

*Case Report* ■

# LOINC® Codes for Hospital Information Systems Documents: A Case Study

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**Abstract** Hospital Information Systems (HIS) handle a large number of different types of documents. Exchange and analysis of data from different HIS is facilitated by the use of standardized codes to identify document types. HL7's Clinical Document Architecture (CDA) uses LOINC (logical observation identifiers names and Codes) codes for clinical documents. The authors assessed the coverage of LOINC codes for document types in a German HIS. The authors analyzed document types that occurred more than 10 times in approximately 1.3 million documents in a commercial HIS at a major German University Hospital. Document types were mapped manually to LOINC using the Regenstrief LOINC Mapping Assistant (RELMA). Each document type was coded by two physicians. In case of discrepancies a third expert was consulted to reach consensus. For 76 of 86 document categories a LOINC code was identified, but for 38 of these categories, the LOINC code was not specific as deemed necessary. More than 93% of our local HIS documents had local document types that could be assigned a LOINC code.

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## Background

Due to the complexity of medicine, hospital information systems (HIS) need to handle a large number of different types of documents. Typically, these documents are customized according to the requirements of each hospital or clinic. In the context of networked health systems there is a growing need for exchange of documents between different HIS. For instance, when a patient is transferred from hospital A to hospital B, it should be possible to map a radiology report from hospital A automatically to the corresponding document category in hospital B's electronic patient record system. This mapping is not trivial, because hospital A and B will typically use different document labels, such as "rad\_report" and "report\_radiology", especially if they are using HIS from different vendors. To provide interoperability between different HIS installations, it would be highly desirable to map local document types to an international standard code.

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The HL7's clinical document architecture (CDA)<sup>1</sup> provides a framework for exchange of documents. The HL7 CDA recommends the use of clinical document codes from LOINC® (logical observation identifiers names and codes)<sup>2,3</sup> to specify the particular kind of document (e.g., discharge summary or progress note) that is being transmitted.

The documents in our HIS had not been coded with LOINC. We conducted a case study to answer the following questions:

1. To what extent can HIS document types in a German tertiary care referral center be coded with the current version of LOINC?
2. Which LOINC codes represent the most frequently occurring document types?
3. What is the potential for improving LOINC regarding categorization of HIS documents?

## Methods

The authors analyzed HIS documents from the University Hospital of Münster, Germany, a tertiary care referral center with approximately 1,500 beds, using the report generator of ORBIS® from Agfa Health Care.<sup>4</sup> At this writing, ORBIS® is applied to the following HIS functions: clinical documentation, administrative documentation, order-entry, and scheduling. ORBIS® provides a set of standard document types; additional local document types were generated during HIS implementation to meet the needs of our hospital.

Although there is a mixture of electronic and paper-based documentation in our institution, the authors assessed only electronic documents in the HIS because the paper-based documents are very poorly standardized and not easily accessible. The authors generated a report of all HIS documents created during 1 year (2007) in the hospital. This dataset was aggregated by document type—as defined by the local HIS—and sorted by frequency of documents of

**Table 1 ■ Pre-processing of Data Regarding HIS Documents. During the Observation Period (Jan to Dec 2007), 1,299,070 Documents were Generated. 55,745 Documents (4.3%) were Excluded From the Analysis**

|  | Number of Documents | Number of Document Types |
|--|---------------------|--------------------------|
| Raw dataset  | 1,299,070           | 168                      |
| Exclusion criteria                                     |                     |                          |
| <10 documents per document type per year               | 205                 | 71                       |
| local document types for internal use (temporary data) | 55,540              | 11                       |
| Analysis dataset                                       | 1,243,325           | 86                       |

HIS = hospital information systems.

each type. Local document types used at least 10 times per year were included in the study.

The resulting list of document types was inspected manually by physicians and mapped to LOINC version 2.24 using RELMA®<sup>3,5</sup> version 3.24. This version of LOINC contains 503 document codes. Local document types for internal use by the system, such as forms for temporary data, were excluded from the analysis. Each document type was mapped to LOINC by two independent physicians; in case of coding discrepancies a third expert was consulted to reach consensus.

## Results

(Table 1) presents an overview of data preprocessing. Approximately 1.3 million HIS documents categorized by 168 document types were generated during the observation period (Jan to Dec 2007). Seventy-one document types were used less than 10 times per year and therefore excluded from the study. Eleven document types covered temporary data for internal use by the system and were removed. The 82 excluded document types accounted for 4.3% of the HIS documents generated in 2007. The analysis dataset consisted of 1,243,325 documents categorized by 86 document types. In 8 of 86 cases, the two physicians mapping the local document types to LOINC disagreed, and a third physician helped to resolve the conflict.

(Table 2) summarizes results from the manual mapping of local HIS document types to LOINC codes. An appropriate

**Table 2 ■ Availability of LOINC Codes for HIS Document Types. For 10 of 86 Document Types No LOINC Code was Identified by Manual Mapping. Overall, for 8 Document Types a Third Physician was Involved to Reach a Consensus on Coding**

|  | Number of Document Types |
|--|--------------------------|
| Analysis dataset   | 86                       |
| No LOINC code available                                  | 10                       |
| LOINC mapping possible, but more specific code necessary | 38                       |
| LOINC code available                                     | 38                       |

HIS = hospital information systems; LOINC = logical observation identifiers names and codes.

**Table 3 ■ Availability of LOINC Codes for HIS Documents. For 93.1% of Documents a LOINC Code was Identified. In 22.5% of Cases a Mapping was Possible, But a More Specific LOINC Code was Deemed Necessary**

|  | Number of Documents | (%)   |
|--|---------------------|-------|
| Analysis dataset   | 1,243,325           | 100.0 |
| No LOINC code available                                  | 86,038              | 6.9   |
| LOINC mapping possible, but more specific code necessary | 279,233             | 22.5  |
| LOINC code available                                     | 878,054             | 70.6  |

HIS = hospital information systems; LOINC = logical observation identifiers names and codes.

LOINC code was identified for 76 of 86 document categories using RELMA. For example, document type “Radiologie”, which is used for findings in radiology, was mapped to LOINC code 11528-7 study.total (Radiology).

However, in 38 of the 76 cases the LOINC code identified was more general than the local document type. For example, 16 different German administration forms were mapped to “Administrative note” (LOINC 51851-4). In another case, the HIS had a specific document type for evaluation and management of diabetes patients, but LOINC code 34109-9 is a general evaluation and management note. The specific documentation form for emergency room procedures for trauma surgery was mapped to LOINC code 34878-9, which defines an evaluation and management note in emergency medicine.

For 10 document types the authors did not identify any appropriate LOINC code. A local form for general order-entry requests is considered a document in this context, because it contains a medical description of certain medical procedures and a legally relevant signature. In this setting a derma histology finding document is used quite frequently. The authors have various medication orders that are considered documents, because they are written individually by physicians and stored in the patient record. Finally, the authors provide specific local quality assurance documents, which are not covered by LOINC codes.

Table 3 presents results of the mapping process in number of documents. Overall, a LOINC code was found for the document types that categorized 93.1% of the HIS documents represented by the study dataset. More specific LOINC codes were deemed necessary for document types that accounted for 22.5% of documents. Table 4 lists 45 unique LOINC codes, which were mapped to these 76 local document types. Figure 1 presents the number of documents for these LOINC codes as a bar chart. Laboratory reports and radiology findings cover 61% of all analyzed documents.

## Discussion

Overall, 93.1% of the local HIS documents could be assigned a LOINC code indicating that, while not yet perfect, this nomenclature is suitable in this setting. For 76 of 86 (88%) local document types a LOINC code was identified. This difference in coverage (93.1 versus 88%) indicates a better

**Table 4 ■ Forty-five Unique LOINC Codes were Identified. These Codes Cover 93.1% of Analyzed HIS Documents**

| Loin<br>Coulombs | Text  | Count  |
|------------------|---|--------|
| 11502-2          | Laboratory report. Total                                  | 518141 |
| 11528-7          | Study. total (radiology)                                  | 185686 |
| 34106-5          | discharge summarization note (hospital)                   | 91873  |
| 51851-4          | administrative note (generic)                             | 69188  |
| 34764-1          | consultation note (General Medicine)                      | 43859  |
| 11488-4          | consultation note (generic)                               | 40330  |
| 53242-4          | charge ticket or encounter form attachment                | 36516  |
| 51897-7          | Health Care associated infection report                   | 28632  |
| 33720-4          | Blood bank consult  | 23595  |
| 34130-5          | subsequent evaluation note (hospital)                     | 12468  |
| 18751-8          | Study report (endoscopy)                                  | 11403  |
| 18746-8          | Study report (colonoscopy)                                | 9909   |
| 11526-1          | Study report (pathology)                                  | 9305   |
| 11504-8          | surgical operation note (generic)                         | 8829   |
| 34104-0          | consultation note (hospital)                              | 8738   |
| 29750-7          | Neonatal Intensive Care records                           | 5744   |
| 18757-5          | Study report (Radnuc)                                     | 5695   |
| 34133-9          | summarization of episode note (generic)                   | 5538   |
| 51847-2          | assessment + Plan note (generic)                          | 5462   |
| 11492-6          | history and physical note (hospital)                      | 3848   |
| 18759-1          | Study report (Respiratory system)                         | 3413   |
| 34861-5          | evaluation and management note<br>(Diabetology)           | 3318   |
| 29751-5          | Critical Care records                                     | 2959   |
| 34112-3          | evaluation and management note (inpatient)                | 2919   |
| 11522-0          | Study report (cardiac echo)                               | 2789   |
| 15508-5          | labor and delivery records                                | 1804   |
| 28570-0          | procedure note (generic)                                  | 1773   |
| 18729-4          | urinalysis studies  | 1629   |
| 34807-8          | consultation note (ophthalmology)                         | 1578   |
| 34761-7          | consultation note (gastroenterology)                      | 1534   |
| 34109-9          | evaluation and management note (generic)                  | 1474   |
| 34806-0          | evaluation and management note (oncology)                 | 1244   |
| 11524-6          | Study report (EKG)  | 1212   |
| 34752-6          | evaluation and management note<br>(cardiology)            | 1175   |
| 34905-0          | evaluation and management note<br>(neurology)             | 671    |
| 52072-6          | non-emergency transportation attachment                   | 605    |
| 28568-4          | visit note (Emergency Department)                         | 505    |
| 34103-2          | consultation note (pulmonary)                             | 485    |
| 34878-9          | evaluation and management note<br>(Emergency Medicine)    | 412    |
| 34796-3          | evaluation and management note<br>(nephrology)            | 387    |
| 52063-5          | prescription for durable medical equipment<br>attachment  | 243    |
| 34782-3          | evaluation and management note (Infectious<br>Diseases)   | 177    |
| 34759-1          | evaluation and management note<br>(dermatology)           | 137    |
| 34824-3          | consultation note (physical therapy)                      | 52     |
| 34876-3          | pre-operative evaluation and management<br>note (Surgery) | 33     |

HIS = hospital information systems; LOINC = logical observation identifiers names and codes.

representation of frequently used document types in LOINC. These numbers may be out of date because of the continuous addition of document codes to LOINC.

Figure 1 shows that the frequency distribution of HIS document types is highly skewed: only two categories account for more than 60% of all documents. From a data analysis perspective, for instance, to conduct HIS benchmarking, consideration should be given to splitting very frequent categories into subcategories. For example, radiology reports could be organized by modality (CT, MRI, etc). The LOINC provides a code for documents on CT head (11539-4). In the HIS the authors only provide one document type for radiology reports.

In addition, there are substantial differences between the German and United States Health care systems, which are reflected in different documentation procedures. For example, billing procedures and related documents are very different in Germany and the United States. Also, prescriptions in German hospitals are usually managed by physicians and not by pharmacists. It is therefore notable that 93.1% of the local HIS documents could be mapped to LOINC, although for 6.9% of cases no suitable LOINC code was found and for document types categorizing 22.5% of the documents a more specific LOINC code was deemed necessary. For 8 of 86 document types a third review was needed to reach consensus on LOINC document coding, indicating that additional guidance on LOINC coding might be beneficial.

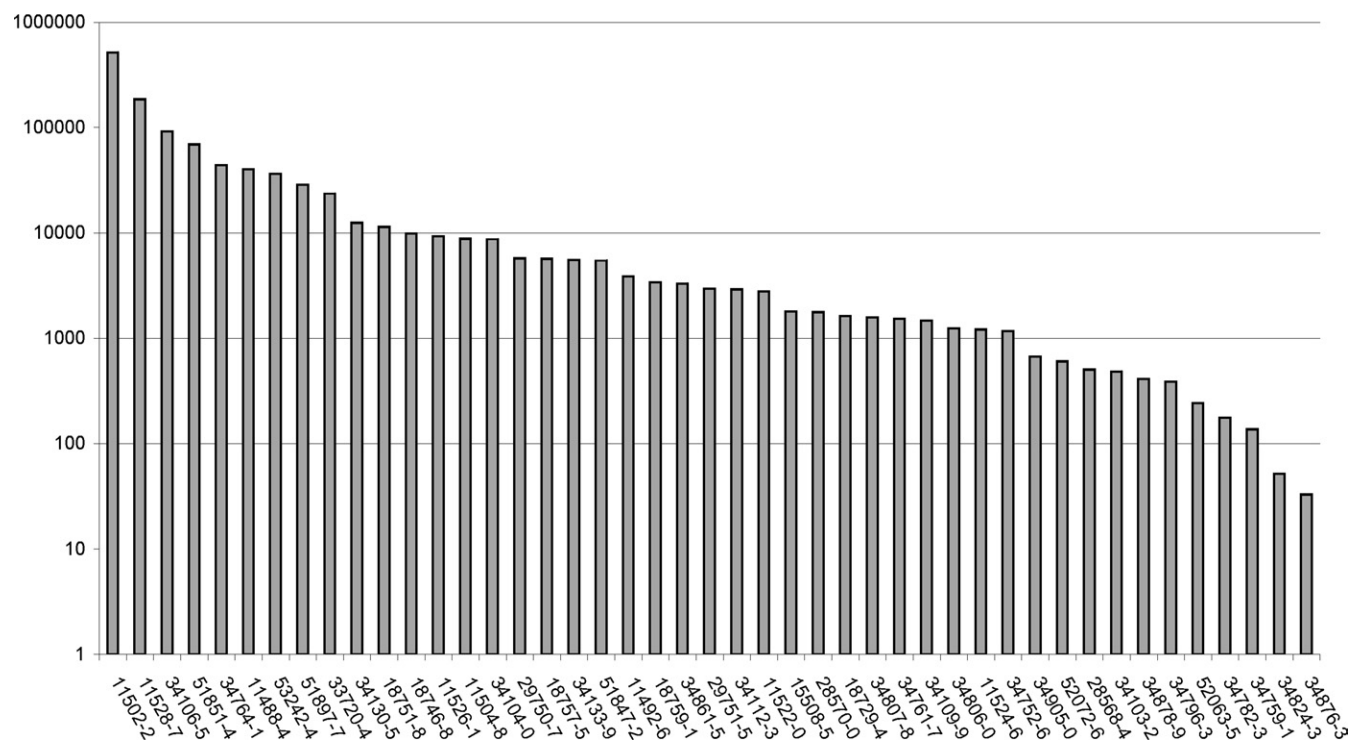
There was a substantial increase in LOINC coverage of the HIS document types between versions 3.23 and 3.24 of RELMA, from 77 to 93%. The clinical LOINC committee is continuing to work on names and codes for clinical notes. This initiative is called HL7 LOINC Document Type Vocabulary Domain Development.<sup>6</sup>

Shapiro<sup>7</sup> analyzed 163 document titles available in the Medical Entities Dictionary at New York Presbyterian Hospital with respect to subject matter domain (SMD) and performed a LOINC mapping. Ninety-one of 163 (56%) were classified as "not specified". In the setting for this study, 10 of 86 (12%) document types could not be mapped to LOINC. Because Shapiro focused on SMD and used an older version of LOINC, there are limitations when comparing these results.

Hyun<sup>8</sup> analyzed nursing document components from a commercial HIS (ECLIPSYS). Forty-three document types contained 308 different section headings. Thirty-eight percent of these sections could be mapped to LOINC. Hyun identified similar issues with the mapping process as in our case, for instance missing entries in LOINC or LOINC codes with limited specificity.

Brown<sup>9</sup> developed a document-naming nomenclature (DNN). He reviewed 1,094 unique note titles from Nashville and Murfreesboro, VA medical centers. An evaluation of DNN was conducted in three hospitals with coverage of 97-99%. The DNN consists of seven categories and altogether 696 terms allowing a multitude of combinations. In contrast, LOINC version 2.24 provides 503 fixed clinical document codes.

Interoperability of healthcare IT systems would be improved if HIS vendors would add LOINC document codes to their products. This would enable an automated mapping of patient documents between different systems; in addition, standards for medical documentation would be fostered. Internationally, standardized document codes would also facilitate



**Figure 1.** Number of documents per LOINC code. Overall, 45 unique LOINC codes were identified covering 1,157,287 of 1,243,325 documents (93.1%). Observation period Jan to Dec 2007.

benchmarking of HIS. For example, it would be possible to analyze documentation patterns for a certain disease between different hospitals and healthcare systems. This is relevant to assess the quality of medical documentation. LOINC document codes are also relevant for clinical research, for instance, because they can be applied to analyze medical practice patterns. Therefore, the authors assume that LOINC codes will play an important role in medical data standards.<sup>10</sup>

## Conclusions

A mapping of LOINC codes to HIS documents is feasible, but more codes are needed to address all clinical document types. Standardized document codes have many potential application areas such as interoperability of healthcare IT systems, HIS benchmarking, as well as clinical research.

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