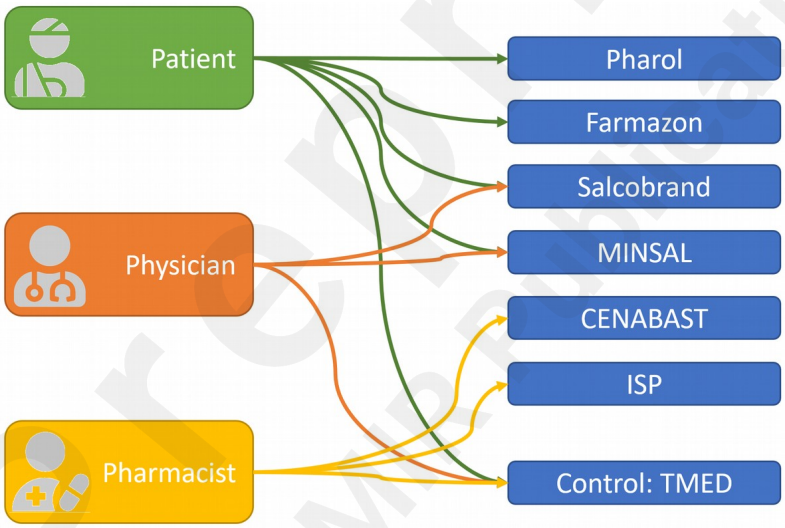


Figure 3 – Graphical representation of user groups patient (green), physician (red) and pharmacist (yellow) and their assigned OCMIS. OCMIS types include Online Pharmacies (Pharol, Farmazon), Pharmacy (Salcobrand), Medication Information Aggregators (MINSAL), Medication Information Platforms (CENABAST, ISP) and a self-developed Platform.

TMED

Terminología de Medicamentos (TMED) is the result of the efforts to create a vendor-neutral, standardized and interoperable knowledge database based on Fast Healthcare Interoperability Resources (FHIR), a standard developed by Health Level 7 (HL7), accommodating the Chilean pharmaceutical sector in its information model, by supporting searching and displaying bioequivalent generic- and brand type medications [17,30,31]. TMED supports identification of suitable medications by quality features and provides the possibility to group medications by principal active substances.

Use Cases

Use cases for user groups were established (Textbox 1) in discussion with domain experts.

Textbox 1 – Typical use cases for user groups of patients, physicians and pharmacists.

- Patient: finding a suitable commercial product for a prescription received from a physician.
- Physician: finding a suitable commercial product to prescribe for a patient based on a principal active substance indicated for a diagnose.
- Pharmacist: finding a suitable product to restock a pharmacy, based on needs for principal active substances issued by physicians.

Relevant medical conditions for a medication search in OCMIS have been selected (Textbox 2) and medications have been verified to be available in the OCMIS during data collection phase.

Textbox 2 – Three user scenarios based on fictional medical conditions.

1. Atypical Pneumonia - with a growing prevalence within the Chilean population [32].
2. Focal Epilepsy - One of the most common neuronal diseases worldwide where 80% of affected individuals live in low- and middle-income countries [33].
3. Hypertension - One of the most common diseases with a prevalence of over 3.6 million people in Chile and 1.3 billion worldwide [34].

During the course of the study, each user received three group specific scenarios in consecutive order, based on the use cases mentioned above. All scenarios are equal in structure, which facilitated learning and familiarization with OCMIS amongst participants.

System Usability

Usability evaluations are critical when designing applications [35]. Approaches from pragmatic- and academic context are relevant when conducting usability studies [36]. ISO 9241-11 considers three dimensions: effectiveness, efficiency and user satisfaction as principal dimensions when designing ergonomic digital information systems [37]. Effectiveness is expressed as task success, efficiency as task completion time and user satisfaction as scoring, e.g. using the System Usability Scale (SUS). These dimensions are subsumed by the term usability.

Task Success

Task success was measured in three discrete levels: complete-, partial- and no success. Results were aggregated dichotomous over all three tasks resolved by the participant by defining anything other than a complete success as not successful. A majority vote then defined if overall success was achieved with at least two tasks completed successfully per user.

Task Completion Time

Task time was measured automatically during the study for each task and user in seconds.

User satisfaction

The System Usability Scale (SUS) was developed to quantify user satisfaction, yielding a score between 0 and 100. This nonproprietary 10-item 5 point Likert-type scaled tool has been extensively validated and translated into different languages [38]. While not being ideal as stand-alone metric, combination with task completion is recommended [39].
The SUS itself contains two principal factors: a usable and learnable factor [40]. OCMIS were rated by each participant using the SUS as a validated measure of learnability and user satisfaction [41].

Sample Size and Internal Consistency

A sample size calculation has been conducted. Literature reports a sample size of 12-14 as sufficient to reliably distinguish user satisfaction between websites [42]. However, a sample size calculation based on a desired margin of error of 12 points in SUS score with a standard deviation of 21 and confidence level of 90% as suggested by the literature [43] and resulted in a minimum sample size of 15 participants per OCMIS. Internal consistency was measured using Cronbach's Alpha. Literature suggests acceptable values between .70-.90 [44,45].

Recruitment and Data Collection

Inclusion and exclusion parameters were defined prior the study: for physicians had to have at least finished their studies (which include two years of practical experience in Chile), pharmacists had to have at least 1 year of professional experience and patients to have bought medication at least once. Participants were contacted via email invitation among special interest groups, e.g. pharmacists: members of the College of Pharmaceutical and Biochemical Chemists of Chile. The data collection phase had a duration of three months.

Statistical Analysis

Group wise statistical tests were conducted comparing platforms in terms of task time, task success and SUS score. If tests were statistically significant, an adjusted pairwise examination was performed to identify the significant different feature. SUS score and task time are compared between OCMIS using the Kruskal-Wallis Test for independent samples to compare means. Task success has been evaluated using chi-squared test in combination with a standardized Z-score residuals post-hoc testing in order to establish a p-value. Pearson´s chi-squared test evaluates how likely it is that any observed difference between the sets arose by chance. Its null hypothesis states the frequency distribution of certain events observed in a sample is consistent with a particular theoretical distribution [46].

Results

Baseline Statistics

Patients (n=136), physicians (n=80) and pharmacists (n=67) have been recruited to participate. The overall response rate was 283 out of 4849 (5.8%) over all participants. (Table 1) provides an overview of study participant demographics. Mean age between groups ranged from 31-38 years. 87 out of 136 (64%) of participants in patients, 36 out 80 (45%) of participants in physicians and 30 out of 68 (45%) pharmacists were female. Self-assessed health-literacy (5-optimal health literacy, 1-4 limited health literacy) of the study population varied between 30-35% for patients and pharmacists and peaked at over 50% within the physician group. 56 of 67 (83%) of pharmacists have used OCMIS before they participated in this study compared to 62 of 80 (77%) amongst physicians and only 80 of 136 (58%) amongst patients.

All participants from all groups reported that they used the Internet on a daily basis, the data collected on Internet use was not included in the overview.

Table 1 – Baseline table of the participants.

			User Group	
		Patient (n=136)	Physician (n=80)	Pharmacist (n=67)
Age				

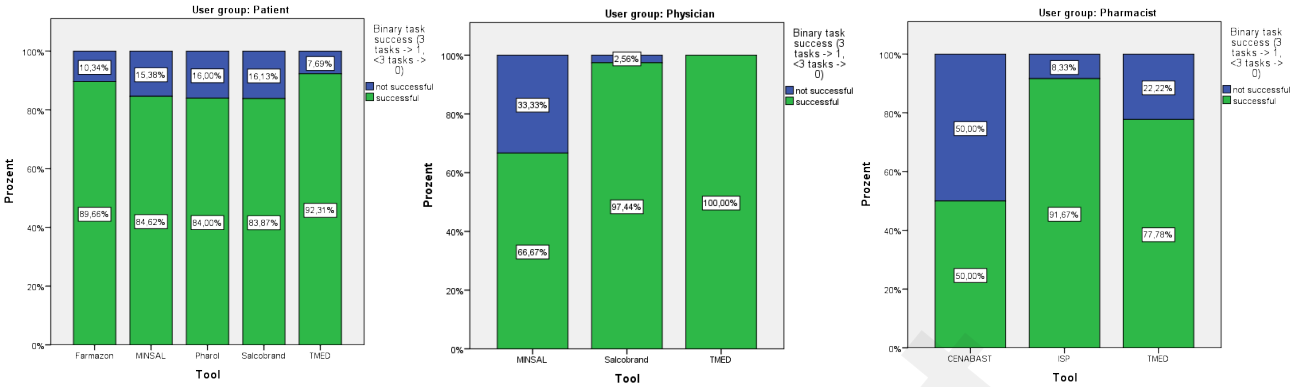
	mean (SD)	38 (11.20)	31 (6.21)	35 (9.24)
Sex				
	female (%)	87 (64%)	36 (45%)	30 (45%)
	male (%)	49 (36%)	44 (55%)	37 (55.2%)
Health Literacy[a]				
	limited (%)	85 (65%)	36 (47%)	45 (68%)
	optimal (%)	46 (35%)	41 (53%)	21 (32%)
Professional experience[b]				
	mean (SD)	-	6.57 (6.62)	8.86 (7.81)
Previous experience with OCMIS?[c]				
	yes (%)	77 (59%)	60 (78%)	55 (83%)
	no (%)	54 (41%)	17 (22%)	11 (17%)
Are generic bioequivalent medications are equal to innovator medications?				
	yes (%)	-	33 (41%)	24 (36%)
	no (%)	-	41 (51%)	30 (46%)
	other (%)	-	6 (8%)	12 (18%)
Observations per OCMIS				
	Farmazon	32	-	-
	Pharol	30	-	-
	Salcobrand	44	39	-
	MINSAL	15	18	-
	CENABAST	-	-	20
	ISP	-	-	28
	TMED	15	23	19

[a] Result of self-assessed health literacy (single item, 1-5 Likert scale): 1-4 = limited, 5 = optimal.
[b] Professional experience in years since graduation from university.
[c] Participant has used an OCMIS at least once in his life before this study.

68 of 80 (85%) physicians reported to consider the health insurance provision when prescribing medications and 57 of 80 (71%) reported to consider the economic situation of the patient. 33 of 80 (41%) physicians believed, that generic bioequivalent medications are equal to innovator products.

45-50% of professionals reject to believe that generic bioequivalent products are equal to their innovator product. Subsequently, only 31 of 67 (47%) pharmacists agreed to replace innovator products with generics without concern. 24 of 67 (37%) disagreed and 12 of 67 (16%) stated some concerns.

Task Success



Patient's success levels were relatively consistent independent of OCMIS, ranging from 84% (Pharol) to 92% (TMED). For physicians and pharmacists things unfolded differently: physicians success was heavily platform dependant, while reaching only a completion rate of 67% on the governmental platform MINSAL while the self-developed platform reached 100% completion. Finally, pharmacists reported 50% success in CENABAST platform, while up to 92% in the ISP platform. TMED performed in the mid field still reaching success in more than 75% of the cases.

Table 2 - Overview of task success, task time and SUS score for all user groups by OCMIS.

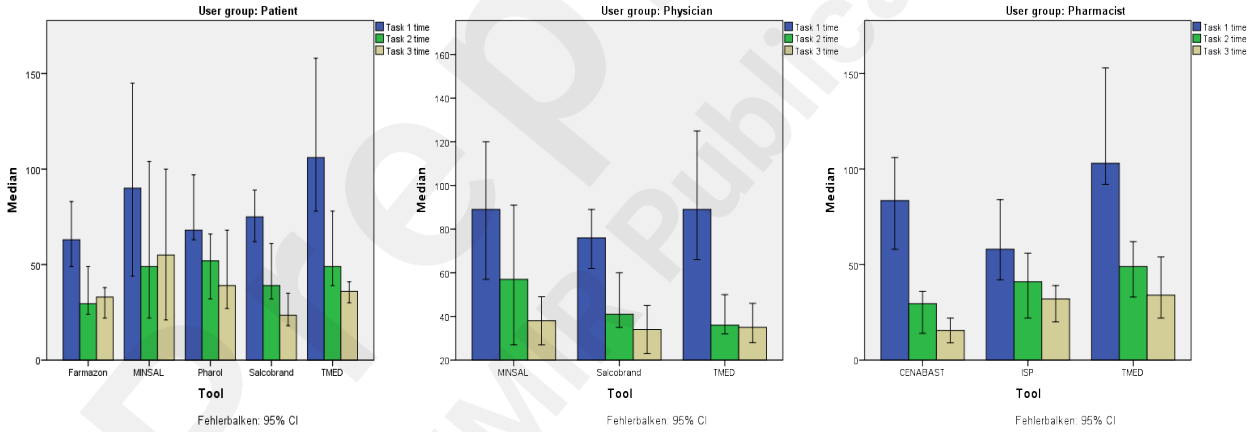
		Online Consumer Medication Information System						
		Farmazon (n_{Pat}=32)	Pharol (n_{Pat}=30)	Salcobrand (n_{Pat}=44, n_{Phy}=39)	MINSAL (n_{Pat}=15, n_{Phy}=18)	CENABAST (n_{Pha}=20)	ISP (n_{Pha}=28)	TMED (n_{Pat}=15, n_{Phy}=23, n_{Pha}=19)
Task Success Rate[a]								
	Patient	89.6%	84.0%	83.8%	84.6%	-	-	92.3%
	Physician	-	-	97.4%	66.7%	-	-	100%
	Pharmacist	-	-	-	-	50.0%	91.7%	77.8%
Median Task Time[b]								
	Patient	50.33 (SD 27.61)	60.67 (SD 50.53)	51.33 (SD 74.03)	63.68 (SD 61.89)	-	-	64.33 (SD 32.65)
	Physician	-	-	50.00 (SD 236.52)	61.00 (SD 478.19)	-	-	56.67 (SD 179.78)
	Pharmacist	-	-	-	-	42.33 (SD 42.55)	47.67 (SD 31.54)	68.00 (SD 33.03)
Mean SUS Score[c]								
	Patient	83.83 (SD 15.18, CI 78,46-	76.38 (SD 19.71, CI 69.13-	66.73 (SD 23.87, CI 59.52-	71.33 (SD 24.72, CI 58.02-	-	-	72.67 (SD 15.36, CI 64.41-81.32)

		89.74)	84.11)	74.39)	85.31)			
	Physician	-	-	79.66 (SD 15.89, CI 74.61-85.22)	77.06 (SD 22.45, CI 65.69-88.78)	-	-	76.85 (SD 17.23, CI 69.66-84.60)
	Pharmacist	-	-	-	-	50.63 (SD 22.24, CI 40.43-61.27)	79.81 (SD 20.68, CI 71.87-88.21)	84.87 (SD 11.62, CI 79.50-90.71)

[a] Percentage of aggregated task success rates.
[b] Median Task Time in seconds and Standard Deviation (SD).
[c] SUS scores take on values between 0 and 100. CI = Confidence Interval (confidence level: .95%).

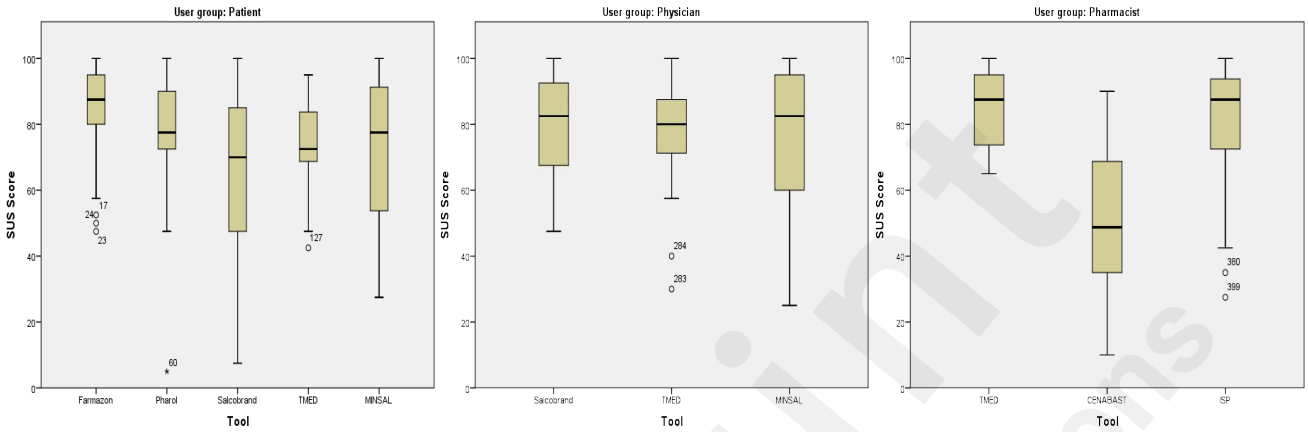
Task Completion Time

Median task completion time for each task in seconds shown in (Figure 5). Due to equal structure in the consecutive tasks, the hypothesis that task times would follow a downwards trend, was overall confirmed, with exceptions for FARMAZON and MINSAL in the patient group, where completion times augmented slightly for the second and third task. In the case of TMED, initial task times are higher but then come close to other OCMIS. On average, physicians took the least time to finish the given tasks. An aggregated comparison can be found in (Table 2).



User Satisfaction

User satisfaction measured by SUS proofed to have a very high overall internal consistency measured by Cronbachs Alpha of .892. With one exception in the patient and pharmacist group, median SUS scores reached above the global average of 68 (Figure 6).



TMED

The mean of the Reference Implementation TMED between groups ranged from 72.5 (SD 15.3) in patients to 80.0 (SD 17.23) in physicians and 84.87 (SD 11.62) in pharmacists. The high SUS score amongst pharmacists could indicate a potential for net promoters of the platform. TMED also scored high for physicians, which could tend towards promoting TMED. Lastly, patients that used TMED were satisfied more than the global average of 73. Scores higher than 68 (SD 12.5) are considered above average when compared to a global database of SUS scores for web-based applications [38]. Transformation of SUS scores to percentiles [43], adjectives and grades [47,48] was performed to facilitate interpretation (Table 3).

Table 3 – Transformed Percentile ranks, adjectives and grades of TMED SUS scores for patients, physicians and pharmacists.

			User group	
		Patient	Physician	Pharmacist
SUS score of TMED				
	mean (SD)	72.67 (SD 15.36)	76.85 (SD 17.23)	84.87 (SD 11.62)
	Percentile	66.9%	88.0%	96,6%
	Adjective	Good	Excellent	Excellent
	Grade (Bangor)	C	B	B
	Grade (Sauro&Lewis)	B-	A-	A+

Statistical Evaluation

The null hypothesis was defined as not exhibiting any differences for any of the given aspects (task time, task success, SUS score) with α= .05. Due to data skewness, normality was not assumed and

subsequently non-parametrical tests were performed.

Patients

For the patient group differences in SUS-score (p= .016) and task time (p= .025) were significant, such that the null hypothesis was rejected. Pairwise SUS-score comparison revealed an adjusted significant difference for Salcobrand and Farmazon (p= .008). For pairwise completion times the two online pharmacies Farmazon and Pharol differed significantly (p= .057). Task success however did not differ significantly from expected values (p= .913).

Physicians

For the physician group differences in SUS-score (p= .083) and task time (p= .723) did not reach significant levels. Due to non-significant results, no consecutive pairwise comparison was conducted. Task success however proofed significant (p< .001) under the chi-squared test. After adjusting (α= .008) within group, MINSAL was identified to deviate significantly (p< .001).

Pharmacists

Pharmacist results indicated a highly significant difference between OCMIS for SUS-scores (p< .001) and task completion times (p= .007). An adjusted pairwise comparison for SUS-scores revealed a significant difference between CENABAST (p< .001) and ISP as well as CENABAST and TMED (p< .001). When focussing on completion time, only CENABAST and TMED expressed significant differences (p= .005). Task Success amongst pharmacists was successfully found significant (p= .008) and after post-hoc adjustment (α= .008), the CENABAST OCMIS was identified as deviant from expected values (p= .004).

Qualitative data

76 of 136 (55%) of patients, 36 of 80 (45%) physicians and 31 of 67 (46%) pharmacists used the opportunity to provide open ended feedback about which features they considered critical in an OCMIS (Textbox 3).

Textbox 3 – User comments on what features are critical for OCMIS.

- Medication price (and price development) should be up-to-date or at least approximated.
- Medication concentrations should be displayed.
- Disambiguation of search terms (e.g. phonetic searches) should be considered.
- Evidence for medications should be shown.
- Personal discounts, for example when being covered by a specific insurer, should be considered in price calculation.
- Adverse effect information should be provided.
- Search flexibility should be increased, e.g. searching for principal active substances or quality parameters.
- Georeferenced information for pharmacies and stock consideration should be included.
- Filters, like dosage or concentration should be implemented.
- Integration to other knowledge databases should be considered.
- Neutrality of the offered information should be a priority.
- Increased amount of information about medications (e.g. about kinetics and posology) should be included.
- Native mobile applications should be preferred.

Discussion

We developed and evaluated an application based on a standardized and semantically interoperable information model to facilitate the access of medication information for different user groups. Three scenarios for all user groups have been created and OCMIS were benchmarked against them, using existing OCMIS for the usability dimensions: task completion, task completion time and user satisfaction.

Principal Findings

For patients, online pharmacies (Farmazon, Pharol) seem to be the most suited application to their tasks due to high SUS score. Task time is significantly lower only for online offerings of traditional pharmacies when comparing to online pharmacies. Regarding task success rates, all platforms seem to be suited for the use case.

Physicians seem to have impairments to fulfill their task when using the MINSAL platform, but not when using online offerings of traditional pharmacies (Salcobrand) or the reference implementation (TMED).

Pharmacist's user satisfaction identified the most usable platforms as both ISP and TMED with no significant difference between them. The public medication supplier (CENABAST) platform performed lower on SUS-scores, while also having reduced task success rates.

The ongoing controversy of whether to prescribe innovator products or use generic, bioequivalent products is reflected within the study population. Generally, physicians are slightly more confident in using generic products than pharmacists.

Strengths and Limitations

The study was evaluated for limitations and they were considered in the final analysis. For the selection of OCMIS a discussion with professional representatives has been conducted, which indicated OCMIS that may not be representative in use by healthcare professionals on a national level. However, more than half of the participants know or have used some of the OCMIS presented in this study, which is an indicator for relevance. Health literacy, which contributes to the perception of OCMIS, was not completely homogeneous amongst participants, which probably reflects reality. Participant recruitment was done using e-mail distribution for special interest groups, which might introduce a bias, due to higher awareness of OCMIS.

Due to the study design of an online usability study, a unique combination of advantages was achieved. No moderation- and social desirability response bias [49] was introduced in this *in-vivo* setting, assuring most natural conditions for the user when evaluating. It facilitated the automated collection of qualitative and quantitative data directly after the experience. In comparison to traditional usability studies, a higher amount of participants was recruited in a shorter time which contributed to the robustness of the results.

Conclusions

The reference implementation (TMED) is a promising approach and a Proof of Concept that using interoperable, vendor neutral information models can empower users in medication decisions. It has proven not inferior in usability aspects to already established OCMIS while offering more flexible search and extension capabilities due to its underlying interoperable information model. The study

has shown the potential of TMED in an *in vivo*-setting and while not being superior significantly for each user group, the underlying information model has proven robust for common scenarios. Based on the results and feedback provided by the participants, improvements can be developed, resolving existing information asymmetries and fostering data democratization within the pharmaceutical sector empowering OCMIS users. Furthermore, the developed information model can serve as a basis for other applications, such as e-prescriptions and enable research through its standardized approach.

Acknowledgements

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Conflicts of Interest

The authors are responsible for the development of TMED, one of the tested Online Consumer Medication Information Systems. No other conflict of interests are declared.

Abbreviations

OCMIS: Online Consumer Medication Information System
HL: Health Literacy
TMED: Medication Terminology (Spanish: *Terminologia de Medicamentos*)

Appendix 1

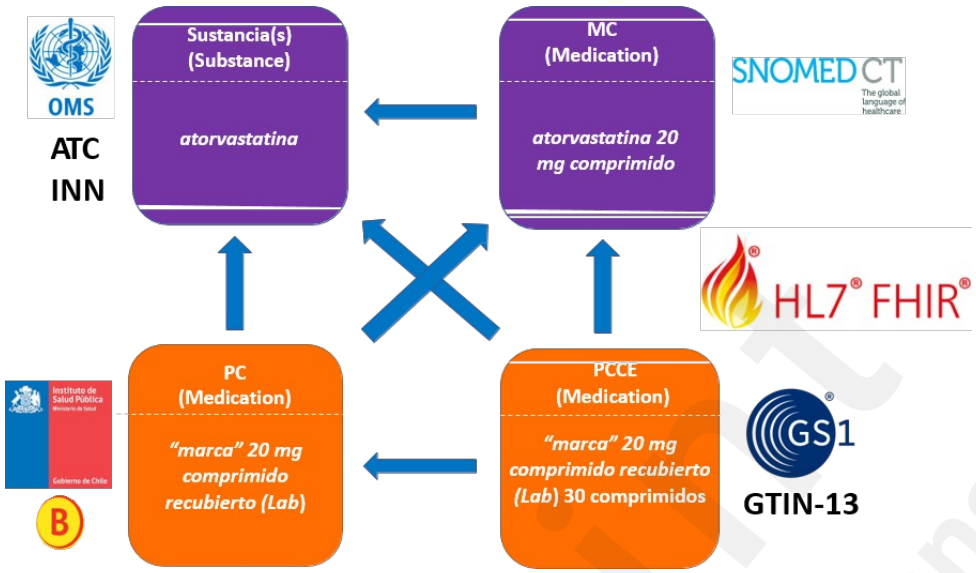
Benchmarking of Online Consumer Medication Information Systems (OCMIS). This benchmark has been part of a previous publication [17].

Platform	Category	Affiliation	# of products	Update Rate	Standarized Data Model	Bioequivalence B	Referenc R	Brand M	Generic G	Search by (brand) product	Search by principal active Susbtance	Price information	Showing Alternative Products	Georefence
Salcobrand	Price comparator	Private	2658	Unknown	No	Yes	No	No	No	Yes, limited to Salcobrand portfolio	Yes, extra search field	Yes	No	No
MINSAL - Tufarmacia	National Price observatory	Public	3300	1 day – 3 months	Yes	Yes, but not for alternatives	Yes	No	No	Yes, in associated pharmacies	Yes	Yes, limited to colaborating pharmacies	Yes, but limited symbology	Yes
Pharol	Online Pharmacy	Private	1121	Unknown	Unknown	Yes	No	No	No	Yes, limited to Pharol portfolio	Yes	Yes, limited to Pharol	Yes	Not necessary (shipment)
Farmazon	Online Pharmacy	Private	3043	Unknown	Unknown	Yes	No	No	No	Yes, limited to Farmazon portfolio	Yes	Yes, limited to Farmazon	Yes	Not necessary (shipment)
Cruz Verde - Buscador de Medicamentos	Medication Information source	Private	5211	Unknown	Unknown	Yes	No	No	No	Yes, limited to Cruz Verde portfolio	Yes, extra search field	No	No	No
SERNAC - Informacion de precios	Price observatory	Public	539	Monthly	No	Yes	No	No	No	Yes	No	Yes, limited to certain farmacies	No	No
CENABAST - Lista de medicamentos	Distributor for the public sector	Public	1065	Monthly	No	Yes	No	No	No	No	No	Yes, limited to CENEBAST portfolio	No	No
Instituto de Salud Publica	National Drug Register	Public	9403	Unknown	Unknown	Yes	Yes	No	No	Yes, vendor independant	Yes	No	No	No

Appendix 2

HL7 FHIR based Information Model covering clinical (purple) domain: Substance(s) (WHO, INN and ATC), Clinical Medicine (MC, SNOMED CT), and logistical (orange) domain: Commercial Product (PC, BE, ISP), Commercial Product with Packaging (CHP, GS1 GTIN-13). The blue arrows

indicate references between the entities. Substance and Medication are resources in FHIR. This model has been part of a previous publication [30].



Appendix 3

System Usability Scale in Spanish, adapted from [19].

1. Creo que me gustaría usar el sistema con frecuencia.
2. Me parece que el sistema es innecesariamente complejo.
3. Pienso que el sistema es fácil de usar.
4. Creo que necesitaría el apoyo de un técnico para poder utilizar este sistema.
5. Me parece que las diferentes funciones de este sistema son una buena combinación.
6. Me parece que el sistema es confuso.
7. Me imagino que la mayoría de la gente aprendería a usar este sistema muy rápido.
8. He encontrado el sistema bastante incómodo para usar.
9. Me siento muy seguro usando el sistema.
10. Necesitaba aprender muchas cosas antes de avanzar con este sistema.

Multimedia Appendix 1

Video – Introduction and overview video to the online usability study. (https://www.youtube.com/watch?v=Ls0ANJK0VZQ)

References

1. Devine T, Broderick J, Harris LM, Wu H, Hilfiker SW. Making Quality Health Websites a National Public Health Priority: Toward Quality Standards. J Med Internet Res 2016;18(8):e211. PMID:27485512
2. Metelmann B, Metelmann C, Schuffert L, Hahnenkamp K, Brinkrolf P. Medical Correctness and User Friendliness of Available Apps for Cardiopulmonary Resuscitation: Systematic Search Combined With Guideline Adherence and Usability Evaluation. JMIR Mhealth Uhealth 2018;6(11):e190. PMID:30401673
3. van Beukering M, Velu A, van den Berg L, Kok M, Mol BW, Frings-Dresen M, Leeuw R de, van der Post J, Peute L. Usability and Usefulness of a Mobile Health App for Pregnancy-Related

Work Advice: Mixed-Methods Approach. JMIR Mhealth Uhealth 2019;7(5):e11442. PMID:31094353
4. Iuga AO, McGuire MJ. Adherence and health care costs. Risk Manag Healthc Policy 2014;7:35-44. PMID:24591853
5. McDaid D, Park A-L. Online health: untangling the web 2010.
6. Wali H, Grindrod K. Don't assume the patient understands: Qualitative analysis of the challenges low health literate patients face in the pharmacy. Res Social Adm Pharm 2016;12(6):885-892. PMID:26827124
7. Brice JH, Travers D, Cowden CS, Young MD, Sanhueza A, Dunston Y. Health Literacy among Spanish-Speaking Patients in the Emergency Department. Journal of the National Medical Association 2008;100(11):1326-1332. doi:10.1016/S0027-9684(15)31512-1
8. Medicine Io, Practice BoPHaPH, Literacy RoH. Health Literacy: Improving Health, Health Systems, and Health Policy Around the World: Workshop Summary. Washington: National Academies Press; 2013. ISBN:978-0-309-28484-4.
9. Gesser-Edelsburg A, Abed Elhadi Shahbari N, Cohen R, Mir Halavi A, Hijazi R, Paz-Yaakobovitch G, Birman Y. Differences in Perceptions of Health Information Between the Public and Health Care Professionals: Nonprobability Sampling Questionnaire Survey. J Med Internet Res 2019;21(7):e14105. PMID:31271145
10. Mira JJ, Lorenzo S, Raban MZ, Tariq A, Richardson L, Byrne M, Robinson M, Li L, Westbrook JI, Baysari MT. Evaluation of Web-Based Consumer Medication Information: Content and Usability of 4 Australian Websites. Interact J Med Res 2016;5(3). PMID:27443680
11. Reen GK, Muirhead L, Langdon DW. Usability of Health Information Websites Designed for Adolescents: Systematic Review, Neurodevelopmental Model, and Design Brief. J Med Internet Res 2019;21(4):e11584. PMID:31012856
12. Bauer MS, Damschroder L, Hagedorn H, Smith J, Kilbourne AM. An introduction to implementation science for the non-specialist. BMC Psychol 2015;3:32. PMID:26376626
13. OECD Economic Surveys: Chile 2015: OECD; 2015. ISBN:9789264248434.
14. OECD. OECD Reviews of Public Health: Chile; 2019.
15. Goldstein E. Ajustes a la Ley de Fármacos y política de genéricos en Chile. 2018.
16. OECD M. Chile - A Healthier Tomorrow: Asessment and Recommendations 2017.
17. Sigle S, Barriga P, Correa F, Juhra C, Härtel S, Fegeler C. Pharmaceutical Sector and Online Consumer Medication Information Systems - An International Perspective.
18. Linstone HA, Turoff M, others. The delphi method: Addison-Wesley Reading, MA; 1975.
19. Health Information and Technology, Evaluation and Quality (HITEQ) Center. Systems Usability Scale Survey Packet: Spanish Template URL: https://hiteqcenter.org/DesktopModules/EasyDNNNews/DocumentDownload.ashx?portalid=0&moduleid=718&articleid=155&documentid=133 [accessed 2019-09-30].
20. Sarkar U, Schillinger D, López A, Sudore R. Validation of self-reported health literacy questions among diverse English and Spanish-speaking populations. J Gen Intern Med 2011;26(3):265-271. PMID:21057882
21. Hewitt ME. Facilitating state health exchange communication through the use of health literate practices: Workshop summary / Maria Hewitt, rapporteur ; Roundtable on Health Literacy, Board on Population Health and Public Health Practice, Institute of Medicine of the National Academies. Washington, D.C.: National Academies Press; 2012. ISBN:978-0-309-22029-3.
22. Devsoft Baltic OÜ. SurveyJS 2019 URL: www.surveyjs.io.
23. Farmazon. Online Pharmacy: (esp.: Farmacia en-linea) 2019 URL: www.farmazon.cl.
24. Pharol. Online Pharmacy: (esp.: Farmacia en-linea) 2019 URL: www.pharol.cl.
25. Salcobrand. Pharmacy with Online Offer: (esp.: Farmacia) URL: www.salcobrand.cl.
26. Ministry of Health (MINSAL), Chile. Your Pharmacy: (esp.: Tufarmacia) 2019 URL: https://tufarmacia.minsal.cl/comparadorprecios/.

27. Institute for Public Health Chile. Sanitary Registration for Medications: (esp.: Registro Sanitario) 2019 URL: www.registrosanitario.ispch.gob.cl.
28. National Consumer Service Chile. Price List of Medications: (esp.: Listado de Precios Vigentes) 2019 URL: www.cenabast.cl/precios-vigentes-en-contratos/.
29. Stefan Sigle. TMED - Visualization of the Chilean Pharmaceutical Terminology: TMED - Motor De Busqueda, Visualizando La Terminologia Farmaceutica Chilena 2019 URL: https://qbigm.scian.cl/tool/.
30. F. Correa, S. Sigle, M. Cabello, S. Espinoza, J. Alegria, S. Hartel, C. Fegeler. Casos de Uso en un Prototipo de Maestro de Fármacos con Terminología Estandarizada: CENS Chile; 2019. Makehealth.
31. Instituto de Salud Publica - Agencia Nacional de Medicamentos. Banco de Referencias para Estudios de Bioequivalencia 2015 URL: http://www.ispch.cl/sites/default/files/BANCO_DE_REFERENTES_2.pdf [accessed 2018-11-15].
32. Valdivia C, others. Epidemiología del adulto adquirida en la comunidad. Revista chilena de infectología 2005;22:s11-s17.
33. Newton CR, Garcia HH. Epilepsy in poor regions of the world. The Lancet 2012;380(9848):1193-1201. doi:10.1016/S0140-6736(12)61381-6
34. Bloch MJ. Worldwide prevalence of hypertension exceeds 1.3 billion. J Am Soc Hypertens 2016;10(10):753-754. PMID:27660007
35. Neubert T-A, Dusch M, Karst M, Beissner F. Designing a Tablet-Based Software App for Mapping Bodily Symptoms: Usability Evaluation and Reproducibility Analysis. JMIR Mhealth Uhealth 2018;6(5):e127. PMID:29848470
36. Mann DM, Chokshi SK, Kushniruk A. Bridging the Gap Between Academic Research and Pragmatic Needs in Usability: A Hybrid Approach to Usability Evaluation of Health Care Information Systems. JMIR Hum Factors 2018;5(4):e10721. PMID:30487119
37. Bevan N, Carter J, Harker S. ISO 9241-11 Revised: What Have We Learnt About Usability Since 1998? In: Kurosu M, editor. Human-computer interaction. Part I, Design and evaluation: 17th International Conference, HCI International 2015, Los Angeles, CA, USA, August 2-7, 2015, Proceedings / edited by Masaaki Kurosu. Vol. 9169. Cham: Springer; 2015. ISBN:978-3-319-20900-5. p. 143–151.
38. Peres SC, Pham T, Phillips R. Validation of the System Usability Scale (SUS). Proceedings of the Human Factors and Ergonomics Society Annual Meeting 2013;57(1):192-196. doi:10.1177/1541931213571043
39. Broekhuis M, van Velsen L, Hermens H. Assessing usability of eHealth technology: A comparison of usability benchmarking instruments. Int J Med Inform 2019;128:24-31. PMID:31160008
40. Lewis JR, Sauro J. The Factor Structure of the System Usability Scale. In: Kurosu M, editor. Human centered design: First international conference, HCD 2009, held as part of HCI International 2009, San Diego, CA, USA, July 19-24, 2009 : proceedings / Masaaki Kurosu (ed.). Vol. 5619. Berlin: Springer; 2009. ISBN:978-3-642-02805-2. p. 94–103.
41. Brooke J. SUS: a" quick and dirty" usability scale in PW Jordan, B. Thomas, BA Weerdmeester, & AL McClelland. Usability Evaluation in Industry: London: Taylor and Francis 1996.
42. Tullis TS, Stetson JN. A comparison of questionnaires for assessing website usability. In: Usability professional association conference. Vol. 1; 2004.
43. Sauro J. A practical guide to the system usability scale: Background, benchmarks & best practices. Denver, CO: Measuring Usability LLC; 2011. ISBN:1461062705.
44. Peterson RA. A Meta-Analysis of Cronbach's Coefficient Alpha. J CONSUM RES 1994;21(2):381. doi:10.1086/209405
45. Cortina JM. What is coefficient alpha? An examination of theory and applications. Journal of

applied psychology 1993;78(1):98.
46. Pearson K. X. On the criterion that a given system of deviations from the probable in the case of a correlated system of variables is such that it can be reasonably supposed to have arisen from random sampling. The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science 1900;50(302):157-175. doi:10.1080/14786440009463897
47. Bangor A, Kortum P, Miller J. Determining what individual SUS scores mean: adding an adjective rating scale. J Usability Stud. 2009; 4 (3): 114-123 2013.
48. Sauro J, Lewis JR. Quantifying the user experience: Practical statistics for user research / Jeff Sauro, James R. Lewis. Second edition. Amsterdam: Morgan Kaufmann; 2016. ISBN:978-0-12-802308-2.
49. McBurney DH. Research methods. Pacific Grove, California: Brooks: Cole Publishing Company 1994.

Supplementary Files

Figures

Multimedia Appendixes

Benchmarking of Online Consumer Medication Information Systems (OCMIS).
URL: https://asset.jmir.pub/assets/03654478189a5081ef67182bce14c532.png

HL7 FHIR based Information Model covering clinical (purple) domain: Substance(s) (WHO, INN and ATC), Clinical Medicine (MC, SNOMED CT), and logistical (orange) domain: Commercial Product (PC, BE, ISP), Commercial Product with Packaging (CHP, GS1 GTIN-13). The blue arrows indicate references between the entities. Substance and Medication are resources in FHIR.
URL: https://asset.jmir.pub/assets/45549f95c9ae9b90d3c89f04dbac20f4.png

Introduction and overview video to the online usability study.
URL: https://asset.jmir.pub/assets/de6a2b660e7284bf759ff0f8ba21d8a5.mp4