

Methods of Information in Medicine

The Significance of Information Quality for the Secondary Use of the Information in the National Healthcare Quality Registers in Finland

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DOI: 10.1055/a-2511-7866

Please cite this article as: Frondelius A, Kinnunen U-M, Jormanainen V. The Significance of Information Quality for the Secondary Use of the Information in the National Healthcare Quality Registers in Finland. *Methods of Information in Medicine* 2024. doi: 10.1055/a-2511-7866

Conflict of Interest: Anna Frondelius:

No conflicts of interest

Ulla-Mari Kinnunen:

Support for the present manuscript:

Should there be APC, the University of Eastern Finland will cover that

Leadership or fiduciary role in other board, society, committee or advocacy group:

A board member of the Welfare, Health and Management (WELMA) Doctoral Programme at the University of Eastern Finland

Leader of the Finnish nursing terminology group

Member of the Publication Forum, panel 14 (<https://www.tsv.fi/julkaisufoorumi/haku.php?lang=en>)

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Abstract:

Background

The aim of the national healthcare quality registers is to monitor, assess, and improve the quality of care. The information utilized in quality registers must be of high quality to ensure that the information produced by the registers is reliable and useful. In Finland, one of the key sources of information for the quality registers is the national Kanta services.

Objectives

The objective of the study was to increase understanding of the significance of information quality for the secondary use of the

information in the national healthcare quality registers and to provide information on whether the information quality of the national Kanta services supports the information needs of the national quality registers, and how information quality should be developed.

Methods

The research data was collected by interviewing six experts responsible for national healthcare quality registers, and it was analyzed using theory-driven qualitative content analysis based on the DeLone and McLean model.

Results

Based on the results, the relevance of the information in the Kanta services met the information needs of the national quality registers. However, due to the limited amount of structured information and deficiencies in the completeness of the information, relevant information could not be fully utilized. Deficiencies in information quality posed challenges in information retrieval and hindered drawing conclusions in reporting. Challenges in information quality did not diminish the intention to use the information when information was considered relevant. Solutions to improve information quality included structuring, development of documentation practices, patient information systems and quality assurance, as well as collaboration among stakeholders.

Conclusions

The Kanta services' information is relevant for the national healthcare quality registers, but developing the quality of the information, especially in terms of structures and completeness, is the key to fully enabling the secondary use of this information.

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Appendix 1. The interview guide of the study. Questions 6.1 and 6.2 are not reported as part of the results of this study.

1. Background Information

1.1 Briefly describe your job duties and responsibilities in quality register work.

2. The Quality of the Information in the Kanta Services: Relevance

2.1 What information contents of the Kanta services are currently used in quality registers?

2.2 What information contents of the Kanta services are intended to be used in quality registers in the future?

2.3 How do you perceive the relevance and usefulness of the information in the Kanta services in relation to the information needs of the quality registers?

3. The Quality of the Information in the Kanta Services: Completeness

3.1 How do you perceive the completeness of the information in the Kanta services in relation to the information needs of the quality registers?

3.2 What effects have the completeness of the information in the Kanta services had on the use of the information in quality registers? Does the completeness of the information affect the intention to use the information in the future and if so, how?

4. The Quality of the Information in the Kanta Services: Usability (Sufficient Structuring)

4.1 How do you perceive the level of structuring of the information in the Kanta services in relation to the information needs of the quality registers?

4.2 What effects have the level of structuring of the information in the Kanta services had on the use of the information in the quality registers? Does the level of structuring affect the intention to use the information in the future and if so, how?

5. The Quality of the Information in the Kanta Services: Other Quality Attributes

5.1 What other quality attributes of the Kanta services' information do you consider essential for quality registers?

5.2 What effects do these quality attributes have on the use of the information or your intention to use the information in the quality registers?

6. User Satisfaction

6.1 How has the quality of the Kanta services' information you have already utilized met your expectations and needs in your work?

6.2 How have your experiences with the use of the information in the Kanta services so far influenced your willingness to use the information in the quality registers in the future?

7. The Development of Information Quality and Additional Information

7.1 How do you think the quality of the information in the Kanta services should be developed in relation to the information needs and information production processes of the quality registers?

7.2 Do you have any additional information or perspectives that you would like to share regarding the research topic?

Appendix 2. The progression and logic of the qualitative content analysis. Original expressions were translated from Finnish to English.

MAIN CATEGORY	ORIGINAL EXPRESSION	SIMPLIFIED EXPRESSION	SUBCATEGORY	UPPER CATEGORY
The development of information quality in relation to information needs	For example, now procedure codes might be used very differently, even though we might think it's very clear how they should be used, but then there are completely different approaches in different regions.	Procedure codes may be used differently in different regions, even though their use is assumed to be unambiguous.	Consistency in documentation	Documentation practices
	The structured documentation of laboratory results, no longer within a text field but in a structured format.	The structured documentation of laboratory test results, not as a free text.	Structured documentation	Documentation practices
	This laboratory information is important, so the national codes, which exists for these examinations, maintained by the Association of Finnish Municipalities, should be systematically utilized, one hundred percent, at least for basic examinations.	The use of the national laboratory examination codes should be 100% implemented, at least for basic examinations.	Codes used by healthcare personnel	Codes and classifications
	Quality checks, I talked about this schematron technique right at the data reception stage, so it would be good to have those, and it would be good to make them public, so that everyone can	It would be beneficial to implement quality checks at data entry and make them public, so that everyone can see the rules required from structures.	Quality assurance upon data entry in the Kanta services	Quality assurance

	see what the required rules for those structures are.			
	It would certainly be beneficial to have a better description of the content of the Kanta services.	The information content of the Kanta services should be better described.	Comprehensiveness of metadata	Metadata
	The fact that some of the information is in unstructured form. It is such an obvious area for development.	Increasing the amount of structured information is an obvious area for development.	Amount of structured information	Defining information structures
	Lifestyle information, such as physical activity and nutrition. We don't have any national consensus on how to record them in patient information systems, and therefore there's no sensible platform or structure for them in Kanta either. That's a significant area for improvement.	There is no consensus on how to document lifestyle information in patient information systems, so there are no structures for them in Kanta either. This is an area for improvement.	Defining new information structures	Defining information structures
	Perhaps the structure or version of the structure that should be used hasn't been implemented in the information systems.	The structure or version of the structure that should be used might not have been implemented.	Changes to patient information systems	Patient information systems
	In many patient information systems, structured documentation has been made surprisingly difficult.	Structured documentation is challenging in patient information systems.	Changes to patient information systems	Patient information systems

	<p>The possibility of feedback, in a way to be in touch with those who produce the information, so that the information is somehow traceable, might enhance the usability of the information. It's a bit like, if we were to discover some ancient Kanta data during an archaeological excavation, we wouldn't know whom to ask or what these are, which reduces the relevance of the data in a way.</p>	<p>The traceability of information and the possibility of feedback to data producers would enhance the usability. If we don't know whom to ask about the information, it will diminish the relevance of the information.</p>	<p>Information traceability and feedback to information producers</p>	<p>Collaboration</p>
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Abstract

Background The aim of the national healthcare quality registers is to monitor, assess, and improve the quality of care. The information utilized in quality registers must be of high quality to ensure that the information produced by the registers is reliable and useful. In Finland, one of the key sources of information for the quality registers is the national Kanta services.

Objectives The objective of the study was to increase understanding of the significance of information quality for the secondary use of the information in the national healthcare quality registers and to provide information on whether the information quality of the national Kanta services supports the information needs of the national quality registers, and how information quality should be developed.

Methods The research data was collected by interviewing six experts responsible for national healthcare quality registers, and it was analyzed using theory-driven qualitative content analysis based on the DeLone and McLean model.

Results Based on the results, the relevance of the information in the Kanta services met the information needs of the national quality registers. However, due to the limited amount of structured information and deficiencies in the completeness of the information, relevant information could not be fully utilized. Deficiencies in information quality posed challenges in information retrieval and hindered drawing conclusions in reporting. Challenges in information quality did not diminish the intention to use the information when information was considered relevant. Solutions to improve information quality included structuring, development of documentation practices, patient information systems and quality assurance, as well as collaboration among stakeholders.

Conclusions The Kanta services' information is relevant for the national healthcare quality registers, but developing the quality of the information, especially in terms of structures and completeness, is the key to fully enabling the secondary use of this information.

Keywords information, information quality, secondary use, quality register

1 Introduction

Quality registers (QRs) are databases containing information about the quality, results, and effects of the care received by patients, and they are used for systematically monitoring, evaluating, and improving healthcare outcomes.¹ The aim is to improve care quality and to produce more efficient and equitable healthcare services.¹ In many countries, such as Sweden, Denmark, and the United Kingdom, QRs have been utilized to improve care quality and patient safety, as well as for research purposes.^{2,3,4} In Finland, the first nine national QRs were subject to controller liability of the Finnish Institute for Health and Welfare by the Ministry of Social Affairs and Health at the beginning of 2023 (Table 1).^{5,6}

The real-world data (RWD) produced in everyday healthcare and reused in QRs must be of high quality to ensure that the information produced by the registers is reliable and useful.^{7,8,9}

The information quality is a multidimensional concept and can be described through quality attributes. The use of the quality attributes is, however, not consistent in the research literature.^{7,10,11} Frequently recurring quality attributes in the literature include correctness, accuracy, currency, and completeness,^{7,10,11,12,13,14} but also relevance, content, and form.^{11,15,16,17,18} When assessing information quality, particularly in terms of its relevance and suitability for intended purpose, emphasis is placed on the information user and the context of use.^{11,15,19} The methods for quality assessment should be chosen according to the requirements of the information's intended use.^{19,20} In this article, the information quality was examined

with a focus on context, considering the needs of the users and the purpose of use. The context-dependent quality attributes of information, particularly perceived completeness, relevance, and usability, were examined.^{16,21}

Several previous studies have aimed to explore the importance of the quality of healthcare information for its secondary use, referring to its utilization outside of direct patient care.^{22,23,24,25,26} Relevance, or suitability for purpose, is a quality attribute related to the content of the information, and it can also be described as perceived usefulness.^{10,17,27} However, information relevant for the intended use is not always complete enough for use.¹⁸ There is no universally applicable threshold for an acceptable amount of missing information.¹⁴ Instead, it is necessary to consider to what extent deficiencies in completeness pose a problem for the planned use of the information.²² User assessment of the completeness of the information in relation to the purpose of use describes the amount of information necessary for intended use.^{10,16,22,27,28} In healthcare QRs, deficiencies in the completeness of information can cause difficulties in carrying out a reliable assessment of patient care outcomes.^{29,30,31,32}

In addition to completeness and relevance, the usability of information can be considered as a key feature for the secondary use of the information. Although usability usually refers to the ease of using an information system,^{12,33} it can also be interpreted as an attribute of information quality.^{10,21,34} In this study, usability was examined as sufficient information structuring in relation to the purpose of use. Structured information is stored by using defined data structures.³⁵ Previous studies have found that structuring patient information produces higher quality information for secondary use.^{23,36}

Information quality has an impact on whether the information is wanted for use and whether the information meets the needs of users. Information quality is a significant factor in users' intention to use information systems.^{37,38,39,40} In QRs, poor-quality information can cause

various problems for the end use of the information produced by these registers. The effects of patient care interventions can be over- or underestimated, and goals set for QRs, such as assessing care quality and making decisions based on registers, cannot be reliably achieved.^{10,31,32,41} Deficiencies in the completeness of information can distort analyses based on the information, while relevance and sufficient structuring are essential for the usefulness and usability of the information.^{9,30,32}

The Kanta services, Finland's national electronic information system services and information resources for healthcare and social welfare⁴², are one of the key data sources for QRs in Finland. The users of the Kanta services include pharmacies, healthcare and social welfare services, and inhabitants.⁴² Pharmacies and healthcare service providers in both public and private sector enter their patient data into the Kanta services.⁴² A professional enters the information into the patient information system, from where it is stored in the Kanta services in an up-to-date format.⁴² The Kanta services' information is transferred to the QRs through separate information retrieval and then processed to be stored in the QRs.^{43,44} The completeness of the information and the amount of structured information in the Kanta services in relation to the information needs of the QRs were examined during the pilot project of QRs in 2018–2020 and during the data vault pilot of the national diabetes QR in 2020–2021.^{43,44,45} Deficiencies were identified in the information completeness, and the amount of structured information in the Kanta services was found to be insufficient.⁴⁴ The quality assurance of healthcare data, the development of the Kanta services, and increasing the role of Kanta services' information in secondary data use are all national strategic objectives in Finland.⁴⁶ Research on the significance of information quality for secondary use is also a central theme internationally, as the secondary use of clinical information increases, including across national borders.⁴⁷

2 Objectives

The purpose of this study is to map the views of the experts responsible for the national QRs on information quality in the Kanta services in relation to the information needs of the national QRs, and the significance of information quality for information usage and intention to use the information. In addition, the purpose is to map the experts' views on how the quality of information should be developed in relation to the QRs' information needs. The study objective is to increase understanding of the significance of information quality for the secondary use of the information in the national QRs, and to provide information on whether the information quality of the Kanta services supports the information needs of the national QRs, and how information quality should be developed.

3 Methods

3.1 Theoretical Framework and Research Questions

The theoretical framework applied in this study was the model of DeLone and McLean¹², in which information quality, information system usage, and intention to use are all interconnected. In this study, the term usage refers solely to information use, not to the use of an information system. Furthermore, usage is considered secondary use of the information from the Kanta services, as reported by the QRs' experts, and it occurs as information retrieval from the Kanta services and as processing, analyzing, and reporting this information as part of the QRs' information production processes. Intention to use describes experts' motivation to utilize the information in the Kanta services and is connected to information quality attributes that may influence intention to use.^{12,21,34} Intended usage targets the phase of defining information needs and identifying relevant information contents from the perspective of QRs. It was assumed in the study design that the quality of the information needed to align with the information needs of the experts to ensure not only an intention to use the information but also its actual use. To address the issue of the significance of information

quality for the secondary use of the information in QRs, we formulated the following research questions:

What is the quality of the information in the Kanta services in relation to the information needs of the national healthcare QRs?

What significance does the quality of the information in the Kanta services have for the use or for the intention to use the information in the national healthcare QRs?

How should the quality of the information in the Kanta services be developed in relation to the information needs of the national healthcare QRs?

This study is based on the Master's thesis published at the University of Eastern Finland by the first author.⁴⁸

3.2 Data Collection Phase

The data collection method used in the study was semi-structured interviews. The sampling method employed was purposive elite sampling, in which individuals were selected for interviews based on the assumption that they would have the best knowledge of the research phenomenon.⁴⁹ The interview questions were formulated based on the model of DeLone and McLean.¹² There was a total of fourteen questions, eight of which were examining the relationship between the information quality and the usage or the intention to use, further divided into questions addressing different information quality attributes and a question focusing on information quality development. Considering information relevance, interviewees were asked which information contents of the Kanta services were used in the national QRs' information production processes at the time of study, and which information contents they intended to use in the future. In addition, the interviewees were asked for background information and were also given opportunities to freely provide any additional

information related to the topic of the study. The interview guide of the study is presented in Appendix 1.

A total of six experts were interviewed. The interviewees were divided into two groups, each consisting of three individuals. The interviews for the study were conducted remotely in January and February 2024. The interviews were conducted as individual, paired, and group interviews. The original plan was to collect data using a specific form of interview: a focus group discussion.⁵⁰ However, the data collection methods varied because it was difficult for the interviewees to participate in the planned interviews due to scheduling reasons. Each interview was recorded and transcribed verbatim, and the transcript was pseudonymized. Finally, transcripts of group, pair and individual interviews lasting a total of 4 hours and 9 minutes were combined. The length of the combined material was 59 pages (font Times New Roman 12, spacing 1).

3.3 Data Analysis

The data analysis method used in this study was theory-driven, deductive, qualitative content analysis, in which the concepts defined according to the DeLone and McLean model¹² and adapted to the research context were integrated into the data analysis.⁵¹ The classification of the data was based on the chosen theoretical model, from which the main categories of the structured analysis matrix were formed: the relationship between information quality and information usage, and the relationship between information quality and the intention to use the information. The analysis matrix was complemented with main categories concerning the relationship between information quality and information needs, and the development of information quality in relation to information needs. These main categories described the information quality required for using the information and how the information quality should be developed to make the information more suitable for QRs in the future. The interview data

was coded, the original expressions were simplified, and the expressions belonging to the analysis matrix were grouped into the main categories of the matrix.⁵¹ The unit of analysis was a complete expression or statement appearing in the original interview data. Simplified expressions placed under the main categories were examined within the category inductively, and subcategories were formed. Subsequently, these subcategories were further condensed into overarching upper categories. These upper categories formed the basis for drawing conclusions. The progression and logic of the analysis is presented in Appendix 2, where the analysis is described with respect to one main category: the development of information quality in relation to information needs. Software was used to support the qualitative content analysis (Atlas.ti 24, ATLAS.ti Software Development GmbH, Berlin).

3.4 Ethical Considerations

This study was conducted following the ethical research guidelines of the Finnish National Board on Research Integrity, the Personal Data Register Act of Finland, and the EU's General Data Protection Regulation.^{52,53,54} Based on the decision of the register controller, the Finnish Institute for Health and Welfare, the research project did not require a research permit. Before the interviews, participants were requested to provide informed, ethical consent to participate in the research. To inform the participants, they were provided with a research information sheet, and they also had the opportunity to familiarize themselves with the research data protection and privacy statements.^{52,53} Participation was voluntary, and the interviewees had the right to discontinue their participation in the research at any time.⁵⁵ In accordance with good scientific practices, material containing personal data was destroyed after the material had been pseudonymized.⁵⁵ The background information of the interviewees was not reported because it was identified as individualizing information.

4 Results

4.1 The Quality of Information in Relation to the Information Needs of the Quality Registers

The interviewees deemed the information provided by the Kanta services to be useful for the QRs, and thus the relevance of the information matched the information needs. Several interviewees emphasized the usefulness of laboratory test results and physiological measurements, as well as diagnosis, medication, oral healthcare and medical procedure information.

“Physiological measurements, I think, are just like a treasure trove, similar to lab tests and results.”

In addition to the actual patient information, interviewees identified information related to service events as a relevant content. They also considered metadata, or descriptive information, to be useful for QRs’ information production processes. However, the amount of structured information in the Kanta services and the information completeness only partially matched the QRs’ information needs. If the information contents relevant for the QRs were only partially structured, the structured portion of the information determined the perceived information completeness. The amount of structured information in the Kanta services was commonly described as limited.

“Actually, the question is precisely how it can be utilized, as the amount of structured information is limited.”

The structuredness and thus also the completeness of the physiological measurements, but also some of the laboratory test results, were perceived as insufficient. In addition, the refinement level of the structuring of the physiological measurements was not sufficient for all variables. Refinement was desired in the information structure regarding whether blood pressure measurement was a single measurement or an average of measurements over several

days. As for laboratory test results, challenges were identified especially in data fields where text was combined with numerical values.

“Numerical results are better structured, but when it comes to positive, negative, or under or over a threshold results, they are not as often structured.”

The structuring of different information contents of the Kanta services in relation to the QRs' information needs and observations made by the interviewees are presented in Table 2.

Experts were mainly satisfied with the medical procedure information and found it sufficiently structured, but they would like the information structures to be refined. Adverse effects of treatment, treatment outcomes, clinical findings, and functional capacity and lifestyle information were identified as relevant information contents for all QRs. However, these were available in the Kanta services only in unstructured format, or the level of structuring or structured documentation was insufficient at the time of study. The lack of sufficient information structuring was given as one reason for using separate local information systems as information sources for QRs.

“These things that are missing, well indeed, such as clinical findings, that in the rheumatology register we have to record separately using completely different information systems, as the patient information systems do not support this, for example, whether the joints are swollen and painful.”

As well as the structuring of the information, information completeness varied depending on the information content and the level of specificity desired.

“It actually depends entirely on what information is being looked at.”

“When it comes to weaknesses in completeness, especially when we delve into more specific details, it's not always as complete.”

Diagnosis and procedure information, as well as some of the laboratory test result information, were perceived as sufficiently complete for the information needs of the QRs. The information completeness was said to depend on clinical practices, or established ways of recording diagnoses and conducting laboratory tests, and it was said to be partly in line with expectations and partly contrary to them. Although the quality of the medication information was deemed good, the absence of medication information from inpatient care reduced the overall information completeness. The information completeness regarding different service providers and regions was considered to be a key strength of the national Kanta services by the interviewees.

“Its usefulness comes from this comprehensiveness...that there is both private and public healthcare, as well as specialized medical care and primary healthcare.”

Adequate descriptive information, or metadata, was considered important for the QRs, because it assisted in identifying relevant information contents and finding information. However, the comprehensiveness of the descriptive information did not entirely meet the QRs' information needs, as finding and interpreting the information was somewhat challenging.

“Of course, a lot of data gets transferred there, all sorts of things thrown into kind of a black sack, and then we have to blindly search and see what's in there, and what hasn't been found yet, so then we're not quite sure if it's there or not, and in what form.”

4.2 The Significance of Information Quality for Information Usage and Intention to Use the Information in the Quality Registers

According to the interviewees, completeness and sufficient structuring of the information were especially significant for information usage. Data integrity and comprehensiveness of metadata were also considered significant. The sufficient structuring of the information and

the comprehensiveness of metadata were perceived as essential for information retrieval and interpreting the information, while completeness was important for analysis and reporting.

Insufficient completeness hindered progress to analyses due to the additional work required to address completeness issues. Insufficient completeness also required consideration of when information was sufficiently complete for drawing conclusions. Interviewees also reported several limits on completeness, which were significant for information utilization in analyses and reporting, and especially in drawing conclusions. The limits of sufficient completeness were register-, variable-, and population-specific.

“If there have been these coverage issues, it certainly slows down our work, slowing down or delaying those analyses, the investigative work that may have to be done.”

“If there is any information, the coverage of which is so patchy that we no longer trust it to be representative and reliable, then we have agreed that in the quality registers, it will not be shown as a result. We only show that the measurement completeness is like this, and reliable conclusions cannot be drawn.”

According to the interviewees, only structured information is directly usable in QRs. Unstructured information is not used in QRs because utilizing unstructured information requires processing it into a structured format. Based on the interviews, there was also no intention to use unstructured information, although partially structured information or information recorded somewhat against the documentation guidelines into a structured field was attempted to be utilized.

“If there isn't structured data, then basically we cannot and will not use it. If it's structured, then basically we're very interested in using it.”

Interviewees also described the importance of sufficient structuring of information in terms of some single information contents. Regarding some laboratory test results, deficiencies in

structuring had caused challenges not only in information acquisition but also in information processing and interpretation. According to the interviewees, the challenges were related to the manner of information acquisition, which had to be adapted due to insufficient availability of structured information. In these cases, information needed to be retrieved and extracted from text fields using string-search methods, as structured fields had not been utilized during the documentation of the information.

“Even if it's a numerical value, it may be entered into a text field. And of course, even a numerical value might be considered structured, but since they often involve units, finding a number that fits the unit and ensuring that they indeed correspond to each other isn't always obvious.”

Based on the interviews, the comprehensiveness of metadata was a significant quality attribute, particularly for information acquisition, but also for information interpretation. Although the metadata comprehensiveness was perceived to be sufficient to some extent, and it was reported that metadata aided in drafting data requests, deficiencies in metadata comprehensiveness had also caused challenges in finding and interpreting information.

“And then when it comes to metadata, which describes the actual data content itself, its absence naturally consumes a lot of working time, as one has to try to guess what might be there or what this data could mean.”

Based on the interviews, the significance of information quality for the intention to use the information mainly appeared in two ways: perceived good information quality increased the intention to use the information, or alternatively, information quality did not diminish the intention to use. The latter alternative occurred when, despite some perceived deficiencies in information quality, the information was still intended to be used. Only unstructured information reduced the intention to use the information, but even then, possibilities to

structure the information were considered. The intention to use the information was defined by experts' motivation to improve the information quality if needed.

“If there's something as important as lab results or physiological measurements, or information about oral health, then we just utilize them despite any problems, and then those quality and other issues just have to be resolved.”

At the time of the study, there was an intention to use the relevant information contents of the Kanta services, which had been identified but not yet utilized, across multiple registers. Additionally, there were plans to gradually expand the utilization of the information contents provided by the Kanta services.

4.3 The Development of Information Quality in Relation to the Information Needs of the Quality Registers

The information quality development areas identified by the interviewees were related to information structures, codes and classifications used in healthcare, patient information systems, documentation practices, and the data production processes prior to secondary use. In addition, decision-making by healthcare service providers regarding information systems, as well as inter-organizational collaboration, was seen as significant for improving the information quality of the Kanta services. Most information quality development areas were related to the information completeness and to enhancing the documentation in structured format (Table 3).

Because structured information was considered necessary for utilizing information in the QRs, experts would like structures defined on a national level for Finnish healthcare to be more widely adopted in the Kanta services and patient information systems. Defining new information structures, as well as improving existing ones, was also considered important.

“Why isn't that information structured, starting from what has been discussed, it hasn't even been defined to be stored in the Kanta services with the right or necessary structures.”

Regarding the existing healthcare codes and classifications, areas for development included more detailed diagnosis classifications, a sufficient hierarchy of classifications, and broader utilization of the Association of Finnish Municipalities' national laboratory test codes in documentation. Implementation of the development of information structures and classifications was wanted without increasing the workload of healthcare professionals due to documentation. The consistency and accuracy of documentation, and the utilization of structured fields, were considered important.

“For example, now procedure codes might be used very differently, even though we might think it's very clear how they should be used, but then there are completely different approaches in different regions.”

“Mostly there is a structured field available for them, but the problem is whether that field has been used.” (physiological measurements)

The development areas related to patient information systems concerned mainly data structures and structured documentation. Experts would like all patient information systems used in Finland to adopt the newer version of the Kanta services' data specifications, which is more structured and contains more data fields compared to the older version. Additionally, it was seen as important that the hierarchy of data models used in patient information systems should be developed in such a way that the connections between the variables would be easier to infer.

“The hierarchy of information, that's an evident area for development.”

Quality assurance upon information entry in the Kanta services was also seen as a development area. After information has been received in the Kanta services, information

contents are rearranged into a format more suitable for secondary use prior to usage in QRs. In terms of this process, the identified areas for improvement were increasing the transparency of the process for secondary users and preventing the disruption of referential integrity. Furthermore, it was hoped that improving the comprehensiveness of metadata would facilitate finding relevant information in the Kanta services, interpreting information, and tracing information in situations in which information quality development requires collaboration among stakeholders.

5 Discussion

The information in the Kanta services was perceived as relevant for the national QRs in Finland, but the completeness and, in particular, the structuredness of the information contents did not fully meet the information needs of the QRs. Based on previous research, structured documentation enhances the quality of the documented information in terms of consistency, accuracy, and completeness, and supports semantic interoperability.^{23,36} The significance of structured information for the secondary use of the information was evident in the results of this study. Although information relevance primarily guided information acquisition, sufficient structuring was perceived as necessary for the possibility to use the information. The perceived usability of unstructured or partially structured information in the QRs was poor. Based on the results, it was also evident that if there was not enough structured information available, information completeness was perceived as insufficient. However, for some information contents, it remained unclear whether the lack of completeness of structured information was due to missing or inadequate structured documentation in patient information systems or problems related to data transmission from patient information systems into the Kanta services. Information coverage across various service providers, and thus throughout the care pathways, supported the QRs' information needs. The perceived amount of structured information and information completeness varied depending on the

information content. Overall, the challenges regarding information quality in the Kanta services in relation to the QRs' information needs identified in this study were very similar to those observed in previous examinations during the QRs' pilot projects.^{43,44,45}

Based on the findings in this study, the significance of information quality for the intention to use the information was associated with the perceived relevance of the information.

Information contents perceived as relevant and high quality were intended to be used also in the future. This is congruent with previous studies using the DeLone and McLean model,¹² which indicate that information quality is a significant factor in users' intention to use information system.^{37,38,39,40} However, in this study, potential challenges in information quality did not diminish the intention to use the information if the information was considered relevant. Only unstructured information was associated with a reduced intention to use, although the experts were considering possibilities to utilize unstructured information in the future. Results can be interpreted as an indication of experts' high motivation to use the national Kanta services' information contents.

Previous studies based on the DeLone and McLean model¹² indicate that the relationship between information quality and information system usage has been challenging to study and interpret due to varying definitions of usage in research designs and an absence of consistent measures of use.^{34,37} Usage has been defined differently depending on the study, either as actual usage or as self-reported usage.³⁷ In this study, the interest focused on understanding the significance of information quality for QRs' information production processes and how it potentially changes practices in these processes. The relationship between reported information usage and information quality was interpreted purely qualitatively, without attempting to measure usage quantitatively or generalize the results.

Based on this study, it can be concluded that the quality of information in the Kanta services is significant for the information usage in QRs. According to interviews, information completeness and the structured format of information were especially significant for information usage. Sufficient information structuring was perceived as important for information retrieval and interpreting the information, while completeness of the structured information was important for analysis and reporting. Insufficient completeness or an absence of structured information slowed down and complicated the operational processes of the QRs' information production. The problems focused on certain information contents of the Kanta services and on the early stages of information production, especially information acquisition, in which the structuredness of information influenced adopted practices. The significance of metadata comprehensiveness was twofold: it either facilitated information acquisition by supporting the drafting of data requests or, when inadequate, hindered the interpretation of acquired information for analyses.

Insufficient completeness, considering certain information contents in the Kanta services, prevented progress to analyses, and subsequently no conclusions were drawn based on this information. In these cases, information was relevant for the intended purpose, but not sufficiently complete to be utilized as planned.¹⁸ In previous studies focused on QRs, the same challenge has been noted regarding completeness. If information is not sufficiently complete, analyses based on the information are not reliable, and conclusions cannot be drawn.^{29,30,31,32}

Based on our results, this challenge was addressed in information production by contemplating acceptable limits of completeness. In the absence of a universal boundary, QR experts reached the same conclusion as Weiskopf and his research team²² in their previous study. The experts on QRs decided to define the limits of acceptable completeness based on information needs on a case-by-case principle. Limits were defined according to the register, population, and variable in question.

Developing information quality in the Kanta services to meet the QRs' information needs is essential for enabling the secondary use of this information. Based on our results, there was a need to develop both the information structures and the completeness in relation to the QRs' information needs, with the information structures being considered a primary area for development. The results also indicated a need for increased collaboration among stakeholders, to form a shared understanding of the quality requirements and implementation processes of quality assurance on a national level. Based on our results, it could be beneficial to consider applying more specific quality standards for the Kanta services' information as well as develop the quality assurance upon data entry in the Kanta services to enhance the information quality and the awareness of information quality requirements.

Information quality, as evidenced in our study and earlier research, influences the reliability of the quality register information and is essential for enabling informed decision-making based on these registers.^{10,30,31,32,41} Information quality is also significant for the QRs' information production processes. Thus, ensuring high-quality information is essential for achieving the goals of the national healthcare QRs in improving healthcare outcomes and the quality of care.

6 Reliability and Limitations

The reliability of this study was considered in terms of consistency, credibility, transferability, and confirmability.^{56,57} The credibility of this study was supported by purposefully selecting interviewees based on their expertise, relative to the research task. To enhance credibility and confirmability, the aim was to describe the analysis process in such a way that the connection between the data and the results is evident.⁵¹ The reliability of the analysis was increased by incorporating authentic quotations into the results,⁵⁷ and the internal consistency was

improved by maintaining a consistent relationship between the theoretical framework, the research questions, and the collection and analysis of research data.

This study has several limitations. Transferability is a typical limitation of qualitative research.⁵⁷ This study was intentionally highly context bound and, accordingly, it is not recommended to transfer the results to another context without careful consideration. The chosen attributes of information quality were linked to the use case, and quality was assessed based on the users' experiences at a certain point in time from the perspective of specific QRs. Another potential study reliability limitation is the data acquisition method, namely interviews. Saturation is reached when further interviews no longer yield additional insights into the research phenomenon.⁵⁸ Increasing the number of interviewees likely would not have brought significantly new information, given that saturation was observed in the chosen sample size. The interviews were conducted as group, pair, and individual interviews, so reliability could have been enhanced by employing the same data collection method in all interviews. In group and pair interviews, interaction between participants emerged, which was considered desirable for the study. A unified, homogeneous group, as in this study, is often preferred in research as it more likely fosters in-depth discussions.⁵⁰ The first author performed data collection and data analysis. The researcher's manner of posing questions and interpreting interview data have naturally influenced both the formed research data and the conclusions drawn from it. The study reliability could have been increased by recoding and analyzing the interview data at another time or by another researcher.

7 Conclusions

In conclusion, the information in the Kanta services is relevant for the national healthcare QRs, but developing information quality, especially in terms of information structures and completeness, is the key to fully enabling the secondary use of this information.

The results of this study can be utilized in the development of information quality in the national Kanta services to better meet the information needs of Finland's national healthcare QRs, and thus in enabling more comprehensive utilization of the Kanta services' information to improve healthcare outcomes and the quality of care. The study findings may also prove beneficial by increasing awareness about the significance of information quality for opportunities to utilize information in secondary use.

Acknowledgements

We would like to thank the interviewees who participated in the study.

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Table 1. Finland’s national quality registers and their target populations

QUALITY REGISTER	TARGET POPULATION
Diabetes Register	Diagnosed patients with diabetes
Cardiac Register	Diagnosed patients with coronary artery disease, including acute coronary syndrome patients
Rheumatology Register	Diagnosed patients with inflammatory rheumatic diseases
Register for Kidney Diseases	Adults who have initiated chronic renal replacement therapy
Psychosis Care Register	Diagnosed patients with psychosis (certain main groups of ICD-10 and ICPC-2 diagnosis classifications)
Spine Register	Patients undergoing spinal surgery

Oral and Dental Care Register	Patients who have visited public oral healthcare services (e.g. periodontal diseases and caries)
HIV Register	HIV-positive patients
Intensive Care Register	Patients treated in an intensive care unit

Data from Finnish Institute for Health and Welfare⁶. Finnish Institute for Health and Welfare.

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Table 2. The structuring of different information contents of the Kanta services in relation to the quality registers' information needs and observations made by the interviewees

INFORMATION CONTENT	STRUCTURING OF INFORMATION	OBSERVATIONS
Diagnoses	Sufficient	The accuracy of the ICD-10 and ICPC-2 classifications is not always sufficient
Laboratory test results	Partly sufficient	Some laboratory test results are unstructured or only partially structured
Procedures	Sufficient	The refinement level of structures is partially insufficient
Medication	Sufficient	The medication information of inpatient care is missing

Physiological measurements	Insufficient	Deficiencies in the completeness of structured information
Oral healthcare information	Partly sufficient	Only part of the relevant information is structured
Image information	Insufficient	Statements of images are unstructured Images are not yet available for secondary use purposes
Treatment outcomes	Insufficient	Unstructured
Adverse effects of treatment	Insufficient	Unstructured
Functional capacity information	Insufficient	National information structures have been defined, but documentation in practice is still unstructured
Clinical findings	Insufficient	Unstructured
Lifestyle information	Insufficient	Unstructured (physical activity, nutrition)

Table 3. Areas for development identified by interviewees to enhance information quality

DEVELOPMENT AREA	
Defining information structures	Adoption of defined information structures New information structures Increasing structuring
Codes and classifications	Broader utilization of the Association of Finnish Municipalities' national laboratory



	codes in documentation
	Accuracy of diagnosis classifications
	Hierarchy of classifications
Documentation practices	Documentation according to guidelines
	Structured documentation
	Correctness of documented information
Patient information systems	Data models (hierarchy of data)
	Adoption of more structured versions
	Usability of systems (ease of structured documentation)
Quality assurance	Quality assurance upon data entry in the Kanta services
Healthcare service providers' decisions	Integration into the Kanta services
	Adoption of more structured information system versions
Information production process of the Kanta services for secondary use	Transparency of the process
	Preservation of referential integrity
Metadata	More comprehensive metadata
Collaboration	Feedback opportunities between stakeholders
	Communication about information quality

Appendices

Appendix 1. The interview guide of the study. Questions 6.1 and 6.2 are not reported as part of the results of this study.

Appendix 2. The progression and logic of the qualitative content analysis. Original expressions were translated from Finnish to English.

