Conceptual Analysis of a Diverse Set of Healthcare Quality Indicators

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Abstract: Computerisation of quality indicators for the English National Health Service currently relies primarily on queries and clinical coding, with little use of ontologies. We investigated attributes and relationships in a diverse set of over 200 healthcare quality indicators, categorising by clinical pathway, inclusion and exclusion criteria and Institute of Medicine purpose. Our results, some of which are described in this paper, were used to create an ontology that could reduce duplication of effort in healthcare quality monitoring.

Key Words: Quality Indicators, Health Care; Medical Informatics Applications; Ontologies

Introduction

Ontologies, described as a specification of a representational vocabulary for a shared domain of discourse [1], can facilitate automated quality monitoring by categorising and establishing relationships between concepts. In terms of ontology development, conceptualisation is the informal representation of domain terms in the form of concepts, instances, relations, and properties [2]. Chan et al [3] suggest a need for research into attributes of quality indicators to support electronic health record (EHR) compatibility. Identification of levels of indicator relationships can serve as a step towards repackaging formulas into reusable components.

A 2009 set of over 200 indicators, collated by the English National Health Service Health and Social Care Information Centre (NHS HSCIC) was chosen to attempt to address some of the gaps in research exploring ontologies and healthcare quality indicators [4]. The gaps included: research on healthcare quality indicator purposes, an ontology for healthcare quality indicators that is not dependent on data available in EHRs, an ontology that covers many clinical subject areas, and a healthcare quality indicator ontology that does not require a framework for indicator development.

We set out to identify relationships and layers of inclusion and exclusion criteria for a large, diverse set of quality indicators from the English NHS. The indicators, originating from different sources ranging from the UK Renal Registry to the NHS Quality and Outcomes Framework, are measures related to processes and outcomes. Our analysis served as the conceptualisation stage for an ontology for the indicators.

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1. Method

We created a Glossary of Terms (Table 1), inspired by the NHS HSCIC's Metadata Library Guide [5]. We used conceptualisation techniques of categorical sorting and repertory grid analysis [6] to analyse relationships between classes of information.

1.1 Quality Indicator Dimensions and Next Stage Review Pathways

The categories of Clinical Pathway and Quality Dimension were based on Lord Darzi's strategic report for the NHS [7]. The pathways include: Acute Care, Children's Health, End of Life Care, Learning Disabilities, Long Term Conditions, Maternity and Newborn, Mental Health, Other, Planned Care and Staying Healthy. Darzi identified three broad dimensions, Effectiveness, Safety and Experience, for the clinical areas.

1.2 Quality Indicator Purpose, with Related Indicators

We created a table categorising the quality indicators by IoM guideline purpose [8] to assess the number of indicators in the Screening and Prevention category and thus suited to expression using Arden Syntax. In the same table, we also indicated any related indicators sharing broader, narrower or same level inclusion criteria to each indicator. Jenders [9] tested Arden Syntax, which uses Medical Logic Modules (MLMs), to assess computer interpretability for a set of quality indicators ACOVE (Assessing Care of Vulnerable Elders). However, most MLMs, originally intended as automated single reminders, have been designed for screening and prevention [9].

The IoM [8] purposes for clinical guidelines are: 1) Screening and prevention, 2) Diagnosis and prediagnosis management of patients, 3) Indications for use of surgical procedures, 4) Appropriate use of specific technologies and tests as part of clinical care, and 5) Guidelines [we used the term 'Indicators'] for care of clinical conditions.

1.3 Inclusion/Exclusion Criteria

We used Statement and Definition metadata from the NHS HSCIC to specify inclusion and exclusion criteria.

2. Results

2.1 Glossary of Terms

Table 1 shows the Glossary of Terms used to initiate the conceptualisation process.

Table 1. Glossary of Terms. The majority of the terms have been sourced or modified from the NHS Information Centre's Metadata Guide [5].

Term	Explanation
Unique Identifier	Unambiguous reference number or string of letters and/or numbers
Reference	The source from which the indicator has been derived. The dataset applied
Statement	A sentence or paragraph clearly describing what is being measured
Formula	Formula for determining indicator data result

Creator	Developer of the indicator
Publisher	Party or parties responsible for making indicator available
Version History	Record of revisions to the indicator
Access Point	Location(s) of results
Relations	Other indicators which may need to be considered in conjunction with this indicator and vice versa
Clinical Terminology Code	The clinical term or terms used to source data to calculate the indicator, along with the corresponding codes
URL	URL with the most detail about methodology
Dimension	Three dimensions, identified from a collated vision from ten NHS Strategic Health Authorities [5]: 1) Effectiveness 2) Safety 3) Patient Experience
Next Stage Review Pathway	Eight priority clinical areas, also known as pathways, identified in a collated vision from ten NHS Strategic Health Authorities [5] : 1) staying healthy 2) maternity and newborn care 3) children and young people 4) mental health 5) long-term conditions 6) planned care 7) acute care 8) end of life care
Purpose	The Institute of Medicine [6]: Screening and prevention Diagnosis and prediagnosis management of patients Indications for use of surgical procedures Appropriate use of specific technologies and tests as part of clinical care Indicators for care of clinical conditions
Notes	Miscellaneous information to support the organisation and referencing of quality indicators.

2.2 Quality Indicator Dimensions and Next Stage Review Pathways

The total numbers of indicators for each Dimension and Next Stage Review Pathway are available from the NHS HSCIC [11]. Listing each indicator alongside the relevant Dimension and Pathway enabled us to enter the Dimensions and Pathways as properties of the indicators in our ontology. This supported our goal of making searching for indicators in a particular pathway possible in the ontology.

2.3 Categorisation of Indicators by IoM Purpose, with Related Indicators

Categorisation of the indicators by IoM purpose for guidelines [8] supported the hypothesis that Arden Syntax is inadequate to express different types of indicators. This categorisation showed that the most common purpose was Indicators for the Care of Clinical Conditions, rather than Screening and Prevention. There were 149 indicators with a purpose of Care of Clinical Conditions and just 28 indicators with a purpose of Screening and Prevention. Categorisation of the indicators by IoM purpose, with related indicators, also allowed us to enter Purpose and broader, narrower and same level relationships as properties of the indicators in our ontology.

2.4 Inclusion and Exclusion Criteria

Variations in complexity of the indicator formulae and inconsistent and incomplete metadata regarding the formulae interfered with the fulfillment of the inclusion/exclusion criteria objective during the conceptualisation process. Dependencies were recorded at same level. For example, " *number of doctors washing their hands between seeing patients"* shows a dependency between doctors and patients. "Access to scanning within 3 hours of admission" has two concepts that are recorded at same level because "within 3 hours of admission" must apply to scanning.

3. Discussion

Our conceptual analysis of a 2009 set of NHS quality indicators sought to determine attributes of healthcare quality indicators and relationships between indicator components. We developed a Glossary of Terms, followed by categorical sorting and repertory grid analysis of concepts within the indicators. Two popular healthcare quality-related publications [7,8] were used to inform some of the categories.

3.1 Glossary of Terms

The following headings were added to supplement those chosen from the NHS HSCIC list: Creator, Access Point, Clinical Terminology Code, Dimension, Next Stage Review Pathway and Purpose. Although the NHS HSCIC had a 'Creator/Producer' heading, this referred to the party responsible for providing the outcome data for the indicator, rather than the creator of the indicator formula, methodology or intent. We added Access Point, due to the intended audience including clinical auditing communities and providers of access to indicator data sets. We added Clinical Terminology Code as clinical codes can assist with sourcing data for indicator outcomes. Dimension, Next Stage Review Pathway and Purpose were added to support categorical sorting.

3.2 Next Stage Review Quality Domain and Clinical Pathway

While the NHS HSCIC listed Darzi's [8] Dimension and Clinical Pathway for each indicator and created a table with the number of indicators for each Dimension and Clinical Pathway [11], they did not create a table showing which indicators were assigned to each Dimension and Pathway, grouping related indicators together. Such a table is useful to the ontology conceptualisation process because it shows how indicators from different sources, are related.

3.3 Categorisation of Indicators by IoM Purpose, with Related Indicators

Some IoM categories were broader than others (e.g., 'Guidelines for care of clinical conditions' is broader than 'Appropriate use of specific technologies and tests as part of clinical care'. Where more specific categories would be possible had the information given been more specific (e.g., treatment vs. surgery), we noted this in our analysis.

3.4 Inclusion/Exclusion Criteria

Semantics influenced the number of layers of Inclusion/Exclusion criteria. There were sometimes more concepts than layers. Dependent concepts were recorded at same level. For example, "*the number of doctors washing their hands between seeing patients"* shows a dependency between doctors and patients, as the doctors must have seen patients. "Access to scanning within 3 hours of admission" has two concepts that are recorded at same level, as "within 3 hours of admission" must apply to scanning.

3.5 Limitations

This study was limited by unpredictable changes in the indicators, lack of previous ontology development experience, level of medical expertise and quality of metadata.

4. Conclusions

The conceptual analysis of this set of indicators serves as a snapshot into indicator status, categories and relationships. Categories of dimension, clinical pathway and purpose were identified as attributes of the indicators, along with broader, narrower and same level relationships between indicators from different sources and sets. This conceptualisation process focused on the indicators themselves, rather than interoperability with EHRs. The benefit is the ability to search components of quality indicators from different sources, with a view to reducing duplication of effort in gathering data for indicators with common criteria.

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