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Address for Correspondence:
Sollip Kim, MD, PhD
Department of Laboratory Medicine, Asan Medical Center, University of Ulsan College of Medicine, 88 Olympic-ro 43-gil, Songpa-gu, Seoul 05505, Korea.
Email: sollip_kim@amc.seoul.kr

ORCID iDs
Kuenyoul Park
https://orcid.org/0000-0003-3950-4946
Min-Sun Kim
https://orcid.org/0000-0003-2061-5726
YeJin Oh
https://orcid.org/0000-0002-8091-1570
John Hoon Rim
https://orcid.org/0000-0001-6825-8479
Shinae Yu
https://orcid.org/0000-0002-9527-5853
Hyejin Ryu
https://orcid.org/0000-0001-8388-0477
Eun-Jung Cho
https://orcid.org/0000-0003-1907-9639
Kyunghoon Lee
https://orcid.org/0000-0002-3154-0347
Ha Nui Kim
https://orcid.org/0000-0003-1928-7411

Gaps and Similarities in Research Use LOINC Codes Utilized in Korean University Hospitals: Towards Semantic Interoperability for Patient Care

Kuenyoul Park [1], Min-Sun Kim [2], YeJin Oh [3], John Hoon Rim [4], Shinae Yu [5], Hyejin Ryu [6], Eun-Jung Cho [7], Kyunghoon Lee [8], Ha Nui Kim [9], Inha Chun [10], AeKyung Kwon [10], Sollip Kim [11], Jae-Woo Chung [12], Hyojin Chae [13], Ji Seon Oh [14], Hyung-Doo Park [15,16], Mira Kang [17,18,19], Yeo-Min Yun [20], Jong-Baeck Lim [4], Young Kyung Lee [21], and Sail Chun [11]

[1]Department of Laboratory Medicine, Sanggye Paik Hospital, College of Medicine, Inje University, Seoul, Korea
[2]Department of Laboratory Medicine, Soonchunhyang University Cheonan Hospital, Soonchunhyang University College of Medicine, Cheonan, Korea
[3]Department of Laboratory Medicine, Green Cross Laboratories, Yongin, Korea
[4]Department of Laboratory Medicine, Yonsei University College of Medicine, Seoul, Korea
[5]Department of Laboratory Medicine, Haeundae Paik Hospital, Inje University College of Medicine, Busan, Korea
[6]Department of Laboratory Medicine, Seegene Medical Foundation, Seoul, Korea
[7]Department of Laboratory Medicine, Hallym University Dongtan Sacred Heart Hospital, Hallym University College of Medicine, Hwaseong, Korea
[8]Department of Laboratory Medicine, Seoul National University Bundang Hospital and College of Medicine, Seongnam, Korea
[9]Department of Laboratory Medicine, College of Medicine, Korea University, Seoul, Korea
[10]Korea Health Information Service, Seoul, Korea
[11]Department of Laboratory Medicine, Asan Medical Center, University of Ulsan College of Medicine, Seoul, Korea
[12]Department of Laboratory Medicine, Dongguk University Ilsan Hospital, Goyang, Korea
[13]Department of Laboratory Medicine, Seoul St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Seoul, Korea
[14]Department of Information Medicine, Big Data Research Center, Asan Medical Center, Seoul, Korea
[15]Department of Laboratory Medicine and Genetics, Samsung Medical Center, Sungkyunkwan University School of Medicine, Seoul, Korea
[16]Department of Medical Device Management and Research, Samsung Advanced Institute for Health Sciences & Technology, Sungkyunkwan University, Seoul, Korea
[17]Department of Digital Health, Samsung Advanced Institute of Health Sciences and Technology, Sungkyunkwan University, Seoul, Korea
[18]Health Promotion Center, Samsung Medical Center, Sungkyunkwan University School of Medicine, Seoul, Korea
[19]Digital Transformation Center, Samsung Medical Center, Sungkyunkwan University School of Medicine, Seoul, Korea
[20]Department of Laboratory Medicine, Konkuk University Medical Center, Konkuk University School of Medicine, Seoul, Korea
[21]Department of Laboratory Medicine, Hallym University Sacred Heart Hospital, Hallym University College of Medicine, Anyang, Korea

ABSTRACT

Background: The accuracy of Logical Observation Identifiers Names and Codes (LOINC) mappings is reportedly low, and the LOINC codes used for research purposes in Korea have

Inha Chun (iD)
https://orcid.org/0009-0008-5540-4586
AeKyung Kwon (iD)
https://orcid.org/0009-0006-8818-1169
Sollip Kim (iD)
https://orcid.org/0000-0003-0474-5897
Jae-Woo Chung (iD)
https://orcid.org/0000-0002-4867-9708
Hyojin Chae (iD)
https://orcid.org/0000-0001-5870-1887
Ji Seon Oh (iD)
https://orcid.org/0000-0002-0205-6492
Hyung-Doo Park (iD)
https://orcid.org/0000-0003-1798-773X
Mira Kang (iD)
https://orcid.org/0000-0002-7842-0035
Yeo-Min Yun (iD)
https://orcid.org/0000-0002-5485-8331
Jong-Baeck Lim (iD)
https://orcid.org/0000-0003-0419-0422
Young Kyung Lee (iD)
https://orcid.org/0000-0003-0433-8028
Sail Chun (iD)
https://orcid.org/0000-0002-5792-973X

not been validated for accuracy or usability. Our study aimed to evaluate the discrepancies and similarities in interoperability using existing LOINC mappings in actual patient care settings.

Methods: We collected data on local test codes and their corresponding LOINC mappings from seven university hospitals. Our analysis focused on laboratory tests that are frequently requested, excluding clinical microbiology and molecular tests. Codes from nationwide proficiency tests served as intermediary benchmarks for comparison. A research team, comprising clinical pathologists and terminology experts, utilized the LOINC manual to reach a consensus on determining the most suitable LOINC codes.

Results: A total of 235 LOINC codes were designated as optimal codes for 162 frequent tests. Among these, 51 test items, including 34 urine tests, required multiple optimal LOINC codes, primarily due to unnoted properties such as whether the test was quantitative or qualitative, or differences in measurement units. We analyzed 962 LOINC codes linked to 162 tests across seven institutions, discovering that 792 (82.3%) of these codes were consistent. Inconsistencies were most common in the analyte component (38 inconsistencies, 33.3%), followed by the method (33 inconsistencies, 28.9%), and properties (13 inconsistencies, 11.4%).

Conclusion: This study reveals a significant inconsistency rate of over 15% in LOINC mappings utilized for research purposes in university hospitals, underlining the necessity for expert verification to enhance interoperability in real patient care.

Keywords: Common Data Model; LOINC; Harmonization; Interoperability; Standardization; Terminology

INTRODUCTION

With the rapid adoption of artificial intelligence in the medical field, an increasing need exists to analyze large amounts of healthcare-related data. However, combining or comparing laboratory results is challenging because test codes and names vary between institutions. Clinical implications can also differ based on sample type, measurement time, reagents, and instruments, even when measuring the same analyte.[1] To ensure interoperability of test results, two main types of standardization are required: standardization of values in terms of measurement traceability, and standardization of formats, including test names, specimen types, and reporting units.[2,3] The continuous standardization efforts by the Korean Society for Laboratory Medicine, Korea Disease Control and Prevention Agency, and Korean Association of External Quality Assessment Service, along with the accreditation of laboratories by the Laboratory Medicine Foundation, have significantly improved the accuracy of test results from a metrology perspective.[4-6] However, little progress has been made in format standardization, with the standardization of test names being the most fundamental and urgent task.[7] The international standard terminologies for laboratory test names are Logical Observation Identifiers Names and Codes (LOINC) and Systematized Nomenclature of Medicine Clinical Terms (SNOMED CT).[8] LOINC is used in 16 countries, while SNOMED CT is employed in Iceland, Slovenia, and Sweden. The U.S. Interoperability Standards Advisory implemented the United States Core Data for Interoperability (US CDI) in 2020 to ensure interoperability. This initiative mandated the use of LOINC codes in the test name field of laboratory tests. Korea also plans to adopt LOINC as the standard terminology for laboratory test names in its CDI.

LOINC describes six main attributes: component (what is being measured), property (mass, substance, catalytic activity), timing (24-hour collection), specimen (type of specimen),

scale (ordinal, nominal, descriptive), and method (procedure used for measurement).[9] The Center for Medicare and Medicaid Services (CMS) in the United States uses a data support system linked to a designated LOINC panel.[10] In Australia, the Royal College of Pathologists of Australasia (RCPA) manages the Australian Pathology Information, Terminology, and Units Standardisation (PITUS) project,[11] which has incorporated LOINC as the standard terminology for laboratory test names in version 3 of the Standards for Pathology Informatics in Australia (SPIA).[11] Switzerland and Austria have also made efforts to adopt LOINC nationally.[3,12]

In Korea, a standardization working group established terminology for 7,508 test observations as K-LOINC in 2004, aligning with the LOINC database.[13] In the 2015 revision, a total of 48,990 laboratory codes were established as K-LOINC.[14] Despite substantial efforts to create a Korean reference set for all laboratory test items quickly, no verification was conducted across institutions or among individuals performing the mapping. Furthermore, a separate reference set translated into Korean meant that K-LOINC updates could not immediately synchronize with LOINC updates. Additionally, no regulations in Korea exist mandating the use of LOINC. Due to the significant effort required for initial implementation, K-LOINC saw limited practical use. Recently, however, with the rise of common data models for multi-center research, some large medical institutions have initiated using LOINC for research purposes. Nonetheless, the use of LOINC for research has not extended to the exchange of actual patient medical information, such as during referral tests or when patients transfer between medical institutions. Consequently, verifying the accuracy or suitability of the mapping for practical use has been challenging.

LOINC mapping accuracy is notoriously low, with reports indicating inaccuracies up to 41% due to the complexity and abundance of LOINC codes.[15-18] Moreover, the accuracy of LOINC used in Korea has not been validated. Our study assessed gaps and similarities in existing research-use LOINC mappings at seven university-affiliated hospitals with a dedicated team of clinical pathologists and terminology experts.

METHODS

Survey scheme

This survey was conducted by the Standardization Management Committee of the Laboratory Medicine Foundation in Korea. Moreover, the survey was dispatched to seven participating university hospital laboratories in Korea in early September 2023, and responses were returned within two months. The hospitals were selected based on the availability of mapped LOINC data, representation across multiple hospitals within their medical groups, and willingness to participate. The study focused on tests frequently requested and those used in nationwide medical programs such as the National Health Screening Programs, the Korea National Health and Nutrition Examination Survey, and the Korean Genome and Epidemiology Study. The selection of frequently requested tests was based on national reimbursement data from the Korea Health Insurance Review and Assessment (HIRA). The 162 tests included, which represented 7.5% of laboratory tests listed on the insurance claims based on 5-digit reimbursement codes, covered > 80% of laboratory testing claims according to the HIRA database (https://opendata.hira.or.kr/). The majority (67.9%) of the included tests (N = 162) were clinical chemistry tests (n = 110), complemented by 26 diagnostic hematology tests, 15 diagnostic immunology tests, and 11 transfusion tests. National

proficiency test codes, used by 2,000 Korean laboratories and conducted by the Korean Association of External Quality Assessment Service, served as intermediary codes for query and comparison, given that insurance reimbursement codes lack the granularity needed to map each test accurately. LOINC v.2.76, distributed on September 18, 2023, was used as the reference dataset. We surveyed hospitals about their processes and staffing, including whether each hospital had standard operating procedures for code management, cross-validation, and the use of automation.

Data analysis

The returned LOINC codes were evaluated by a research team comprising 19 dedicated members, including seventeen clinical pathologists and two terminology experts. With replies from seven institutions, two clinical pathologists curated optimal and suboptimal codes for each test item. If there was a conflict between two clinical pathologists, the research team discussed the optimal and suboptimal codes. Finally, all optimal and suboptimal codes were approved by team consensus (**Fig. 1**). The remaining codes were classified as inconsistent. The general rule for mapping optimal codes included: 1) Codes with a status of deprecated or discouraged were considered inconsistent; 2) The most specific LOINC codes were selected based on available information; 3) The method was specified only if it had a clinical impact on the interpretation of results or was specified in
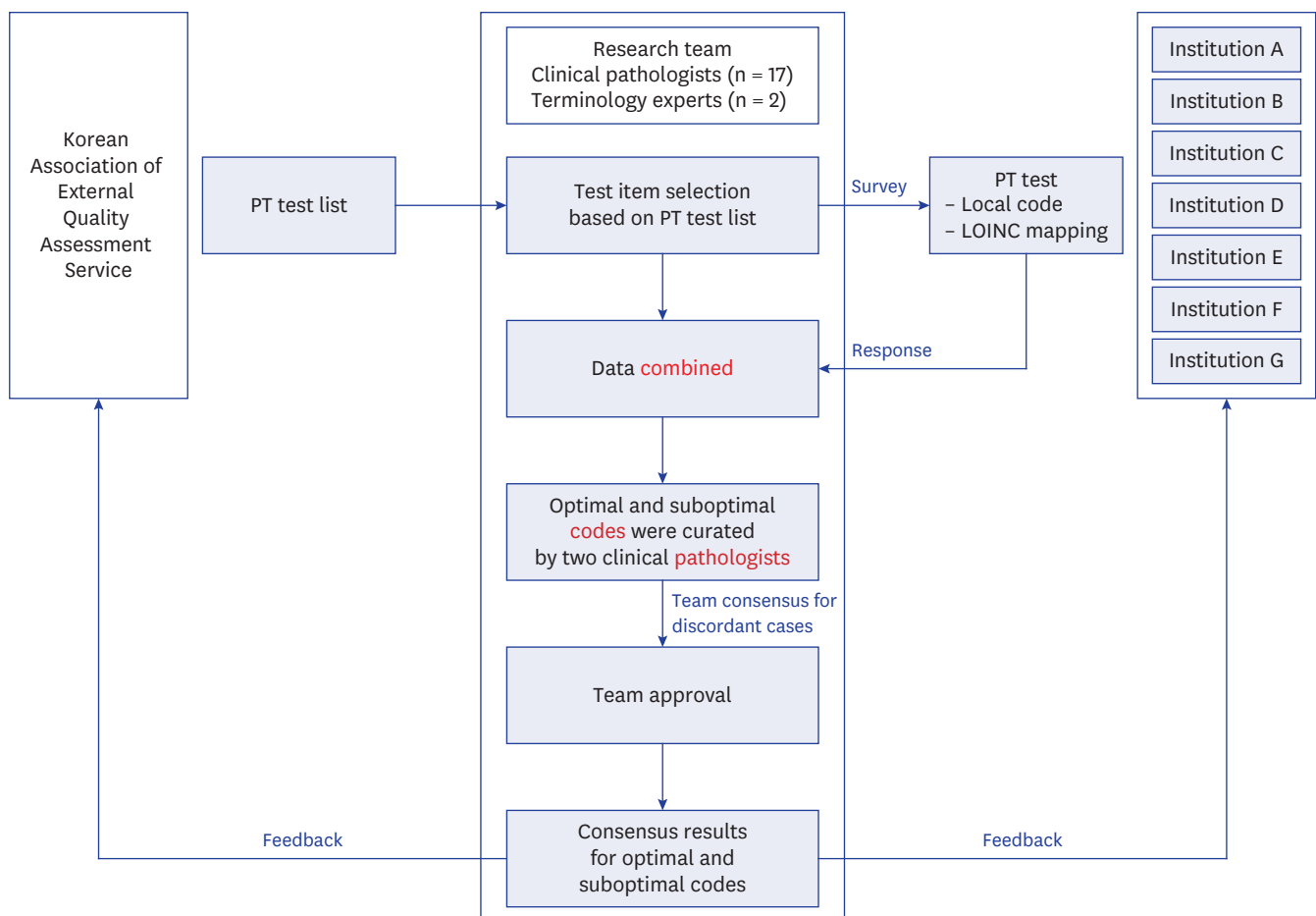

Fig. 1. Flowchart outlining the process for selecting test items and determining the optimal and suboptimal codes.
PT = proficiency testing, LOINC = Logical Observation Identifiers Names and Codes.

the LOINC guidelines. Specifically, methods were noted in the following cases: automated complete blood cell count (e.g., white cell count), estimated glomerular filtration rates using various calculation formulas, tests reported with results calculated (e.g., osmolarity), tests where different measurement methods affect the results (e.g., lactate dehydrogenase), cardiac marker protein tests (high-sensitivity C-reactive protein), urine albumin tests with a detection limit, cotinine confirmatory tests, urinalysis tests performed using an automated strip panel, and tests distinguished by automated count and light microscopy (e.g., urine red blood cells [RBCs]). Suboptimal codes were designated when the same test was mapped to different codes due to different reporting units (for instance, a difference between substance concentration and mass concentration) depending on the institution, or when the test was matched to a code that specified the test method used by the institution. Inconsistencies were evaluated based on which part of the process caused the discrepancy.

RESULTS

Optimal LOINC code selection

A total of 235 LOINC codes were designated as optimal for 162 frequently tested items, as detailed in **Supplementary Table 1**. Interestingly, despite the frequent use of code 771-6 (nucleated erythrocytes [#/volume] in blood by automated count), ranking 178 in common tests and described in the mapping guideline as "Most modern auto differential counts can identify nucleated RBC," nucleated erythrocyte counts are generally not reported using automated counters in Korea. Therefore, we mapped 19048-8 to nucleated RBCs for Korean laboratories. LOINC codes were not applicable for ABO subgrouping and Rh CcEe antigen tests as LOINC codes are only designated for specific results of these tests. More than two LOINC codes were designated as the optimal code for 51 test items, including 34 urine tests, primarily because properties such as quantitative/qualitative distinctions or differences in units were not described in the test name (**Table 1**). At seven responding institutions, clinical pathologists and terminology experts performed LOINC mapping: both in two institutions, terminology experts only in two institutions, and clinical pathologists only in three institutions. Of the institutions where only clinical pathologists participated in the mapping, two involved laboratory technicians. Cross-checking was performed at all institutions except one, which performed inter-institutional cross-checking for a subset of laboratory tests.

Table 1. Examples of tests mapped to two or more optimal LOINC codes

Reasons to have multiple optimal codes	Examples
Various calculation formulas	
eGFR codes	eGFR 77147-7 MDRD; 62238-1 CKD-EPI
Specific methods	
HPLC, IFCC protocol	Hemoglobin A1c 59261-8 IFCC; 17856-6 HPLC
Automated count vs. light microscopy	Urine RBC 46419-8 Automated count; 13945-1 Microscopy high power field
Test strip panel vs. automated strip panel	pH of Urine 5803-2 Test strip; 50560-2 Automated test strip
Screen vs. confirmatory	Cotinine 72786-7 Screen method; 92643-6 Confirmatory method
P-5'-P addition	Alanine aminotransferase 1744-2 No addition of P-5'-P; 1743-4 With P-5'-P
Lactate to pyruvate vs. pyruvate to lactate	Lactate dehydrogenase 14804-9 Lactate to pyruvate reaction; 14805-6 Pyruvate to lactate reaction
Direct assay vs. calculation	Osmolarity 2692-2 direct assay; 18182-6 calculation
Unit difference	
Mass/volume vs. mole/volume	Iron 14798-3 (Moles/volume); 2498-4 (Mass/volume)
Challenge tests	
Post-meal vs. post-glucose PO	Glucose 1-hour post 10449-7 1-hour post-meal; 1507-3 1-hour post 75 g glucose PO

LOINC = Logical Observation Identifiers Names and Codes, eGFR = epidermal growth factor receptor, MDRD = Modification of Diet in Renal Disease, CKD-EPI = Chronic Kidney Disease Epidemiology Collaboration, HPLC = high-performance liquid chromatography, IFCC = International Federation of Clinical Chemistry, RBC = red blood cell, PO = by mouth.

Table 2. Strategies for LOINC mapping in seven institutions

Strategies	Institution						
	A	B	C	D	E	F	G
Participating personnel	1 CP, 2 TE	1 CP, 4 TE	4 CP	1 TE	1 TE	2 CP, 8 LT	5 CP, 6 LT
Cross-checked	Yes	Yes	Yes	Yes	No[a]	Yes	Yes
Standard operating procedure	None	Presence	None	None	Presence	None	None
Automated tools	Not used	RELMA[b]	Not used	Not used	USAGI[b]	RELMA	Not used

LOINC = Logical Observation Identifiers Names and Codes, CP = clinical pathologist, TE = terminology experts, LT = laboratory technician, RELMA = REgenstrief LOINC Mapping Assistant.
[a]Three hundred high-frequency laboratory test codes were cross-checked with other institutions in Korea.
[b]Automated tools have been used for subsets of laboratory test codes.

Only two institutions had established standard operating procedures for LOINC mapping. Automated tools were used at three institutions: REgenstrief LOINC Mapping Assistant (RELMA) at two institutions and USAGI (https://www.ohdsi.org/analytic-tools/usagi/) at one institution (**Table 2**).

Inconsistency analysis for survey responses

A total of 962 LOINC codes corresponding to 164 tests were returned by seven institutions. Of them, 792 (82.3%) of these codes were identified to be consistent and categorized as either optimal or suboptimal responses; 635 (66.0%) responses were identical to optimal codes and the remaining 157 responses were regarded as suboptimal. Of the 169 inconsistent responses, 114 unique inconsistent codes were identified and classified based on the LOINC parts that caused the inconsistency (**Fig. 2**). Among the six LOINC parts, the highest inconsistencies occurred in the analyte with 38 cases (33.3%), followed by methods with 33 (28.9%), and properties with 13 (11.4%); specific reasons for these inconsistencies are detailed in **Tables 3** and **4**. For instance, the code 1989-3 for vitamin D3 was considered incorrect when mapped to a total of 25-hydroxyvitamin D, illustrating the confusion in assigning the correct LOINC code when multiple forms of vitamin D are considered. Additional inconsistencies arose from situations such as the use of discouraged codes (e.g., 57023-4 Auto Differential Panel – Blood), "W Reflex" codes which are recommended against (e.g., 57020-0 Urinalysis Dipstick W Reflex Microscopic Panel – Urine), challenge test codes applied inappropriately (e.g., "47670-5 Insulin [Units/volume] in Serum or Plasma – pre-meal" for baseline insulin
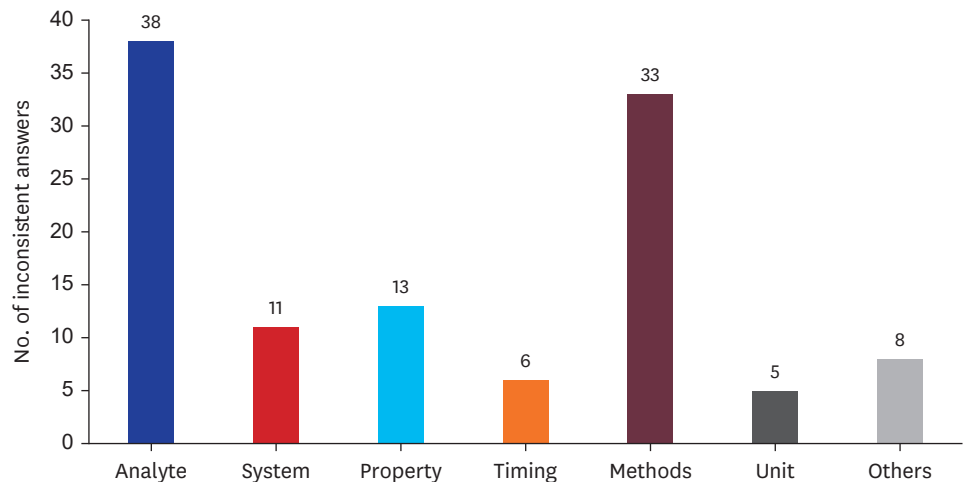

Fig. 2. Distribution of the LOINC parts with inconsistent LOINC codes (N = 114). Other denotes inconsistencies identified in other than six LOINC parts.
LOINC = Logical Observation Identifiers Names and Codes.

Table 3. LOINC mapping cases with inconsistencies observed in analyte, system, property, and timing

Parts	Reasons causing inconsistency	Examples
Analyte	Single-code tests mapped to panel tests	844-1 A1 Ag [Presence] on Red Blood Cells mapped to ABO subgroup typing
	Group codes mapped to subtype tests or vice versa	883-9 ABO group [Type] in Blood mapped to A Ab, B Ab, A1 Ab, and H Ab respectively
	Mapping of non-predictive screening codes to specific antibody tests	890-4 Blood group antibody screen [Presence] in Serum or Plasma mapped to each of A Ab, B Ab, A1 Ab, H Ab
	Confusion between uppercase and lowercase antigens (e.g., c vs. C, e vs. E)	948-0 C Ag [Presence] on Red Blood Cells mapped to Little c Ag
	Assignment of other similar analytes	30413-9 Abnormal lymphocytes/100 leukocytes in Blood mapped to Variant lymphocytes
	Clerical errors	26446-5 Blasts/100 leukocytes in Blood mapped to Plasma cells
	Mapping of other cell codes due to not reporting the corresponding analyte	730-2 Leukocytes other/100 leukocytes in Blood by Manual count mapped to plasma cells
	Single test codes answered as a panel test	50556-0 Urinalysis dipstick panel - Urine by Automated test strip mapped to Urine Erythrocytes (Qualitative)
	Mapping a Total test to a test that measures only some analytes	53294-5 Epithelial cells.non-squamous [#/area] in Urine sediment by Automated count mapped to Urine Epithelial cells
	Incorrect matching of IgG and IgM	40724-7 Hepatitis A virus IgG Ab [Presence] in Serum by Immunoassay mapped to Hepatitis A IgM Ab
	Analyte's antibody mapped to analyte	57416-0 Thyrotropin receptor Ab [Units/volume] in Serum by Immunoassay mapped to Thyroid stimulating hormone
System	Specimen code of a specific specimen mapped to a general specimen code	947-2 C Ag [Presence] on Red Blood Cells from Donor mapped to Rh CcEe antigen
	Mapping of Serum/plasma code to Whole Blood code or vice versa	2339-0 Glucose [Mass/volume] in Blood mapped to Glucose in serum/plasma
	Urine test mapped to body fluid code	53612-8 Urate [Mass/volume] in Body fluid mapped to Urate urine
	Urine test mapped to serum/plasma code	2345-7 Glucose [Mass/volume] in Serum or Plasma mapped to Urine Glucose (Qualitative) mapped to
Property	Qualitative test mapped to quantitative test or vice versa	50561-0 Protein [Mass/volume] in Urine by Automated test strip mapped to Urine Protein (Qualitative)
Timing	24-hour test mapped to Point-in-time test	21194-6 Chloride [Moles/volume] in 24-hour Urine mapped to Chloride urine

LOINC = Logical Observation Identifiers Names and Codes, Ag = antigen, Ab = antibody, Ig = immunoglobulin.

Table 4. LOINC mapping cases with inconsistencies observed in method, unit, and non-LOINC parts

Parts	Reasons causing inconsistency	Examples
Method	BY ESTIMATE code mapped to measurement code	49498-9 Leukocytes [#/volume] in Blood by Estimate mapped to White cell count
	Mapping automated codes where automated testing is not possible	42250-1 Variant lymphocytes/100 leukocytes in Blood by Automated count mapped to Variant lymphocytes
	Assay mapped to results by calculation code	17855-8 Hemoglobin A1c/Hemoglobin.total in Blood by calculation mapped to HbA1c
	Codes mapped to different measurement methods	14804-9 Lactate dehydrogenase [Enzymatic activity/volume] in Serum or Plasma by Lactate to pyruvate reaction mapped to Lactate dehydrogenase (Pyruvate to lactate)
	Automated test strip tests mapped to test strip test codes	5803-2 pH of Urine by Test strip mapped to Urine pH
	Urine chemistry test mapped to Urinalysis test code	2756-5 pH of Urine (class: CHEM) mapped to Urine pH (class: UA)
	Automated test strip tests mapped to confirmatory method codes	58450-8 Bilirubin [Presence] in Urine by Confirmatory method mapped to Urine Bilirubin (Qualitative)
	Automated test strip test mapped to methodless code	33051-4 Erythrocytes [Presence] in Urine mapped to Urine Haemoglobin
	Automated count test responded with manual test	13945-1 Erythrocytes [#/area] in Urine sediment by Microscopy high power field mapped to Urine RBCs
	Mapping of hsCRP test to normal CRP test	30522-7 C reactive protein [Mass/volume] in Serum or Plasma by High sensitivity method mapped to C reactive protein (Quantitative)
Unit	Mapping of mg/24hr unit tests to mg/dL unit test codes	20624-3 Creatinine [Mass/volume] in 24-hour Urine mapped to Creatinine urine mass/24hr
	Mapping of mg/24hr tests to mmol/24hr test codes	15077-1 Glucose [Moles/time] in 24-hour Urine mapped to Glucose excretion urine 24h
Others	Codes used when prescribed alone (typically a result code that goes out with a panel prescription)	The Term Description for 4544-3 states, "This is the test that referring labs will report when hematocrit alone is ordered."
	Discouraged codes	57023-4 Auto Differential panel - Blood (last updated Version 2.48) with a current status of 'Discouraged'
	Test panel specifying W Reflex	57020-0 Urinalysis dipstick W Reflex Microscopic panel - Urine to Urinalysis mapped to Urinalysis
	Mapping a pre-meal test to an unconditioned test	47670-5 Insulin [Units/volume] in Serum or Plasma -pre-meal mapped to insulin
	The challenge test specifies different conditions	47670-5 Insulin [Units/volume] in Serum or Plasma -pre-meal mapped to insulin --baseline

LOINC = Logical Observation Identifiers Names and Codes, hsCRP = high-sensitivity C-reactive protein, CRP = C-reactive protein.

levels in a challenge test), and special situation codes used for general purposes (e.g., "4544-3 Hematocrit [volume fraction] of Blood by Automated Count" is recommended if only hematocrit is ordered).

DISCUSSION

We examined optimal LOINC codes for 164 frequently requested tests with LOINC mapping results from seven university-affiliated hospitals. This investigation revealed that 18% of the codes mapped to test names were inconsistent. Previous studies reflect similar challenges: 19.6% of responding LOINC codes were mismatched to test items among CAP survey participants,[16] and 4.6% of mappings for quantitative tests were incorrect, with high error rates of 7.5% for diagnostic hematology tests in a research consortium.[17] Additionally, 4.5% of LOINC mappings for 884 test items from only three institutions were incorrect.[15] Notably, one study comparing manufacturer's recommended LOINC codes and the codes used in hospitals demonstrated that 41% of 331 tests were mismatched,[18] suggesting that manufacturer's recommended codes could benefit from refinement through review by clinical pathologists and terminology experts. The high discrepancy rates observed in this study may be attributed to domestic unfamiliarity with LOINC codes. These findings could serve as a reference for countries new to LOINC when adopting it, highlighting the need for enhanced LOINC education. This is due to the rapid spread of the terminology and guidelines of LONIC. The mismatch rates varying from 4% to 41% may not only reflect differences among participating institutions but also the challenges faced by the research team. This is due to the complexity of evaluating correctness without a clear hierarchy or relationship among LOINC codes. However, the recent collaboration between LOINC and SNOMED CT aims to improve the granularity of LOINC terms.[19] To address these challenges, 19 team members collaboratively reviewed the optimal codes to ensure their accuracy and practical application with available test codes from real-world laboratories. Considering that LOINC mapping was performed by clinical pathologists and terminologists in only two hospitals, collaboration between the two expert groups is highly recommended for practical mapping. Furthermore, rather than attempting to map all tests at once—which can lead to reduced mapping accuracy—prioritizing and accurately mapping frequently requested tests is more efficient.

With 235 LOINC codes identified as optimal, the "method" part often presented challenges. Typically, LOINC recommends methodless codes for tests where the method does not affect the results. However, each page of the LOINC code has a separate mapping guide on whether to specify the method, complicating accurate mapping when using RELMA,[20] a mapping tool provided by LOINC, or the LOINC mapping guides.[21] Additionally, standard LOINC codes assigned in Korea often differ from those in other countries due to variations in result-reporting practices. Moreover, because LOINC codes are primarily designed for result reporting, instances have been reported where LOINC codes do not exist for group tests such as ABO subgrouping or Rh CcEe antigen tests. In such cases, employing SNOMED CT for requesting names, as practiced in Australia may be necessary.[22]

In addition to not simply mapping the six parts, we determined that a LOINC code was inappropriate in several cases. This included the exclusion of "W reflex codes" or codes with "discouraged code" status, which are not always elucidated on the LOINC website. Therefore, continually monitoring LOINC guideline updates to ensure accurate mapping is necessary.

To keep up with the constant changes in code policy, code management enforcement teams are essential, and for these teams to update mappings without missing a beat, the master data that governs them must be managed digitally to ensure consistency and accuracy. Additionally, in some instances, such as with vitamin D and bilirubin, precise mapping requires a thorough understanding of the test itself to accurately map the specific analytes. This underscores the need for increased involvement from clinical pathologists, not just terminology experts.

Most laboratory results exchanged between hospitals in Korea are still paper-based. Several reasons exist for the delayed digital transformation compared with the U.S. and Australia[10,11]: insufficient efforts to implement terminology standards for clinical use and insufficient financial and political support. In South Korea, time was spent creating insurance codes for LOINC mappings that were difficult to match accurately, resulting in the creation of an unnecessary additional code called KOSTOM, which was unmanageable. The created code was barely publicized to actual users, and there were no benefits or regulations for its use. In contrast, in the US, the Centers for Medicare and Medicaid Services has mandated the use of LOINC as the vocabulary standard for laboratory tests,[23] and the US Food and Drug Administration has also designated LOINC as the standard for laboratory test names in clinical trials.[24] Australia has developed, validated, and promoted the use of real-world, clinically usable value sets by experts in the field, such as the RCPA, and has worked to standardize the LOINC mapping of test names, and the proposed standardization of the units needed to exchange diagnostic tests and the reporting of non-quantitative results.[22] The implementation of terminology standardization requires a lot of resources, but is not directly necessary for individual healthcare organizations; hence, it requires structural support from the government, as shown in the United States,[25,26] and strong leadership for standards at the government level. In Korea, continuing groundwork is needed to standardize these terminologies, and the standards developed need to be used for national projects such as the Korea National Health and Nutrition Examination Survey.

We obtained LOINC codes with their local tests from seven hospitals that use common data models (CDM). In 2019, a distributed research network based on CDM called FeederNET was established in Korea, with 57 general hospitals participating. This network could be used for cardiovascular research,[27] and CDM-based research is being actively conducted in Korea, such as on chronic kidney disease and pharmacovigilance systems including adverse drug reactions.[28-30] However, inaccuracies in LOINC mapping for CDM may cause difficulties in accurate test mapping and affect the accuracy of these CDM-based studies. Therefore, in addition to real-world patient care, accurate LOINC mapping is essential for research applications such as CDM; hence, this study could guide other countries building CDM networks.

This study was inherently limited by the small number of participating hospitals, as LOINC is primarily used for research and not widely employed for clinical purposes in Korea. Consequently, the research team included clinical pathologists from sixteen institutions in this study.

This study highlights a notable inconsistency rate exceeding 15% among research-use LOINC mappings in university hospitals. The observed results underscore the need for verification by both terminology experts and clinical pathologists to ensure interoperability for real patient care, as the terminology should accurately reflect the characteristics of the actual laboratory tests being performed. From this perspective, the implementation of LOINC in clinical laboratories for patient care must undergo cross-validation.

SUPPLEMENTARY MATERIAL

Supplementary Table 1
Two hundred thirty-five optimal LOINC codes designated for 162 frequent tests in Korea

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