1. Negation Requirements for Interoperability Standards

Table of Contents

> Note to readers: This document is not intended to constrain or complicate efforts to design useful specifications, but rather to provide a forum for consensus about what works, and, ideally, reduce the need to recapitulate the problem in future discussions. If there are important facets missing, we would like to include them. We call special attention to the maps in appendix D.

1.1. Introduction to negation

Standards provide value by establishing consistent conventions for communication. When different communities of stakeholders establish these conventions for the same or for overlapping domains, the divergence in standards compromises their value. This divergence presents a fundamental challenge to any effort to broaden interoperability standards beyond the communities that define them. The problem affects even the most easily harmonized elements: two standards families may define specifications that are both structurally and semantically identical for, e.g., allergy criticality, but use different data types, names, and terminology systems to express these specifications.

Different elements may differ in how deeply they suffer from this issue. Allergy criticality specifications differ, but their structural similarity suggests a simple path for harmonization, so simple that ad hoc operational transformation may seem like an easier way to handle the difference than trying to coordinate consensus around harmonizing the standards themselves.

Negation is different: it has been represented is forms so diverse that it is not always obvious how to transform or harmonize them, or even when such transformation might be necessary. Negation is often modeled as a property of a business class, but logically and semantically, it's not really a predicate so

much as a quantification: it doesn't refine our understanding of a concept; rather, it tells us how many of them there are. As a result, its presentation as a property causes a variety of problems:

1. Negative answers to questions can be modeled as binary forms; records of absence of notionally present business objects require different forms, and these forms tend to be inconsistent.

2. The scope of what parts of the model are negated must be carefully specified; e.g., to assert that a rash was absent at a point in time does not negate other properties of the record, e.g., the identity of the person making the assertion.

3. Negation can be implied by positive assertions, and the scope of what parts of reality are negated can depend on fluid colloquial assumptions of open and closed world boundaries. E.g., "left hemiplegia" seems to imply an absence of "right hemiplegia" but not of "headache."

4. The indeterminacy of the boundaries of implication mean that negation is logically intractable. Attempts to use computable logical tools such as description logic fail when faced with content that contains logical negation.

This document was conceived of to encourage consensus on how to support common understanding of this peculiarly difficult data element.

1.2. Objective

In order to properly represent negation consitently in standards specification and provide guidance on dealing with the variety of specifications that already exist. We attempt to address both of these, this document will:

1. Identify best practices for incorporating negative semantics into standards design, and

2. Specify explicit transformations between the most prevalent standards(CDA and FHIR).

1.3. Methods

1.3.1. Scope

The problem is abstract, and it requires some care to define.

First, "negation" as a term of logic has a long history of difficult implications[1]. It is defined as the logical operation of asserting the falsehood of a proposition, or as a proposition that is the negative of some other proposition. Efforts to apply description logics (DL) to clinical decision support have successfully demonstrated the ability to infer general facts from specific ones, e.g., a cerebral hemorrhage from a subdural hemorrhage: positive statements can be "classified"' with DL, making the application of rules that apply to large numbers of concepts simpler. But introducing negation causes logical propositions to become computably intractable. In addition, identifying where negation occurs is not always simple, because a one positive assertion may entail another negative one; e.g., asserting that a patient has a blood type of A implies that the patient does not have a blood type of B. For these reasons, most efforts to implement description logics begin by excluding negative semantics from scope.

Efforts to use logically negative semantics in information modeling, too, have encountered difficulties of unanticipated depth. A prominent example is the HL7 Version 3 Reference Information Model (RIM). The

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[1]A full bibliography would be a project in itself, but for a survey, see Laurence Horn, A Natural History of Negation (Chicago: University of Chicago Press, 1989); for a cogent summary for informatics, see Alan Rector, "What's in a code?" Kuhn KA, Warren JR, Leong T-Y, (eds) Medinfo 2007. IOS Press; 2007. pp 730-734.

RIM goes to some length to define precise semantics for a negation indicator and its effect on each attribute of the classes in which it is used, but when it was implemented in CDA by knowledgeable architects, it was found that the intuitively obvious meaning assigned in CDA was contrary to its definition in the RIM.

We avoid the issues caused by the abstractness of the concept of negation, and of its implications for computability, by focusing instead on more concrete requirements. In none of the cases we examine do patients or providers use the terms "negation," "true," or "false." We use the term "negation" only as a convenient label for the problems we discuss in this document. No actual information artifact or specification should use the term, for to do so is to introduce an intractable problem into the design. Where the concept seems applicable, it can always be specified more concretely and in better alignment with domain business practices: e.g., as a status of "refuted" or "resolved" for a condition, as a status of "not done" for a procedure," or as a clearly defined test result value.

Second, the boundary between negation and ignorance is complex and murky. Where possible, we differentiate the two. An assertion that no information is available is simply an assertion of ignorance; it does not tell us anything about the presence or absence of a phenomenon. We do not find many cases where the issues overlap: a value of "not applicable" for "last menstrual cycle" or of "no information" for "family history" complicates the data type for the response, but it does not mix the semantics of the answer and the metadata.

The case of "no known allergies" does complicate things. Logically, the semantics of this phrase are complex, describing a clinical history in which no allergies have been detected, but with respect to the actual presence of allergies it can be considered to be null. However, we may observe that this is true for any negative assessment. A statement that the patient has "no bleeding disorders," recorded before administration of a blood thinner, in practice means "no known bleeding disorders." Functionally, the bleeding disorder statement and the allergy statement are equivalent: both intend a prima facie assertion of absence, and both are subject to uncertainty. Clinicians may want to know whether such a denial has been recorded, but they will also always ask again before undertaking a procedure. The epistemological uncertainty of the record means that logical inference is always defeasible – always subject to revision in the light of new evidence – and this state means that automated decision support can never control care decisions, but only inform decision makers.

Similarly, the question of **certainty** overlaps explicitly with assertions of absence. It seems, in a logical framework, that a 90% level of confidence in an assertion is equivalent with a 10% level of confidence in the assertion's negation, and that any level under 100% would therefore imply a simultaneous negative assertion. But this is not the case. The assertions in question are not value-neutral; they are records of clinical concern. A 10% likelihood of cancer is an indubitable concern, and any negative semantics that might be implied may affect the urgency, but not the tenor, of the concern.

Data **quality** is closely related to certainty, and it follows the same pattern. Irrespective of the confidence we place in the source, if a concern is asserted, concern is present.

1.3.2. Approach

Our approach is twofold.

For the objective of identifying best practices for standards specifications, we collect and catalog cases where negative semantics are used in health records. We consider three facets for these cases: the content (what cases are recorded for something being absent, not done, or otherwise "negated"), the use (when and how are these cases employed), and the form (the patterns that specifications have adopted for representing this information). For these cases, we identify characteristic problems and attempt to articulate best practices for designing standards that avoid the problems.

We collected examples from the following sources:

- Veterans Administration use cases

- Patient Care workgroup meetings, listserv threads, and project conference calls

- Clinical Quality workgroup meetings, listserv threads, and project conference calls

- NegEx Lexicion

- Individual participant contributions

- Physician Quality Reporting System (PQRS) measures

- Veterans Administration Informatics Architecture project team

- HL7 CDA Example task force examples

- FHIR examples

For the objective of providing guidance to implementers of existing standards, we collect the currently published examples of negation and propose transformation mappings.

1.4. Results

Relevant information came in many forms. In the examples, we identify kinds of content (prohibitions, absent pathologies, etc.) and kinds of use (orders, decision support, condition life cycle, etc.). We also identify different information structures.

The full list of examples is in appendix A.

1.4.1. Content cases

We found six general classes of content.

A. Normal phenomenon absent

　　a. Blindness, amenorrhea, asplenia

　　b. No next of kin

B. Pathological phenomenon absent

　　a. Patient has not had chicken pox

　　b. No evidence of cancer

　　c. Resolved problems; e.g., Healed fracture

C. Risk factor absent

　　a. My uncle does not have hemophilia

　　b. No allergy to latex

D. Procedure not done

     a. Test not performed because patient in incubator

     b. Patient did not keep appointment

E. Procedure contraindicated

     a. Do not turn patient

     b. Consent not given

F. Patient engagement

     a. Patient does not have goal

1.4.2. Use cases

We find ten general cases of use, with associated content patterns.

Note that content pattern A, normal phenomenon absent, does not appear in the list of usage cases. We find these cases consistently identified as positive assertions of concern rather than as absent phenomena; e.g., "blind," not "vision absent."

It's not clear whether patient disengagement (content case F) should be considered a contraindication.

1. Change in circumstances. A phenomenon is asserted to have some probability of presence which is later retracted because a condition was resolved.

     a. Content cases: B (Pathological phenomenon absent)

     b. Examples

          i. The patient had [communicable disease] but it has been cured.

          ii. No evidence of cancer

2. Change in knowledge. A phenomenon is asserted to have some probability of presence which is later retracted because a condition was misdiagnosed and later refuted, entered in error, or because it was a possible or differential diagnosis that was later refuted.

     a. Content cases: B (Pathological phenomenon absent)

     b. Examples

          i. The patient was suspected of having Lyme disease but it has been refuted.

3. Diagnostic protocol. A clinician asks about phenomena associated with a suspected condition in order to refine clinical understanding.

     a. Content cases: B (Pathological phenomenon absent), C (Risk factor absent)

     b. Examples

          i. A clinician asks a patient with scleritis whether the patient has any autoimmune diseases.

          ii. A test for presence of streptococcus is returned negative.

          iii. PTSD screening negative.

4. Order criterion. Direction is given while or until a phenomenon is absent.

    a. Content cases: B (Pathological phenomenon absent)

    b. Examples

        i. Nothing to eat or drink until respiratory distress dissipates.

5. Quality criterion. A measure defines a population in whom a phenomenon is absent

    a. Content cases: B (Pathological phenomenon absent)

    b. Examples

        i. "Percentage of patients . . . who do not experience a major complication . . ."

6. Clinical Decision criterion. A rule makes operation dependent on the absence of a phenomenon.

    a. Content cases: B (Pathological phenomenon absent)

    b. Examples

        i. Recommend aspirin to ED patients presenting with chest pain with no bleeding disorders.

7. Specific safety protocol. A clinician asks about contraindications before conducting a procedure.

    a. Content cases: C (Risk factor absent)

    b. Examples

        i. The clinician asks about allergies before administering an antibiotic.

        ii. The clinician asks about adverse effects of a medication.

        iii. Patient is not NPO.

8. General safety protocol. A clinician asks about general risk factors.

    a. Content cases: C (Risk factor absent)

    b. Examples

        i. A patient reports no tobacco use.

        ii. Not pregnant.

9. Quality target. A measure identifies procedures not done.

    a. Content cases: D (Procedure not done)

    b. Examples

        i. "Percentage of children . . . not dispensed an antibiotic prescription"

10. Prohibition

    a. Content cases: E (Procedure contraindicated)

    b. Examples

i. "do not flush central line"

1.4.3. Specification Patterns

We find 4 modeling patterns, with examples spanning specification families.

Table 1.1. Modeling Pattern

Category		Example
Absent Class		CIMI Clinical Statement with Absence Context
Coded property	focal	FHIR Allergy code, including "no known allergies"
	modifier	FHIR Condition status, including "refuted"
Boolean presence indicator		RIM Observation value negation indicator FHIR Procedure not done indicator
Quantification		Observation result value of 0 ANF value of 0..0

The broadest pattern is the use of distinct classes for distinct kinds of assertion. CIMI provides a "present assertion" class for identifying problems and other instances and an "absence assertion" for communicating the absence of such problems. This seems appealing in that the details of a problem's attributes are specific to the presence assertions, and these details may be irrelevant to an assertion of absence. One issue with this assumption is that a negation may be intended to apply to a more specific case; e.g., it may be necessary to assert that a patient has no stage 4 pressure ulcers, though lower-stage ulcers may be present. Other properties generally considered proper to presence assertions may, in some cases, be needed for absence assertions. Actual cases have not been identified for this requirement, so it may not be needed.

A more common pattern is the use of coded properties to assert **absence**. Allergy records may be the most common domain where the documentation of absence is necessary, and the FHIR AllergyIntolerance resource uses this pattern. The "code" property (formerly "substance") supports values identifying a variety of substances, but it also supports "no known allergies," as well as a small set of more specific absences. Once concern with this approach is that the meanings of the values imply different semantics for their association with the model: "latex" is the subject of "what substance causes the problem"; "no allergy to latex" re-wires the predicate to "full statement of presence or absence of sensitivity to substance." For close-to-user forms, this divergence does not present problems. For secondary uses, it may be acceptable: if the use is to check a proposed substance administration against allergies, and the routine finds no match between the proposed dose of penicillin and the record object "no known allergies," the semantic mismatch doesn't cause a problem. But there is a mismatch, and it could cause unanticipated problems.

A special case of the **coded property** pattern is where a property that usually only qualifies the class includes a value that modifies it. The Condition resource has a status property that includes "resolved" and "refuted" values, each of which denotes the absence of the subject condition.

The **Boolean presence indicator pattern** hews closest to the logical semantics of negation, and it brings most the resulting issues into the information modeling world. The range of a Boolean property is "true" and "false." These values presume the existence of a proposition with a truth value. Software classes don't

typically meet this requirement: even when they are presumed to be assertions of the existence of the business objects they represent, the properties of the class are properties of the represented object, not of the assertion. The HL7 RIM addresses this difficulty by distinguishing between properties that represent the clinical phenomenon and those that annotate the representation: "descriptive" properties, which describe the referent phenomenon (and whose semantics may change according to negation and mood), and "inert" properties, which describe the assertion itself (and whose semantics don't change with mood and negation). This distinction is, as we have observed, subtle enough to confuse the very experienced.

An additional wrinkle for these properties is that they tend to be envisioned as special cases, so they are named for the edge cases they support. As a result, the semantics of the value is inversely related to the semantics of the modified class. A negation indicator of "true" means that the notional observation is not present; "false" means that it is present.

A final pattern leverages the fact that negation is a quantification by recording presence and absence as **quantities**. The Analysis Normal Form assertion contains a quantity property that can be used both for quantitative measurements and for quantities of presence. In order to do so, it defines an interval data type that supports open and closed boundaries. A value of absent has closed upper and lower bounds of zero (i.e., "[0..0]"); a value of present has an open lower bound of zero (i.e., "(0..#)"). An allergy specification would record not only a substance (or class of substances) but its presence or absence as an interval quantity. Negative semantics don't complicate the computation, and the meaning of the substance code field remains stable. (A minor semantic wrinkle is that ∞ isn't a number, so that value will have to be handled prior to calculation.)

The goal of this design is to represent clinical facts as consistently as possible to support automated inference. The ability to use such a record as a reliable indicator of absence still relies on the effective application of quantification to open-world semantics: the assertion that an allergy assertion has a count of zero does not necessarily rule out the possibility that some other allergy assertion might not. And any assertion of absence is, as noted above, defeasible.

1.5. Discussion

1.5.1. Content

Most cases fit in well-defined categories. Category boundaries depend on judgment, and it's possible to defined categories at higher or lower levels of granularity. Our goal is to differentiate categories only when they require different processing logic. Absence of sight and amenorrhea are both typically represented as positive assertions of concerns, so we classify them together and expect both to surface in clinical records as concerns; absence of a bleeding disorder is a record of a safety check, and we do not expect to see it as a concern.

Most cases were classified as absences of pathologies. This may be partly an artifact of the data collection process, but it is true that absence is typically relevant to care provision as the result of checking for some kind of notional concern, whether actually suspected or as a safety protocol.

A significant number of items might be expected to be inferred from broad normal findings, using the "chart by exception" pattern. A radiology image, for instance, may be annotated by the radiologist as showing "no mediastinal widening," but for a given modality and angle, absence of certain pathologies may be inferred. A normal chest x-ray implies "no mediastinal widening" whether it is annotated or not. The confidence with which such conclusions may be asserted may vary with the uniformity of the protocol, but whether the absence is stated or inferred, its representation is that of absent pathology.

Assertions that procedures were not done were exclusively the province of quality measures. There were also cases of patients not showing up for appointments—the procedure did not occur, and the reason is

provided, just as for a quality measure. Clinical uses for procedure all involve prohibition and contraindication.

The most difficult cases were those that most closely aligned with actual negation semantics, being where a patient denies holding a goal or denies consent for a treatment. The latter case is a contraindication; the former context to help providers understand compliance issues.

We did not find cases that exercise the limits of negative semantics, such as double negatives or inference of negation given some logically contradictory situation. The few line items in the sample that venture near this territory were judged "not relevant" due to being contrived, not based on actual requirements.

1.5.2. Uses

The ten categories of use align broadly as N: updates to durable condition records, negative answers to protocol questions, use of these facts as criteria, and prohibitions.

When providers record changes in circumstances or knowledge (a resolved or refuted condition), the knowledge typically involves a durable concern. These phenomena may be recorded as problems, and they may have a significant body of supporting evidence, goals, related procedures, and other information associated with them.

Negative answers to protocol questions, on the other hand, are typically transient forms of little utility beyond the immediate clinical context. Safety protocol negatives ("not pregnant") demonstrate this most clearly. Whether it holds for "chart by exception" inferences on diagnostic procedures, such as "no mediastinal widening" based on a normal chest x-ray, may depend on the degree of interest on concern regarding the phenomenon.

Facts that serve as criteria may fall into either category. Criteria for future acts tend to be recorded as needed; e.g., direction to take a medication until a symptom abates can be supported by periodic assessment of the symptom. Criteria for measures tend to be existing records, and absence is usually inferred from a lack of documentation. As we observed earlier, criteria for clinical use, including decision support, are confirmed at the point of care, and prior records cannot be relied on.

A more critical category of negation is prohibition. Assertions that procedures are not to be done must be persisted for human review and for order checks, so a key dimension is the timeframe over which the prohibition is in effect. Whether classification is necessary may depend on the complexity of the prohibition. An order to avoid turning a patient is unlikely to cause logical confusion; an order to avoid specific classes of medication is a bit more complex but can be supported with affirmative classification logic.

1.5.3. Patterns

It's critical to be able to distinguish records of presence from records of absence in a predictable way. It is less clear what design patterns are best suited to this need. The pattern of using **distinct classes** for present and absent phenomena makes the distinction clear. It also makes it difficult to aggregate statements about presence, absence, and degrees of uncertainty or state change. The convention doesn't provide obvious direction on how to handle phenomena that were present at one time and have ceased to be present. There may be uses for which this pattern is well suited, but we haven't identified them.

The **coded element** pattern is more common, partly because it is a convenient extension of the presence pattern. The primary difficulty is that there are two distinct patterns of extension—by status and by protocol: both patterns are common. Extension by status includes state changes that denote absence, whether clinical progression (i.e., resolution) or epistemological progression (i.e., refutation or "entered-in-error"). Extension by protocol encompasses cases where a question is asked by protocol and refuted, and the refutation is captured in the same property as the classification of the affirmation—viz., "no known allergies" in the allergy field.

The **negation indicator** seems to be an inappropriately aggressive abstraction of domain information. Boolean properties in general are more abstract than the concrete requirements of the domain; this might be acceptable where such generalization provides a way to aggregate diverse colloquialisms, but where no such value is identified, it only obfuscates the clinical semantics. The result is an inaccurate promise of logical tractability at the cost of human comprehensibility. The problem can be ameliorated by giving a Boolean property a more specific name, e.g., "not done indicator," but such a property usually overlaps semantically with status values (refuted, cancelled). This may not be the case with ProcedureRequest.doNotPerform, but a coded property would still provide flexibility for use cases not yet recognized.

The **quantified presence** pattern may be a workable the answer for secondary uses. It seems too far from an intuitive representation of clinical processes to be generally useful for close-to-user forms. But, unlike the Boolean pattern, it does provide a consistent, unambiguous, and logically tractable way to represent the presence of concerns consistently, whether captured as unary "symptoms" or "concerns" or as binary questions with answers.

1.6. Conclusions

Recorded assertions of absence are defeasible; they can never be used for clinical decisions. They might be used to support decision-support recommendations, subject to effective and safe usability engineering. It may not be advisable to spend much effort trying to make such computations accurate, as no matter how sophisticated the analysis of prior assertions, the underlying data will always be stale.

Patterns for capture of such statements may use any of the identified modeling patterns, with some caveats.

The **distinct class** pattern offers limited benefits for significant overhead. In quality measure systems, distinct classes may be useful, but the negative flavors are often inferred from empty queries, so it's not clear that a corresponding structure on the clinical capture side make sense.

The **negation indicator** pattern offers the promise of logical inference, but the promise is false. Negation is logically is intractable, and the abstraction of the Boolean structure obfuscates the actual domain information of interest. At least one case was identified where a concrete question seems defensibly supported by a Boolean value, but it could be equally well supported by terminology without preventing support of unforeseen use cases.

The **coded element** solution works, though it also presents challenges, including model impedance. As long as the challenges are recognized and handled appropriately, they may be the least problematic cost of the domain. Specifications need to address absence and other negative semantics and provide explicit and concrete guidance to implementers on how to manage impedance and other sources of model ambiguity.

The **quantified presence** solution offers unparalleled consistency in recording facts. Its counter-intuitive representation makes it difficult to promote in domain information models, but it may provide an excellent pattern for analytical transformations.

For standards design, we propose four best practices:

1. Model negative semantics concretely, in ways that are fit for purpose (e.g., "refuted," "contraindicated"). Avoid generalizing to more abstract forms without specific near-term use cases for doing so.

2. Support consistency within models by providing implementers with one way to say things.

3. Support consistency across clinical models by using similar patterns and providing concret guidance on managing impedance issues.

4. Provide explicit instructions for how negated statements in your specification should be transformed from and to other widely adopted specifications.

With respect to the tactical issue of transformation, we provide transformations from C-CDA to FHIR in appendix C. Note that the alignment issues here are global: the CDA allergy, for instance, is explicitly represented within a concern act, which is not present in FHIR. This context issue means that the mappings provided will either be asserted to be incorrect or they will document agreed but implicit semantics in one or both formalisms.

1.7. Appendices

1.7.1. Glossary

Table 1.2. Glossary

Term	Definition
Defeasible	capable of being annulled or made void (Webster)
Finding	A fact asserted about a patient Stedman's: "A clinically significant observation, usually used in relation to one found on physical examination or laboratory test."
Modifier	A concept that changes the meaning of another concept. E.g, to say that a patient has a "family history of" diabetes does not state that the patient has diabetes. Compare Qualifier. SKMT: string which, when added to a term, changes the meaning of the term in the clinical sense (ISO)
Negation	the logical operation of asserting the falsehood of a proposition, or a proposition that is the negative of some other proposition. SKMT: indicator specifying tha tthe Act statement is a negatoin of the Act as described by the descriptive (HL7)
Observable	A property that may be assessed and characterized in terms of a result value; a question. SKMT: Hierarchy in SNOMED CT which represents a question about something which may be observed or measured. (SCT)
Post-coordinated	The quality of being composed of separate concept identifiers. Post-coordination can be achieved either in expression syntaxes defined by code systems for the creation of valid post-coordinated concepts or in model elements with model bindings that articulate how the respective element values are related. SKMT: Representation of a clinical meaning using a combination of two or more concept identifiers (SCT; Candidate)
Pre-coordinated	The quality of being composed of a single concept identifier, as defined in a code system.

Term	Definition
	SKMT: compositional concept representation (2.4.1) within a formal system (2.5.1), with an equivalent single unique identifier (ISO)
Qualifier	A concept that refines another concept within its semantic scope. E.g, a "left" arm is still an arm. Compare Modifier. SKMT: string which, when added to a term, changes the meaning of the term in a temporal or administrative sense (ISO)

1.7.2. Sources

Cheatham, Edward. SNOMED CT Post-Coordination rules, Draft guidance document. NHS NPFIT, document NPFIT-FNT-TO-DPM-0311.01

- Guidance suggests storing "close-to-user" forms is a more conservative approach, and that canonical forms can be derived for data operations.

Ceusters, Werner, Peter Elkin and Barry Smith. "Negative Findings in Electronic Health Records and Biomedical Ontologies: A Realist Approach", International Journal of Medical Informatics 2007; 76: 326-333. PMC2211452.

- "We introduced a new family of 'lacks' relations into the OBO Relation Ontology. . . . By expanding the OBO Relation Ontology, we were able to accommodate nearly all occurrences of negative findings in the sample studied."

Ceusters, Werner, Peter Elkin and Barry Smith. "Referent Tracking: The Problem of Negative Findings" (MIE 2006), Studies in Health Technology and Informatics, vol. 124, 741–6. (This issue also published as Ubiquity: Technologies for Better Health in Aging Societies. Proceedings of MIE2006, edited by Arie Hasman, Reinhold Haux, Johan van der Lei, Etienne De Clercq, Francis Roger-France, Amsterdam: IOS Press, 2006.)

- "Referent tracking" assigns IDs to things to avoid confusion, e.g., when two people assert that a patient has a fracture and it cannot be determied whether they are the same fracture. To the extent that particulars have identifiers, this is in line with Restful (or OWLish) URIs. But they are also required to be unique. Another constraint is the identifiers are only given "real world phenomena," so the question is how to handle something negated. The authors propose a new "lacks" relationship for describing particulars that don't exhibit identified universals.

HL7. HL7 Version 3 Reference Information Model

- Observation.valueNegationInd 6.36.2 "This attribute should only be used when the terminology used for Observation.value is not itself capable of expressing negated findings. (E.g. ICD9)."

- Act.actionNegationInd 6.5.5 "The actionNegationInd works as a negative existence quantifier on the actual, intended or described Act event. In Event mood, it indicates the defined act did not occur. In Intent mood, it indicates the defined act is not intended/desired to occur. In Criterion mood, it indicates that the condition is based on the non-occurrence of the event. It is nonsensical to have a negationInd of true for acts with a mood of definition. The actionNegationInd negates the Act as described by the descriptive properties (including Act.code, Act.effectiveTime, Observation.value, Act.doseQty, etc.) and any of its components."

Horn, Laurence. A Natural History of Negation (Chicago: University of Chicago Press, 1989).

- Thorough.

Rector, Alan. What's in a Code?

- On separation of ontology from terminology & use of "situation" construct to harmonize positive & negative assertions

Rector, Alan. Negation & Null Values (rough notes)

- On preference for "absent" to "negation," at least at first

Rhodes, Bryn. Negation in QDM. https://github.com/esacinc/cql-formatting-and-usage-wiki/wiki/negation-in-qdm

- Analysis of decisions for quality language expressions.

SNOMED International. SNOMED CT Technical Implementation Guide: 7.8.2.4.7 Retrieving absent findings

- This section discusses how negation changes the rules for subsumption testing. The solution is to reverse the candidate/predicate relation for Situation with Explicit Context findings using "known absent" or a descendant. Note that this approach assumes a pattern of Procedure with explicit context. The pattern of an Observable with value "absent" is not addressed. This approach can probably be generalized. Note: TiG in revision. This information can be reviewed in a prior version, but it is subject to change and is not a current SI publication.

Wagner, Gerd. Web Rules Need Two Kinds of Negation. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.331.2050

- Seems to address case of inferred vs explcit negation, but examples cloud the issue. Suggests that because the richness of domain information does not fit neatly into Boolean categories, Boole needs more values (as opposed to not using a Boolean operator).

1.7.3. Use Cases

Table 1.3. Use Cases

ID	Item	Content category	Use category	Source
1	m. CXR: Normal. No mediastinal widening, valve disease, or CHF i.e., no CHF	Pathological phenomenon absent	Diagnostic protocol	VA Use Case Angina 1 - EDCare 2.20.15
2	b. Confirms allergies: No known drug allergy	Pathological phenomenon absent	General safety protocol	VA Use Case Angina 1 - EDCare 2.20.15
3	d. Smoking history: No tobacco use	Pathological phenomenon absent	General safety protocol	VA Use Case Angina 1 - EDCare 2.20.15
4	b. CV: Chest pressure 5 out of 10 after 3 SL-NTG tablets, S1S2, No murmurs or gallop Exam: No murmur	Pathological phenomenon absent	Diagnostic protocol	VA Use Case Angina 1 - EDCare 2.20.15

ID	Item	Content category	Use category	Source
5	e. GU: Verbalizes no problems with voiding	Pathological phenomenon absent	Diagnostic protocol	VA Use Case Angina 1 - EDCare 2.20.15
6	b. Since chest pain started 45 minutes ago, it is too early to see any elevation in cardiac enzymes (Troponin, CK-MB)	Not relevant: Null		VA Use Case Angina 1 - EDCare 2.20.15
7	a. History of Tobacco use: No	Pathological phenomenon absent	General safety protocol	VA Use Case Angina 2 TelemetryCare 2.20.15
8	a. Notes cardiac rhythm: Sinus rhythm without ectopy, HR 84 i.e., No ectopy	Pathological phenomenon absent	Diagnostic protocol	VA Use Case Angina 2 TelemetryCare 2.20.15
9	Cardiologist evaluates the reading and enters the interpreted result in the EHR. Result: Normal echocardiogram. No cardiomegaly or effusion. Good valve function. Ejection Fraction: 58% i.e., No cardiomegaly	Pathological phenomenon absent	Diagnostic protocol	VA Use Case Angina 2 TelemetryCare 2.20.15
10	Reviews ECG reading and enters the interpreted result in the EHR. Result: SR 76. No ectopy. No hypertrophy. i.e., No hypertrophy	Pathological phenomenon absent	Diagnostic protocol	VA Use Case Angina 2 TelemetryCare 2.20.15
11	a. Begin light exercise (walking on a level surface for 5 minutes, 3 times a day). Add 1 minute to each session, each day until able to	Pathological phenomenon absent	Clinical decision criterion	VA Use Case Angina 2 TelemetryCare 2.20.15

ID	Item	Content category	Use category	Source
	complete 10-15 minutes in each session without cardiac symptoms. cardiac symptoms absent			
12	Allergies: No known drug allergy	Pathological phenomenon absent	General safety protocol	VA Use Case CHF - ED 20150305
13	o Cardiac rhythm (ECG): Sinus tachycardia (ST) without ectopy i.e., No ectopy	Pathological phenomenon absent	Diagnostic protocol	VA Use Case CHF - ED 20150305
14	1. Sinus tachycardia (ST) Q waves in the inferior leads, inferolateral ST- and T-wave changes (This is unchanged from the previous admission-3 months ago).	not relevant: Comparison		VA Use Case CHF - ED 20150305
15	i. If the patient does not produce 250ml urine in first 30 minutes, furosemide 40mg IV x1 should be administered	not relevant: Threshold		VA Use Case CHF - ED 20150305
16	a. Confirms allergies: No known drug allergy	Pathological phenomenon absent	General safety protocol	VA Use Case CHF - ED 20150305
17	a. Smoking history: No tobacco use	Pathological phenomenon absent	General safety protocol	VA Use Case CHF - ED 20150305
18	1. Nothing to eat or drink until respiratory distress dissipates	Contraindication	Clinical decision criterion	VA Use Case CHF - ED 20150305
19	1. History of Tobacco use: No	Pathological phenomenon absent	General safety protocol	VA Use Case CHF - IMC 20150305
20	a. AUDIT-C - Score: 0 (No symptoms of abuse)	Pathological phenomenon absent	Specific safety protocol	VA Use Case Depression - Outpatient Follow-up 2.26.15

ID	Item	Content category	Use category	Source
21	Head/Neuro: WNL Heart: S1S2, BP normal	not relevant: Normal		VA Use Case Depression - Outpatient Follow-up 2.26.15
22	Abdomen: Soft, benign. No GI/GU issues. i.e., No GI/GU issues	Pathological phenomenon absent	Diagnostic protocol	VA Use Case Depression - Outpatient Follow-up 2.26.15
23	Extremities: No swelling, pedal pulses strong. i.e., No swelling	Pathological phenomenon absent	Diagnostic protocol	VA Use Case Depression - Outpatient Follow-up 2.26.15
24	b. Adverse effects from the medication a. None noted	Pathological phenomenon absent	Diagnostic protocol	VA Use Case Depression - Outpatient Follow-up 2.26.15
25	i. Provider notices that the patient did not tolerate Prazosin in the past (which was started to address difficulty sleeping)	Normal phenomenon absent	Specific safety protocol	VA Use Case Depression - Outpatient Follow-up 2.26.15
26	[Wellbutrin] . . . was discontinued due to irregular heartbeats and hyperventilation	Procedure not done	Procedure assessment	VA Use Case Depression - Outpatient Follow-up 2.26.15
27	[Prozac] discontinued due to irregular heartbeats and restlessness	Procedure not done	Procedure assessment	VA Use Case Depression - Outpatient Follow-up 2.26.15
28	Patient still refuses cessation treatment despite motivational interventions	Procedure not done	Procedure assessment	VA Use Case Depression - Outpatient Follow-up 2.26.15
29	a. Smoker: No	Pathological phenomenon absent	General safety protocol	VA Use Case DM 1 Diagnosis of Diabetes 2.20.15
30	a. Substance Use: No	Pathological phenomenon absent	General safety protocol	VA Use Case DM 1 Diagnosis of Diabetes 2.20.15
31	Patient completes PTSD screening k. Results: Negative	Pathological phenomenon absent	Specific safety protocol	VA Use Case DM 1 Diagnosis of Diabetes 2.20.15

ID	Item	Content category	Use category	Source
32	Patient completes alcohol use screening l. Result: 2 (Negative)	Pathological phenomenon absent	General safety protocol	VA Use Case DM 1 Diagnosis of Diabetes 2.20.15
33	Extremities: No swelling, bilateral pedal pulses +2, i.e., No swelling	Pathological phenomenon absent	Diagnostic protocol	VA Use Case DM 2 Follow Up Outpatient Visit 2.20.15
34	Head/Neuro: WNL	not relevant: Normal		VA Use Case DM 2 Follow Up Outpatient Visit 2.20.15
35	a. Smoker: No	Pathological phenomenon absent	General safety protocol	VA Use Case DM 3 - Referral for Annual Podiatry Screening 2.20.15
36	b. Alcohol Use: No	Pathological phenomenon absent	General safety protocol	VA Use Case DM 3 - Referral for Annual Podiatry Screening 2.20.15
37	5. Wound assessment: Medial portion of right big toe (approx. 5 mm x 5mm) at top of toenail is slightly red. No breakdown. No sign of infection. i.e., No breakdown	Pathological phenomenon absent	Diagnostic protocol	VA Use Case DM 3 - Referral for Annual Podiatry Screening 2.20.15
38	Provider removes ingrown toenail without complications. No infection noted. Skin intact, with slight inflammation. i.e., No infection noted	Pathological phenomenon absent	Diagnostic protocol	VA Use Case DM 3 - Referral for Annual Podiatry Screening 2.20.15
39	a. Patient notes that work has been busy, and that no time has been available to make the appointment	Patient alignment	Procedure assessment	VA Use Case DM 4 Care Coordinator Telephone Follow Up 2.20.15
40	do not know whether uncle has/ had colon cancer	not relevant: Null		HL7 PC Orlando 1/12/16

ID	Item	Content category	Use category	Source
41	my uncle does not have hemophilia	Risk factor absent	Specific safety protocol	HL7 PC Orlando 1/12/16
42	Congenital absence of coronary artery	Normal phenomenon absent		HL7 PC Orlando 1/12/16
43	Left kidney resected (absent)	Normal phenomenon absent		HL7 PC Orlando 1/12/16
44	Left leg amputated (not present)	Normal phenomenon absent		HL7 PC Orlando 1/12/16
45	No vision in right eye	Normal phenomenon absent		HL7 PC Orlando 1/12/16
46	no menses	Normal phenomenon absent		HL7 PC Orlando 1/12/16
47	no spleen	Normal phenomenon absent		HL7 PC Orlando 1/12/16
48	definiteExistence e.g., obvious	not relevant: Certainty		NegEx Lexicon
49	definiteNegatedExistence e.g., patient was not	not relevant: Certainty		NegEx Lexicon
50	experiencer e.g., sister's	not relevant: Other subject		NegEx Lexicon
51	future e.g., at risk for, concern for	not relevant: Risk		NegEx Lexicon
52	historical e.g., changing, previous	not relevant: Past		NegEx Lexicon
53	indication e.g., rule out	not relevant: Rule out		NegEx Lexicon
54	probableExistence e.g., evidence for, appears	not relevant: Certainty		NegEx Lexicon
55	probableNegatedExistence e.g., fails to reveal	not relevant: Null		NegEx Lexicon
56	pseudoExperiencer e.g., by her husband	not relevant: Other subject		NegEx Lexicon
57	pseudoHistorical e.g., history and examination	not relevant: Past		NegEx Lexicon

ID	Item	Content category	Use category	Source
58	pseudoNegation e.g., no change	not relevant: Comparison		NegEx Lexicon
59	uncertain e.g., either	not relevant: Certainty		NegEx Lexicon
60	Radiology negative findings - get example list for chart by exception	Pathological phenomenon absent	Diagnostic protocol	RadLex (Richard Esmond)
61	Assertion of intention not to breast feed	Patient alignment	Procedure assessment	CIMI CQI project
62	Absence of assertion of intent to breast feed	not relevant: Null		CIMI CQI project
63	1. It is the case (that I do know) that the Patient has problem X,	not relevant: Abstract	affirmative, not negation	PC thread 2/25
64	2. It is not the case (that I do know) that the Patient has problem X,	not relevant: Abstract	null value	PC thread 2/25/16
65	3. It is the case that I don't know if the Patient has problem X,	not relevant: Abstract	null value	PC thread 2/25
66	4. It is the case that I don't know if the Patient has any problems (ie any).	not relevant: Abstract	null value	PC thread 2/25
67	5. It is the case (that I do know) that the Patient has no problems (ie none).	not relevant: Abstract	TH/readcpr c thdrreads (ie that the cC	PC thread 2/25/16
68	patientAssertedStatus - unconfirmed/ excluded - scope of "I'm allergic to penicillin"	not relevant: Abstract	How to interpret the focal concept (drug, product, class) is orthogonal to negation	PC thread 2/29/16
69	clinicianAssertedStatus - confirmed/ refuted - "Patient is/isn't allergic to penicillin"	Pathological phenomenon absent		PC thread 2/29/16

ID	Item	Content category	Use category	Source
70	no allergy to latex	Pathological phenomenon absent	Specific safety protocol	PC thread 3/1/16
71	closed head injury without loss of consciousness i.e., no loss of consciousness	Pathological phenomenon absent	Two observations. Conjunction introduces de Morgan's law if negated.	Kcampbelll
72	mother not present	Normal phenomenon absent		Unknown
73	not allergic to clindamycin (from MU test data - allergy list) - provenance is important to consider	Pathological phenomenon absent	Specific safety protocol	20160323 call
74	does not have diabetes (from MU test data - problem list) - provenance is important to consider i.e., no diabetes	Pathological phenomenon absent		20160323 call
75	Preference that an action not be done: [Margaret]	Patient alignment	Preference	Negation call 3/23
76	Goal was not met	not relevant: Status	status of tracked goal	Negation call 3/23
77	won't admin flu vaccine due to egg allergy	Contraindication		Negation call 3/30/16
78	reason for discontinuing medication	Procedure not done		Negation call 3/30/16
79	Quitting smoking is not my goal	Patient alignment		Negation call 3/30/16
80	5-year survival is not my goal	Patient alignment		Negation call 3/30/16
81	follow up not needed	Contraindication		Negation call 3/30/16
82	patient did not show up	Patient alignment	May record as appointment status	Negation call 3/30/16
83	procedure not done because patient ate	Procedure not done		Negation call 3/30/16

ID	Item	Content category	Use category	Source
84	did not use antithrombotic device on legs (supply)	Procedure not done	EGAT3ion callocero egateion callegs not uy)oegatio	Negation call 3/30/16
85	did not supply electric wheelchair	Procedure not done		Negation call 3/30/16
86	did not provide vaccine because out of stock	Procedure not done		Negation call 3/30/16
87	did not do a variety of things for reason X	Procedure not done		FHIM call 4/1/16
89	No bleeding disorders	Pathological phenomenon absent	Safety process; not on problem list	NEMSIS
90	Not on anticoagulants or thinners	Risk factor absent		NEMSIS
91	Refute the absence of a condition	not relevant: Abstract	No concrete example found	
92	patient not pregnant	Risk factor absent		Negation call 4/13
93	"No Known Medicine Allergies, mom sts food Allergies"	Pathological phenomenon absent		MM mail 4/5
94	"no known med allergies but has food other allergies"	Pathological phenomenon absent		MM mail 4/5
95	"Father states pt has no known allergies, but states close family members have had severe reactions to: PCN, succinylcholine chloride, anectine, and quelizine"	Pathological phenomenon absent		MM mail 4/5
96	"no known allergies but has problems with ingesting some meds"	Pathological phenomenon absent		MM mail 4/5

ID	Item	Content category	Use category	Source
97	"NO KNOWN. CODEINE CAUSES NAUSEA"	Pathological phenomenon absent	Question of whether codeine should be recorded with low criticality	MM mail 4/5
98	"Allergic to antibiotics but no known which class"	not relevant: Null		MM mail 4/5
99	hearing screening not done - needed for quality measure	Procedure not done		Negation call 4/20
100	Hand lost in accident	Normal phenomenon absent		invented 5/5/16
101	[condition in remission]	not relevant: Status	This is a problem clinical status	WGM 5/10/16
102	[condition refuted]	not relevant: Status	This is a problem verification status	WGM 5/10/16
103	Ted: nested negation See fhir dstu questionnaire	not relevant: Abstract	no concrete example found	WGM 5/10/16
104	[assert that a batch of stuff is absent]	not relevant: Abstract		WGM 5/10/16
105	[handle context conduction]	not relevant: Abstract	no concrete example found	WGM 5/10/16
106	no family; no home; transportation; POA i.e., no family	Normal phenomenon absent	These are concerns	WGM 5/10/16
107	No next of kin	Normal phenomenon absent	These are concerns	decomposition of other requirements 6/21
108	no evidence of cancer (path)	Pathological phenomenon absent	Note that this assertion is qualified	decomposition of other requirements 6/21
155	no mrsa found (lab)	Pathological phenomenon absent		decomposition of other requirements 6/21
109	no family; no home; transportation; POA i.e., no home	Normal phenomenon absent	These are concerns	decomposition of other requirements 6/21
110	no family; no home; transportation; POA i.e., no transportation	Normal phenomenon absent	These are concerns	decomposition of other requirements 6/21

ID	Item	Content category	Use category	Source
111	no family; no home; transportation; POA i.e., no POA	Normal phenomenon absent		decomposition of other requirements 6/21
112	No abnormality detected (BL) [openEHR-EHR-CLUSTER.exam.v0]	Pathological phenomenon absent	OPENEaHR examcHRec openEeRHR examTERno abnormR.cEH	openEHR exam pattern
113	Represent inference of "absence" from empty query - specific use not yet determined, but, e.g., CDS logging	not relevant: Abstract		CQI call 8/5
114	Reason for [absence or] delay in fibrinolytic therapy	Procedure not done	For [Absenation	CQI - The Joint Commission Measure AMI-7a
115	Reason for discontinuation of parenteral anticoagulation therapy	Procedure not done		CQI - The Joint Commission Measure VTE-3
116	Reason for delay in initiation of IV thrombolytic	Procedure not done		CQI - The Joint Commission Measure STK-4
117	Reason for not providing overlap medication (IV or subcutaneous anticoagulation therapy and warfarin on the same day)	Procedure not done	-t Theiamvi -em Thehe same reason fomedication (IV oriommission Measure VTE-	CQI - The Joint Commission Measure VTE-3
118	Reason for not providing tobacco cessation medication at discharege	Procedure not done		CQI - The Joint Commission Measure TOB-2, TOB-3
119	Reason for not providing Venous thromboembolism therapy or prophylaxis (medication or antithrombotic device use	Procedure not done	t Theisevi e Thec device reason fonot providing Venous thromboembolism thiommission Measures STK	CQI - The Joint Commission Measures STK-1, VTE-1, VTE-6

ID	Item	Content category	Use category	Source
120	Reason for not providing statin medication at discharge	Procedure not done		CQI - The Joint Commission Measure STK-6
121	Reason for not initiating antenatal steroids	Procedure not done		CQI - The Joint Commission Measure PC-03
122	rule out	not relevant: Status	ambiguous: use "provisional," "differential" or "refuted"	Negation call 8/10
123	to exclude a search result for specific code system	not relevant: query		FHIR list, 8/23
124	do not turn patient	Contraindication		FHIR Gforge comment
125	do not give blood or blood products	Contraindication		FHIR Gforge comment
126	do not flush central line	Contraindication		FHIR Gforge comment
127	do not take blood pressure on left arm	Contraindication		FHIR Gforge comment
128	"patient says that they have never had chicken pox"	Pathological phenomenon absent		FHIR Zulip 9/5
129	not currently taking	Risk factor absent	Typically not represented as a provider intervention but as a fact about the patient.	FHIR Zulip 9/5
130	Patient does not consent to surgery	Patient alignment		PC 9/20/16
131	healed fracture (no fracture)	not relevant: Status	This is a concern status	PC 9/20/16
132	Patient is not NPO	Doesn't fit	Specific safety protocol	PC 9/20/16
133	1. Nothing to eat or drink until respiratory distress dissipates [respiratory distress absent]	Pathological phenomenon absent		VA Use Case CHF - ED 20150305
156	1. Nothing to eat or drink until	Contraindication		VA Use Case CHF - ED 20150305

ID	Item	Content category	Use category	Source
	respiratory distress dissipates [NPO]			
134	Percentage of patients aged 65 years and older who have an advance care plan or surrogate decision maker documented in the medical record or documentation in the medical record that an advance care plan was discussed but the patient did not wish or was not able to name a surrogate decision maker or provide an advance care plan.	Patient alignment	Closed world	PQRS 47
135	Percentage of children 3 months through 18 years of age who were diagnosed with upper respiratory infection (URI) and were not dispensed an antibiotic prescription on or three days after the episode	Procedure not done	Closed world	PQRS 65
136	Percentage of patients aged 18 years and older with a diagnosis of multiple myeloma, not in remission, who were prescribed or received intravenous bisphosphonate therapy within the 12-month reporting period [condition not in remission]	not relevant: Status	this is a problem status	PQRS 69
137	Percentage of patients aged 2	Procedure not done	Closed world	PQRS 93

ID	Item	Content category	Use category	Source
	years and older with a diagnosis of AOE who were not prescribed systemic antimicrobial therapy			
138	Percentage of patients, regardless of age, with a diagnosis of prostate cancer at low risk of recurrence receiving interstitial prostate brachytherapy, OR external beam radiotherapy to the prostate, OR radical prostatectomy, OR cryotherapy who did not have a bone scan performed at any time since diagnosis of prostate cancer	Procedure not done	Closed world	PQRS 102
139	Percentage of adults 18 through 64 years of age with a diagnosis of acute bronchitis who were not prescribed or dispensed an antibiotic prescription on or 3 days after the episode	Procedure not done	Closed world	PQRS 116
140	Percentage of patients aged 18 years and older with a diagnosis of chronic kidney disease (CKD) (stage 3, 4, or 5, not receiving Renal Replacement Therapy [RRT]) who had a fasting lipid profile	Procedure not done	Closed world	PQRS 121

ID	Item	Content category	Use category	Source
	performed at least once within a 12-month period			
141	Percentage of patient visits for those patients aged 18 years and older with a diagnosis of chronic kidney disease (CKD) (stage 3, 4, or 5, not receiving Renal Replacement Therapy [RRT]) with a blood pressure < 140/90 mmHg OR ≥ 140/90 mmHg with a documented plan of care	Procedure not done	Closed world	PQRS 122
142	Percentage of patients, regardless of age, with a current diagnosis of melanoma or a history of melanoma whose information was entered, at least once within a 12 month period, into a recall system that includes: • A target date for the next complete physical skin exam, AND • A process to follow up with patients who either did not make an appointment within the specified timeframe or who missed a scheduled appointment	Procedure not done	Closed world	PQRS 137

ID	Item	Content category	Use category	Source
143	Percentage of patients aged 18 years and older with a diagnosis of primary open-angle glaucoma (POAG) whose glaucoma treatment has not failed (the most recent IOP was reduced by at least 15% from the pre-intervention level) OR if the most recent IOP was not reduced by at least 15% from the pre-intervention level, a plan of care was documented within 12 months	not relevant: Threshold	threshold, not negation	PQRS 141
144	Final reports for procedures using fluoroscopy that document radiation exposure indices, or exposure time and number of fluorographic images (if radiation exposure indices are not available)	not relevant: Comparison	2 conditional queries	PQRS 145
145	Percentage of patients aged 18 years and older undergoing isolated CABG surgery who have a postoperative stroke (i.e., any confirmed neurological deficit of abrupt onset caused by a disturbance in blood supply to the brain) that did not resolve within 24 hours	not relevant: Status	Clinical status of disorder	PQRS 166
146	Percentage of patients evaluated	Procedure not done	Closed world	PQRS 243

ID	Item	Content category	Use category	Source
	in an outpatient setting who within the previous 12 months have experienced an acute myocardial infarction (MI), coronary artery bypass graft (CABG) surgery, a percutaneous coronary intervention (PCI), cardiac valve surgery, or cardiac transplantation, or who have chronic stable angina (CSA) and have not already participated in an early outpatient cardiac rehabilitation/ secondary prevention (CR) program for the qualifying event/ diagnosis who were referred to a CR program			
147	Percent of patients undergoing open repair of small or moderate sized non-ruptured abdominal aortic aneurysms who do not experience a major complication (discharge to home no later than post-operative day #7) i.e., who do not experience a major complication	not relevant: Threshold	Discharge threshold	PQRS 258
148	Percent of patients undergoing endovascular repair of small or moderate non-	not relevant: Threshold	Discharge threshold	PQRS 259

ID	Item	Content category	Use category	Source
	ruptured abdominal aortic aneurysms (AAA) that do not experience a major complication (discharged to home no later than post-operative day #2)			
149	Percentage of patients 18-50 years of age with a diagnosis of low back pain who did not have an imaging study (plain X-ray, MRI, CT scan) within 28 days of the diagnosis.	Procedure not done	Closed world	PQRS 312
150	Patients aged 18 years and older who had surgery for primary rhegmatogenous retinal detachment who did not require a return to the operating room within 90 days of surgery.	Procedure not done	Closed world	PQRS 384
151	Percentage of patients with a diagnosis of primary headache disorder for whom advanced brain imaging was not ordered.	Procedure not done	Closed world	PQRS 419
152	Left hemiplegia	Normal phenomenon absent	implies right hemiplegia absent	team call 3/8/17
153	Closed head injury		implies no open head wound	team call 3/8/17
154	Do you have a spleen? Order check question for live vaccine	Normal phenomenon absent		team call 3/8/17

ID	Item	Content category	Use category	Source
157	Patient has zero pressure ulcers	Pathological phenomenon absent	count question synonymous with "absent"	VA IA project
158	Head CT without Contrast	Procedure not done	Modality kind	IA group call 17/10/20
159	Are you experiencing chest pain now?	Pathological phenomenon absent		IA group
160	Have you experienced chest pain in the past?	Pathological phenomenon absent		IA group
161	When you experience chest pain does it radiate?	Pathological phenomenon absent		IA group
162	wound has no odor	Pathological phenomenon absent		IA group
163	What concerns are active?	Pathological phenomenon absent		

1.7.4. Maps

Table 1.4.

C-CDA key elements	FHIR key elements	Notes
<act classCode="ACT" moodCode="EVN"> <code code="CONC" codeSystem="2.16.840.1.113883.5.6"/> > <statusCode code="active"/> <entryRelationship typeCode="SUBJ">	Concern not covered in FHIR example	This could be membership in a FHIR concern list; no examples exist
<observation classCode="OBS" moodCode="EVN" negationInd="true">	"resourceType": "AllergyIntolerance"	CDA observation is generic; FHIR implies allergy object
<code code="ASSERTION" codeSystem="2.16.840.1.113883.5.4"/> >		C-CDA pattern follows TermInfo
Not covered in example subentry for problem status?	"clinicalStatus": "active", "verificationStatus": "confirmed",	FHIR statuses might be seen to narrow the scope of the negation;

C-CDA key elements	FHIR key elements	Notes
		they are also optional. Would recommend removal.

CDA status describes the record object; also supports a problem status (deprecated) but it's not specified in Allergy or used in example |
| \<effectiveTime\>

\<low nullFlavor="NA"/\>

\</effectiveTime\> | | time required by C-CDA template |
| \<value xsi:type="CD" code="419199007"

displayName="Allergy to substance (disorder)"

codeSystem="2.16.840.1.113883.6.96" codeSystemName="SNOMED CT"/\> | "coding":

"system": "http://snomed.info/sct",

"code": "716186003",

"display": "No Known Allergy (situation)" | Semantic mapping engages here

716186003 has 'allergic disposition' as its associated finding, the parent of 'allergy to substance' |

Table 1.5.

CCDA to FHIR	FHIR to CCDA
When observation.code is Assertion & observation.value is a descendant of [allergic condition?], create a FHIR AllergyIntolerance resource	When valueCode is a descendant of [allergic condition?], create an observation with code of Assertion and value of the condition
If negationInd is null or false, use the allergic condition value	When valueCode is a Situation, with a findingContext of "known absent," put the associatedFinding value into the observation.value, and set the negationInd to True
If negationInd is True, use the situation with explicit context that asserts the the condition identified is known absent	Set required fields: statusCode to "completed" and effectiveTime to NA
If no such situation code exists, provide an expression	
clinicalStatus and verificationStatus are optional: do not populate unless the CDA instance includes a status	

C-CDA example: http://hl7-c-cda-examples.herokuapp.com/examples/view/0ff4ddb1f9ccae6fd6aa9b5db98ae4d9f22290af

FHIR example: http://build.fhir.org/allergyintolerance-nka.json.html