Adequacy of evolving national standardized terminologies for interdisciplinary coded concepts in an automated clinical pathway

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Abstract

Purpose. The purpose of this analysis was to determine the adequacy of evolving national standardized terminologies with regard to coded data elements (concepts) in an automated clinical pathway designed to drive adherence with the *American College of Cardiology (ACC)/American Heart Association (AHA) Guidelines for Evaluation and Management of Chronic Heart Failure.*

Method. Concepts were identified in a previously developed automated clinical pathway and associated tools. Once identified, concepts were categorized according to the conceptual domains identified by Campbell et al. (1997). A review of evolving national standardized terminologies and coding systems was initiated to determine if the identified concepts had corresponding representation in one of these coding systems. Available codes were then evaluated for adequacy with respect to national guideline adherence measures put forth by the Centers for Medicare/Medicaid Services (CMS) and Joint Commission on Accreditation of Healthcare Organizations (JCAHO).

Results. The concept domain model put forth by Campbell et al. (1997) worked well for organizing concepts and for providing a useful framework for data analysis. Using our method, 260 unique pathway concepts were identified, of which, 91.9% (239) are represented by one or more of the standardized coding systems. Logical Observation Identifiers Names and Codes (LOINC) and SNOMED CT alone represented 86.2% of the concepts. Seventy percent (70%) of the clinical pathway concepts are represented using the Health Insurance Portability and Accountability Act (HIPAA) mandated national terminologies alone. Less than 50% of CMS and JCAHO guideline adherence concepts were found to have representation in the HIPAA mandated terminologies. The addition of Logical Observation Identifier Names and Codes (LOINC) and SNOMED CT improved representation up to 86.4%, but did not include representation of all concepts necessary for complete electronic monitoring of guideline adherence.

Conclusions. Evolving national standardized terminologies provided matching terms for the majority of the data elements in the automated clinical pathway. Standard clinical terminologies with granular terms such as LOINC and SNOMED CT are required to represent the depth and detail of certain procedures and guideline-based care. Gaps exist in Health Insurance Portability and Accountability Act (HIPAA) mandated terminologies for representing interdisciplinary concepts in national adherence measures.
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1. Introduction

Heart failure is a major public health problem in the United States. It affects 4.9 million Americans and is the primary cause of hospitalization in Medicare beneficiaries. In 1998, $3.6 billion ($5471 per discharge) was paid on behalf of Medicare beneficiaries for treatments related to heart failure [1]. Research over the past decade has identified medications, treatments, and patterns of care with efficacy in heart failure patients. However, prognosis after the diagnosis of heart failure remains poor and the total societal costs associated with this chronic illness in terms of human suffering and medical resources continue to rise as the population ages. Although the characterization of outcomes associated with heart failure is a complex issue, published literature demonstrates that practice variability contributes to suboptimal treatment of acute and chronic heart failure [2–5].

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Automated systems have been found to improve documentation of the application of core practice guideline recommendations [6–10] and to increase patient knowledge and participation in the decision-making process [11,12]. Automated knowledge management tools such as clinical pathways, prompts and reminders, automated standard orders, and automated access to evidence in the form of "Infobuttons" promote access to evidence [13] and guideline adherence [14–16]. The purpose of this paper is to evaluate the adequacy of the HIPAA-mandated and other evolving national standardized terminologies with regard to coded data elements (concepts) in an automated clinical pathway that has been integrated with guideline recommendations contained in the *American College of Cardiology (ACC)/American Heart Association (AHA) Guidelines for Evaluation and Management of Chronic Heart Failure.*

1.1. Clinical practice guidelines and clinical pathways

The Institute of Medicine (IOM) defines practice guidelines as "statements to assist practitioner and patient decisions about health care for specific circumstances" [17]. Integration of clinical practice guidelines (CPGs) into the processes of care provides one means of reducing practice variation. Successful adoption and implementation of CPGs requires that guidelines first undergo customization to be consistent with local practice patterns and standards [18]. One means of conversion and integration of practice guidelines is with the use of clinical pathways as an over-arching framework [19–21]. Clinical pathways have been defined as the sequence or timing of key interventions designed to drive desired outcomes [22,23].

The integration of practice guidelines into a clinical pathway model can address multiple issues. Practice guidelines embrace external best practice: gold standard evidence such as that generated from clinical trials is often the foundation of practice guidelines. However, local evidence is also important as it assists in decision-making, improving quality of patient care, and reducing medical costs [24]. Local evidence and practice patterns are generally the foundation of clinical pathways. Clinical pathways can be tailored to manage local interdisciplinary practice issues and provide an additional source of data for implementing and tracking modified practice patterns. Because clinical pathways and practice guidelines are frequently developed separately as paper-based tools, integration into workflow and processes of care can be difficult. In addition to the complexity associated with integration of knowledge from many sources, the practical implications of work flow issues, data collection and analysis with largely paper-based systems are major barriers to widespread use of these tools [7,25]. Automated clinical pathways that integrate

practice guideline recommendations can function as documentation tools, data collection tools, as well as abstraction tools, thus overcoming existing barriers to the 'real-time' benefits [26–28].

The integration of guideline knowledge into a clinical pathway differentiates the automated pathway from other guideline models. Unlike computer-interpretable guideline models, the temporal and other relationships normally represented by a guideline representation model are, in this case, handled by the clinical pathway framework, which is integrated with the practice guideline recommendations. The automated pathway functions as the knowledge base from which all relationships are generated, temporal or other.

1.2. The use of automated tools to facilitate monitoring of quality

The current focus on implementation of automated tools to reduce practice variation, improve quality of health care services and prevent errors of omission further underscores the need for an electronic medical record. The Institute of Medicine's (IOM) report on *The Computer-Based Patient Record (CPR)* [29] highlights the beneficial effects of access to data and information at the point of care on clinician abilities to analyze data for management and research purposes, improve quality, and reduce the costs of care (IOM, 1997). The conclusion of this well publicized report is that the beneficial effects of CPRs with regard to quality of care and patient safety make them essential for modern health care. The valuable effects of using technologies to promote safe and effective practice has been echoed in subsequent IOM reports, *To Err is Human (2000)* [30] and *Crossing the Quality Chasm (2001)* [31], which describe the potential for computerized physician order entry (CPOE) to decrease medication related medical errors by up to 50%. The most recent IOM report on the CPR entitled, *Key Capabilities of an Electronic Health Record System* (July, 2003) identifies "the provision of knowledge and decision-support that enhance quality, safety and efficiency of patient care" as essential capabilities of an electronic health record system. Additionally, the report identifies support of patient care delivery, management, support processes, financial and administrative processes, and patient self-management as primary functions of an electronic health record [32]. Electronic monitoring of these functions is desirable for performance improvement and for research purposes.

The value of automated tools to facilitate monitoring of quality through data collection as an integral part of documentation (without the requirement of separate abstracting or encoding processes) has long been recognized as a beneficial effect of automated systems [33]. Automated methods of data abstraction during the

documentation process could potentially detect deficiencies in patient care and provide automatic rapid feedback to the clinician. Unlike paper documentation systems which generally require separate manual abstraction processes to track guideline adherence, automated systems may provide a real-time opportunity for improvement at the point-of-care.

1.3. Standardized terminologies in clinical pathways and guidelines

Incorporation of reference terminologies into electronic systems is an important precursor to creating systems capable of monitoring quality and driving guideline-based decision-making [34]. The value of standardized terminologies for supporting guideline-based documentation and monitoring of adherence was summarized by Chute et al. [35] as follows (p. 504):

> The use of guidelines and other decision-support tools to enhance the quality of health care depends on the use of common terms and concepts in patient records and knowledge support resources. The business practices of performance benchmarking, measuring and interpreting outcomes, continuously improving care, and allocating limited resources to optimize quality and effectiveness similarly require comparable data and a standardized approach to information that adequately captures the details of clinical variation. Standardization of information is dependent on standardization of underlying terminologies, which include classifications and nomenclatures. The quality and resolution of those terminologies dictate the quality of health care information.

Although lack of a common vocabulary has been a barrier to integration of CPRs for over a decade, there appears to be agreement within the informatics community that the use of a combination of available and tested concept oriented terminologies is an approach that is both practical and desirable to progress beyond current obstacles [35–41].

1.4. HIPAA and identification of evolving national standards

Partially in an effort to accelerate the development of industry—wide standards for patient medical record information (PMRI) and electronic data interchange (EDI) of health care data, the United States Congress passed the Health Insurance Portability and Accountability Act of 1996 (HIPAA). The "Administrative Simplification" component of this statute aims to improve the efficiency and effectiveness of the health care system through the development of standards and requirements for transmission of electronic health data that are believed to be essential to creation of a Nation Health Information Infrastructure [42]. The provisions of this act dictate that the National Committee on Vital and Health Statistics (NCVHS) study issues related to adoption of national standards for PMRI and electronic

exchange of information [43]. Acting on the recommendations of the NCVHS, the Secretary of Health and Human Services adopted the following standards for electronic code sets as part of the final HIPAA rule ("Health Insurance Reform," 2003):

- International Classification of Diseases, 9th edition, Clinical Modification, Volumes 1 and 2 (ICD-9 CM).
- National Drug Codes (NDC).
- Code on Dental Procedures and Nomenclature (CDT).
- Health Care Financing Administration Common Procedure Coding System (HCPCS).
- Current Procedural Terminology, 4th Edition (CPT-4).

The provisions for HIPAA's EDI transaction standards seek to establish common data definitions for use in clinical as well as administrative and financial data transmission. Additional code sets designated by leaders in the terminology field and selected by the federal government as potential sources of clinical concept codes (but not identified in the "Transactions and Code Sets Rule" of the *Federal Register*) are Logical Observation Identifiers Names and Codes (LOINC) and SNOMED CT. Both of these code sets have been found to be useful for accurately and efficiently encoding a large scope of clinical data to facilitate data aggregation and analysis [41,44,45]. LOINC is maintained by the Regenstrief Institute and represents laboratory results and clinical observations, including concepts from several nursing terminologies such as Home Health Care Classification's (HHCC) goal/outcome assessments, the Omaha problem rating scale, and the pain and cardiovascular assessments from Intermountain Health Care. SNOMED is maintained by the *College of American Pathologists (CAP)* and represents a broad spectrum of clinical data [46,47]. SNOMED Clinical Terms (SNOMED CT) is a collaborative work being developed by the United Kingdom's National Health System (NHS) Information Authority and the College of American Pathologists (CAP). This work combines CAP's SNOMED with the NHS Clinical Terms Version 3 (Read Codes). The goal of merging of these two works is to create a comprehensive clinical terminology to support the computerized patient record [48]. SNOMED CT contains concepts from several nursing terminologies, including NANDA, Nursing Interventions Classification (NIC), Omaha, Georgetown Home Health Care Classification (HHCC), and Perioperative Nursing Data Set (PNDS), with Nursing Outcomes Classification (NOC) to be included in the near future. The federal license for SNOMED CT includes nursing concepts from the system, but not mapping tables to original terminologies. Mapping tables must be purchased separately if the concepts are used as part of the original terminology, rather than as SNOMED CT concepts.

1.5. The role of standardized terminologies in the measurement of quality

The Institute of Medicine (1990) defines quality of care as "the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge." In an effort to set standards related to the evaluation of quality in health care, the US Agency for Healthcare Research and Quality (AHRQ) has developed the National Quality Measures Clearinghouse (NQMC) [49]. This website provides information on use, selection, application, and interpretation of standard measures of quality. The NQMC defines a quality measure as "a mechanism that enables the user to quantify the quality of a selected aspect of care by comparing it to a criterion" [49]. Quality measures are based on evidence and may be derived from practice guidelines, peer reviewed studies, systematic reviews or formal consensus procedures involving expert clinicians and clinical researchers [49]. The NQMC inclusion criteria require standardized and evidenced-based measures of quality, many of which are based on clinical practice guideline recommendations and have realized national consensus through widespread dissemination, use and testing [49]. For example, the adherence measures related to heart failure in the NQMC include measures put forth by several different agencies; Centers for Medicare/Medicaid Services (CMS) and Joint Commission on Accreditation of Healthcare Organizations (JCAHO), AHRQ and the Veteran's Administration (VA). All of the measures are based on the ACC/AHA practice guidelines and other current evidence. Heart failure quality measures and sources included on the NQMC website are listed in Table 1. The first four measures in Table 1 are put forth by CMS and JCAHO.

Practice guidelines are designed to inform interdisciplinary care. Both the CMS and the JCAHO key quality indicators for heart failure evaluate adherence with guideline recommendations. Adherence to these guidelines is measured at regular intervals via reporting the interventions that have been provided to individuals with specific disorders, e.g., heart failure. Many of the interventions are carried out by nurses and other non-physician providers and include smoking cessation counseling, diet teaching, weight monitoring, and self-evaluation of status for signs of worsening symptoms. Unfortunately, guideline adherence measures like these are not traditionally collected as electronic data since they are not considered 'billable' items. Those that are 'billable' are often abstracted manually after a patient is discharged. In the move towards computer-based patient records, terminologies are needed to represent clinical concepts with a broad range of clinical application and granularity such as those contained in Table 1. This would facilitate capture of guideline adherence at the point of care and provide a means to improve care processes for individual patients at the point of care, as well as retrospectively in the aggregate. Concept-oriented terminologies such as LOINC and SNOMED CT, as well as those terminologies mandated through the HIPAA rule, must be accepted as national standards in order to represent inter-disciplinary care and fully support evidence-based practice [50].

1.6. Purpose/Research questions

The purpose of this analysis is to determine the adequacy of the HIPAA-mandated and other evolving national standardized terminologies with regard to coded data elements (concepts) in an automated clinical pathway that has been integrated with guideline recommendations contained in the *American College of Cardiology (ACC)/American Heart Association (AHA) Guidelines for Evaluation and Management of Chronic*

Table 1
Heart failure quality measures and sources

Quality measure	Source
Heart failure: percent of patients who are prescribed an angiotensin converting enzyme inhibitor (ACEI) at hospital discharge	Centers for Medicare and Medicaid Services; Joint Commission on Accreditation of Healthcare Organizations. 2002 Aug. NQMC:000285
Heart failure: percent of patients with a history of smoking cigarettes who are given smoking cessation advice or counseling during hospital stay	
Heart failure: percent of patients with documentation that left ventricular function was assessed before arrival, during hospitalization, or is planned for after discharge	
Heart failure: percent of patients discharged home with written discharge instructions or educational material	
Congestive heart failure: hospital admission rate	Agency for Healthcare Research and Quality. 2002 Oct. NQMC:000118
Heart failure: percent of patients discharged with a principal diagnosis of heart failure with complete discharge instructions in the medical record	Veterans Health Administration. 2002 Mar. NQMC:000031
Congestive heart failure: mortality rate	Agency for Healthcare Research and Quality. 2002 Jun. NQMC:000145

Heart Failure. The automated clinical pathway is designed to provide users with access to guideline recommendations as they move through the pathway The research questions are as follows:

1. What are the concepts contained within the automated clinical pathway?
2. Can the sample of identified clinical pathway concepts be represented by evolving national standardized terminologies (e.g., those mandated by HIPAA, LOINC, and SNOMED)?
3. How adequate are Campbell's Concept Domains of a Computerized Patient Record for classifying clinical pathway and practice guideline concepts?
4. What is the level of inter-rater reliability (IRR) when two domain experts abstract concepts from predefined measures of guideline adherence?
5. How adequate are evolving terminologies for representing concepts related to measures of adherence to the ACC/AHA practice guidelines (i.e., guideline adherence concepts) put forth by CMS and JCAHO?
6. How useful are the evolving clinical terminology standards for tracking national measures for guideline adherence?

2. Methods

Clinical pathway concepts were identified through a thorough evaluation of the following guideline-based documentation tools by a domain expert (PCD):

1. *An automated clinical pathway that was designed based on ACC/AHA practice guidelines.* The clinical pathway consists of an interdisciplinary plan of care and standardized order sets built into the electronic medical record. These plans of care and order sets cue clinicians to document against adherence measures and best-practice interventions.
2. *Discharge documentation tool.* This double-sided form was developed by an interdisciplinary team based on the ACC/AHA practice guidelines, and functions as the patient discharge orders, educational handouts, and Supplemental State of Connecticut W-10 Interagency Transfer form.
3. *Guideline adherence data collection tools.* The *Get With The Guidelines (GWTG) Patient Management Tool* is part of an on-line, interactive assessment and reporting system that was developed by Outcome Sciences in conjunction with the American Heart Association and is designed to assist with implementing guideline-based care. This data collection tool provides patient-specific guideline information and the ability for institutions to track its adherence to guidelines against national benchmarks over time [51]. In this institution, the Patient Management Tool is used to track guideline adherence retrospec-

tively. Currently, the data are manually entered into this tool as well as into the electronic medical record. Although the GWTG Patient management tool is useful for quality improvement purposes, the process would be more efficient in an integrated electronic system where the data collected during the documentation process could be reused for such reporting.

4. *Patient self-management educational handout.* This handout is a single page, double-sided form developed by an interdisciplinary team for teaching patients self-management skills related to heart failure. The form contains basic information about heart failure, weight and symptom monitoring; a 'heart healthy diet,' smoking cessation interventions, medication information, and follow-up care.

Once the clinical pathway concepts were identified, they were categorized according to the following conceptual domains identified by Campbell et al. [38]: *Administrative Concepts, Demographics, Attributes, Interventions, Findings, Diagnoses And Impressions, Plans, Equipment and Devices, Events, Human Anatomy, Etiologic Events, Documents, Legal Agreements, and Agents.* This model was selected as an organizing framework because its domains represent not only the wide range of conceptual data found in a medical patient record but also a means with which to represent varying levels of detail [38].

To evaluate the usefulness of evolving clinical terminology standards for electronically tracking national guideline adherence, concepts were extracted from the CMS and the JCAHO key quality indicators for heart failure. To evaluate inter-rater reliability (IRR) for the guideline adherence concepts identified, two coders independently reviewed the CMS and JCAHO quality indicators for discharge instructions, abstracted guideline adherence concepts, and organized the abstracted concepts into the Campbell framework. Once guideline adherence concepts were identified in the CMS and JCAHO quality measures, a review of HIPAA-mandated coding systems plus LOINC and SNOMED CT was initiated to determine if the identified guideline adherence concepts had corresponding representation (e.g., exact matches) in one of these coding systems.

3. Results

Two hundred and sixty unique clinical pathway concepts were identified of which 91.9% (239) were represented by one or more of the evolving national standardized coding systems (one or more exact match). Seventy percent of clinical pathway concepts were represented in HIPAA-mandated terminologies alone (without the addition of the LOINC and SNOMED CT

clinical standards). LOINC and SNOMED CT alone represented 86.2% of the clinical pathway concepts.

Data elements related to the *Administrative* domain, e.g., facilities, institutions, practitioners, standardized terms were found in CPT-4, HCPCS, LOINC, and SNOMED CT. Data elements for the *Demographics* domain were best represented by SNOMED CT. *Attributes*, e.g., severity and staging of heart failure with ejection fraction, appropriate matches were available in CPT only. Data elements related to *Interventions* could be found in all terminologies. Data elements from the *Findings* domain were mapped to HCPCS, ICD-9-CM, LOINC, and SNOMED CT. Concepts within the *Diagnoses and Impressions* domain were mapped to HCPCS, ICD-9-CM and SNOMED CT. See Table 2 for percent of representation by domain and by standardized terminology and Table 3 for percent coverage of

concepts by mandated terminologies, LOINC and SNOMED CT and total representation.

Sixteen clinical pathway concepts (6.2%) did not have exact matches in the evolving standardized terminologies (HIPAA mandated, LOINC or SNOMED CT). However, on closer examination, most of these terms had close matches within existing terminologies that could be adequately represented with related concepts (see Table 4) or could be represented using post-coordination of terms. Of the remaining clinical pathway concepts ($n = 7$ or 2.7%), almost half are necessary for monitoring guideline adherence, but could not be represented with any of the evolving national standards.

In the CMS measure, 26 concepts were identified by one coder (PCD) and 12 by the other (JJC). A total of 30 concepts were identified, 8 of which were exact matches

Table 2
Clinical pathway/practice guideline concepts: percent of representation by domain and by standardized terminology

Domain	n	CPT (%)	DRG (%)	HCPCS (%)	ICD-9CM (%)	LOINC (%)	NDC (%)	SNOMED (%)
1. Administrative	40	22.5	0	17.5	7.5	45	0	85
2. Demographics	13	0	0	0	0	30.8	0	92.3
3. Attributes	10	40	0	0	0	60	0	90
4. Interventions	80	16.3	0	12.5	11.3	30	53.8	71.3
5. Findings	65	3.1	0	4.6	35.4	38.5	0	84.6
6. Diagnoses and impressions	25	0.4	68	28	100	20	0	100
7. Plans	20	0.5	0	10	0.5	45	0	85
8. Equipment and devices	1	0	0	100	100	100	0	100
9. Event	1	0	0	0	0	100	0	100
10. Human anatomy	1	0	0	0	0	100	0	100
11. Etiologic agents	1	0	0	0	0	0	0	0
12. Documents	1	0	0	0	0	100	0	100
13. Legal agreements	1	0	0	0	0	0	0	100
14. Agents	1	0	0	0	0	0	0	100

Table 3
Percent coverage of pathway concepts by domain in evolving national standard terminologies

Domain (Campbell, 1997)	Mandated terminologies: CPT, ICD-9, HCPCS (%)	Other evolving standards: LOINC and SNOMED (%)	Total representation (%)
1. Administrative	27.5	82.5	87.5
2. Demographics	0	92.3	92.3
3. Attributes	40	90	90
4. Interventions	81.3	75	96.3
5. Findings	36.9	89.2	89.2
6. Diagnoses and impressions	100	100	100
7. Plans	15	90	90
8. Equipment and devices	100	100	100
9. Event	0	100	100
10. Human anatomy	0	100	100
11. Etiologic agents	0	100	100
12. Documents	0	100	100
13. Legal agreements	0	100	100
14. Agents	0	100	100
Total representation:	70	86.2	91.9

Table 4
Closest matches and post-coordinated representation for non-matching concepts

Domain number	Concept	Closest matches (SNOMED unless specified)	Potential post-coordinated match(es) (SNOMED unless specified)
1	Medicare (payer)	• Patient has private medical insurance (finding)-F-02048 • Private health insurance held (finding)-F-00143	NA
1	Other inpatient (D/C status)	NA	NA
1	Home IV therapy	NA	NA
3	Symptoms worsen	NA	NA
4	Cardiac risk interventions	NA	NA
4	Cardiac risk Intervention	• Risk assessment P0-0008C • Risk management P0-0034F	
4	Weight management	• Weight monitoring P0-004BE	
5	Contraindications to Aspirin	• Contraindication to (contextual qualifier; qualifier value) G-0044	• Contraindication to (contextual qualifier; qualifier value) G-0044 • Aspirin (product) C-60320
5	Contraindications to lipid lowering medications	• Contraindication to (contextual qualifier; qualifier value) G-0044	• Contraindication to (contextual qualifier; qualifier value) G-0044 • Lipid lowering therapy P0-00482
5	Severe hypotension	• Chronic hypotension: NAD3-04003	• Chronic hypotension: NAD3-04003 • Severe (severity modifier) (qualifier value); G-A003
5	ACEI induced cough	• Cough (finding) F-24100 • Increasing frequency of cough (finding)-F-24103 • Persistent cough (finding)-F-24107	• Cough (finding) F-24100 **OR** • Increasing frequency of cough (finding)-F-24103 **OR** • Persistent cough (finding)-F-24107 • ACE inhibitor prophylaxis P0-006F4
5	Left ventricular dysfunction (LVSD)	• Cardiac ejection fraction, function (observable entity)-F-32070 • Left ventricular ejection fraction (observable entity)-F-02224	NA
5	Bleeding risk	• Finding of tendency to bleed (finding)-F-009F3	NA
5	Medication adherence	• Chronic disease - drug compliance check (finding)-F-02E15 • Drug compliance good (finding)-F-04484 • Drugs—partial non-compliance (finding)-F-01A80 • Drugs—total non-compliance (finding)-F-01A7F	NA
7	Step II AHA diet	• Liquid cardiac diet-C-F2122 • Cardiac semi-soft 2 gram sodium diet (finding)-C-F2124	NA
7	Written discharge instructions	• Final inpatient visit with instructions at discharge (procedure)-P2-10390 HOSPITAL DISCHARGE INSTRUCTIONS: 8653-8 (**LOINC**)	NA

Table 5
Heart failure smoking cessation counseling (*JCAHO measure*)

	Pertinent codes from standardized terminologies	
Denominator description		
Include	All patients with a primary diagnosis of heart failure who have a history of smoking within one year prior to admission	*Primary diagnosis of heart failure* Diagnostic codes: DRG: 127 HCPCS Level II Codes: G0263 ICD-9CM codes: 402.01, 402.11, 402.91, 404.01, 404.11, 404.91, 428.0, 428.1, 428.9. SNOMED: D3-16000; D3-16007; D3-16010 *Past history:* Smoking history/tobacco use ICD-9 CM Codes: 305.1; V15.82 LOINC Codes: 11366-2; 11367-0 SNOMED Codes: F-93108; F-04127; F-005FF; R-211A5 *Discharge status:* D/C to home with and without services or non-acute facility CPT codes: 97799; 93797; 93798; 99311-99313; 99201-4 HCPCS Level II Codes: G0170-81; H2001; S9472 ICD9-CM: V57 LOINC: 8650-4 SNOMED codes: R-302F4; R-30272; PA-630F8; PA-63010; PA-63000; S-84010; S-84020; S-84030; S-84040; S-84050; R-30261; S-81120; S-81050; F-04710
Exclude	Patients who expire or are transferred to another acute facility	*Discharge status:* SNOMED codes: (Acute care facility) S-81000; R-3018E; (Expired): F-04719; DF-D0007; P0-10830; F-01048; F-03E68; F-01C69; F-03E6A; F-03E69; F-011B2; F-0120F
Numerator description		
All patients who receive smoking cessation advice/counseling upon discharge Goal: 100%		*Risk interventions:* Smoking cessation intervention codes HCPCS Level II Codes: S9075; G9016; S9453 NDC Codes: 54868-1976; 54868-1988; 54868-1989; 58887-810; 59568-0810; 54868-2011; 54868-0301; 61815-001 55045-2212; 56125-401; 56125-402; 50580-899; 59632-0899; 59632-0901; 63552-556; 0173-0556; 51129-1340 SNOMED: P2-11809; P0-20811; P0-20779

Description: Percent of patients who are current smokers and who receive smoking cessation advice or counseling during hospitalization.

(identified by both coders) and 22 were unique. Guideline adherence concepts identified by both coders included the following:

- Home (discharge status)
- Weight monitoring
- Heart failure
- Diet
- Activity level
- Follow-up appointment
- Discharge medications
- Symptom monitoring

Additional guideline adherence concepts identified in the CMS measure by both coders were closely related but displayed varying levels of granularity. Examples include:

- Patient given educational material ⇒ • Educational material
- Follow-up appointment ⇒ • Physician follow-up
- Written instructions ⇒ • Caregiver given written discharge instructions

The JCAHO quality measure for heart failure discharge instructions more clearly define intended data elements than the CMS measure and this may have slightly improved concordance with identifying guideline adherence concepts. For this measure, 29 concepts were identified by one coder (PCD) and 17 by the other (JJC). A total of 33 concepts were identified, of which 13 were identified by both coders and 20 were unique. For the JCAHO measure, the following set of core guideline adherence concepts was identified by both coders:

- Admission date
- Birth date
- Discharge medications
- Discharge status
- Heart failure
- Follow-up appointment
- Discharge status: home
- Activity level
- Weight monitoring
- Discharge status: home care
- Diet
- Symptom monitoring
- Discharge status: IV therapy

Table 6
Heart failure quality measures: CMS and JCAHO

CMS quality measure	Criterion met or acceptable alternative
Heart failure patients discharged home with written instructions or educational material given to patient or caregiver at discharge or during the hospital stay addressing all of the following: • Activity level • Diet • Discharge medications • Follow-up appointment • Weight monitoring • What to do if symptoms worsen	Discharge Instructions. For patients discharged home, with or without home health services, documentation of written instructions or education material given to the patient or caregiver must address ALL of the following: • The patient's activity level after discharge • The patient's diet/fluid intake after discharge • The names of all discharge medications • Follow-up with a physician/nurse practitioner/physician assistant after discharge • Weight monitoring after discharge • What to do if heart failure symptoms worsen after discharge

JCAHO quality measure	*Data elements*
Numerator statement: Heart failure patients with documentation that they or their caregivers were given discharge instructions or other educational material addressing **ALL** of the following: 1. Activity level 2. Diet 3. Discharge medications 4. Follow-up appointment 5. Weight monitoring 6. What to do if symptoms worsen	• Discharge instructions address activity • Discharge instructions address diet • Discharge instructions address follow-up • Discharge instructions address medications • Discharge instructions address symptoms worsening • Discharge instructions address weight monitoring
Denominator statement: Heart failure patients discharged home. Included populations • ICD-9 code principle diagnosis of heart failure as defined in appendix. • D/C to home, home care or home IV therapy	Data elements: • Admission date • Birthdate • Discharge • ICD-9 Principal Diagnosis codes

Source. http://www.qualitymeasures.ahrq.gov; www.jcaho.org.

Additional guideline adherence concepts identified in the JCAHO measure by both coders were closely related but as with the CMS measure, they displayed varying levels of granularity. Examples include:

• Educational material	⇒	• Patient given educational material
• Follow-up appointment	⇒	• Discharge instructions address follow-up
• Written discharge instructions	⇒	• Patient given written discharge instructions

The representation of guideline adherence concepts abstracted from these measures ranged from 26.9–47.1% in the mandated terminologies and from 66.7–84.6% in LOINC & SNOMED CT. Total representation of guideline adherence measure concepts in the evolving terminology standards (HIPPA mandated terminologies, LOINC and SNOMED) ranged from 75% (for CMS guideline adherence measures) to 84.6% (JCAHO guideline adherence measures) (Table 6).

4. Discussion

The concept domain model put forth by Campbell et al. (1997) worked well for organizing clinical pathway concepts and for providing a useful framework for data analysis. All concepts were represented by these domains and most clinical pathway concepts in this analysis (97.3%) fell within the following domains: *Administrative* (16.3%), *Demographics* (5.5%), *Attributes* (4.1%), *Interventions* (29.8%), *Findings* (25.7%), *Diagnoses and impressions* (10.1%), and *Plans* (6.1%). Because all of the clinical pathway concepts were extracted from acute, inpatient, guideline-based documents and tools, these seven domains were adequate to classify the data. See Table 7 for Campbell's domain classification, percent representation, and examples of matching ACC/AHA guideline concepts.

We found that two of the Campbell framework domains, *Interventions* and *Plans*, lack clarity because of overlapping definitions. For example, in the Campbell model, nursing interventions fall under *Plans* and all other interventions (e.g., educational interventions) are classified under *Interventions*. However, several of the educational interventions can be completed by many disciplines, including nurses and if low sodium diet teaching is initiated by a nurse and then followed-up by a dietitian or physician, one might be an educational encounter classified as a *Plan* and the other as an *Intervention*. This ambiguity is problematic throughout the

Table 7
Guideline represented concept domains of computerized patient record

Conceptual domain	Definitions	% Total guideline concepts represented in this domain	Examples of concepts represented
1. Administrative	Attributes of the CPR that are properties of the health care system that are necessary data elements within the CPR. (e.g., facilities, institutions, practitioners, patients, payers)	15.5	Patient, admission date, admission time, discharge date, discharge time, patient ID
2. Demographics	Descriptors of living situations, major ethnic/racial categories, social or behavioral characteristics, or other properties of health care clients that identify them as individuals or quantify clinical risk (e.g., address, telephone, ethnicity)	5.1	Age, gender, female, male, race, African American, Asian, Caucasian, Hispanic, Native American
3. Attributes	Features that change the meaning or enhance the description of an event or concept (e.g., topography, site, negation, severity, stage, baseline, trend)	3.9	Admission status, emergency, elective, urgent, admission type.
4. Interventions	Activities used to alter, modify or enhance the condition of a patient in order to achieve a goal of better health, cure of disease, or optimal life style (e.g., diagnostic, laboratory or radiographic procedure, mediation, therapeutic procedure, educational intervention)	30.8	Procedures, echocardiogram, LVF assessment, ACE inhibitor, ARB, medications, diet counseling, medication counseling
5. Findings	An observation regarding a patient (e.g., history, symptoms, functional reports, physical exam, test results)	25	ACE inhibitor (ACE-I) allergy, contraindications to ACE-I, HbA1C
6. Diagnoses and impressions	Determination or description of the nature of a problem or disease; a concise technical description of the cause, nature or manifestations of a condition, situation or problem (e.g., disease-focused, testing, function-focused or nursing diagnosis).	9.6	Heart failure, chronic heart failure, congestive heart failure, atrial fibrillation, diabetes, hypertension, previous MI
7. Plans	A method or proposed procedure, documented in the CPR for achieving a patient/client goal or outcome (e.g., referrals, contracts, order, appointments, nursing interventions)	7.7	Activity recommendations, low sodium diet, low cholesterol diet, discharge instructions
8. Equipment and devices	Objects used by providers or client/patients during provision of health care services, in the pursuit of wellness or to educate or instruct (e.g., medical device, biomedical or dental material, biomedical supplies)	.4	Oxygen
9. Event	A broad attribute type used for grouping activities, processes and states into recognizable associations (UMLS); A noteworthy occurrence or happening (Webster 3rd International Dict.) (e.g., encounter, patient life event, episode of care)	.4	Admission
10. Human anatomy	A set of concepts relating to components or regions of the human body, used in the description of procedures, finding and diagnoses (e.g., body location or region, part, organ, space, substance or hormone)	.4	Lipids
11. Etiologic agents	Forces, situation, occurrences, living organisms, or other elements that may be instrumental or causative in the pathogenesis of human illness or suffering (e.g., infectious agents, trauma)	0	NA
12. Documents	A writing, as a book, report, or letter conveying information about a patient, event or procedure	.4	Medical record
13. Legal agreements	Contractual and other legal documents, made by or on behalf of the patient, in order to document patient wishes, enforce or empower patient priorities, or to assure legal resolution of issues in a manner in keeping with the patient's personal choices	.4	Do not resuscitate
14. Agents	Other individuals, who must be referenced in the CPR because of important family or personal relationships to the patient	.4	Caregiver

Adapted from: Campbell (1997). Phase II Evaluation of Clinical Coding Schemes: Completeness, Taxonomy, Mapping, Definitions, and Clarity. JAMIA, 4: 250-51.

concepts we identified in our analysis. For example, smoking cessation counseling, weight, and symptom monitoring education or any of the educational interventions might be classified as either Plans or Interventions in the Campbell model. Similar ambiguity was noted in the IRR analysis where a nurse coder (PCD) classified educational interventions as ''plans,'' while the physician coder (JJC) classified them as interventions.

The IRR analysis underscored the subjective and problematic nature of the concept abstraction process. We noted that the results of abstracting concepts from the pathway and associated tools are dependent on the tools themselves and the overall analysis proved to be somewhat subjective. For example, after completing the initial abstraction process, we went back and mapped each of the guideline adherence concepts for the JCAHO Smoking Cessation measure to corresponding codes in the evolving terminologies (see Table 5). At this point, we realized that many of the NDC codes for medications in the hospital formulary would need to be added to the clinical pathway concept table, as prescription of these medications are included as evidence of adherence for this measure. This analysis would have been strengthened if one or more additional domain experts had conducted the initial clinical pathway concept identification.

The results of this evaluation support the use of evolving national standardized terminologies for representing concepts from a clinical pathway integrated with the *ACC/AHA Guidelines for Evaluation and Management of Heart Failure*. Matching codes were found for 70% of the clinical pathway concepts in one or more HIPAA mandated terminologies (CPT, ICD-9-CM, and HCPCS). Representation improved to 91.9% with the addition of LOINC and SNOMED CT. The HIPAA mandated terminologies offer matching terms for a significant portion of the data elements in the automated clinical pathway data set and provide a basic foundation for coding data related to guideline-based care.

However, gaps in content persist in concept representation for automated tracking of CMS and JCAHO guideline adherence measures. In this case, less than 50% of guideline adherence concepts were found to have representation in the HIPAA mandated terminologies. The addition of LOINC and SNOMED CT improved representation substantially (75–86.4%) but still did not include representation of all concepts necessary for complete electronic monitoring of adherence.

SNOMED CT and LOINC were included in this study due to the general recognition of these terminologies as evolving standards and inclusion of broad interdisciplinary clinical terms, including many nursing concepts. A separate nursing terminology system was not included in the terminology mapping process because these systems are not universally integrated into CPRs. As noted in the IRR study, interdisciplinary terms that include terms common to the domain of nursing are necessary to capture the richness of clinical encounters and to improve the quality of information retrieval. Fuller integration of nursing terminologies into national standards would theoretically provide more complete representation of interdisciplinary concepts necessary for tracking guideline adherence. Guideline adherence concepts currently not represented by any of the evolving terminologies and required to document adherence with CMS and JCAHO heart failure measures include symptom monitoring, weight monitoring after discharge, and written discharge instructions. One of the most significant areas in which adherence measures are under-represented is related to written discharge instructions. This is likely because in a hospital setting, these instructions are often given to the patient by nurses, but are not required for any other reporting process. Continued integration of nursing terminologies into the current national standards may improve representation of these guideline adherence concepts.

An important limitation of this study is that a single domain expert (PCD) identified all clinical pathway concepts in the automated clinical pathway and associated tools. Differences in naming of guideline adherence concepts that were identified by multiple raters in the adherence measures interrater-reliability exercise highlight this as a methodological weakness. In addition, the SNOMED CT temporary browser (July 2002) was used to search for concepts. A number of nursing terminology concepts were integrated into SNOMED CT in January of 2003 that are not accessible from the temporary browser (personal email from Kathy Ax, SNOMED Administrator. May 15, 2003). The addition of nursing terminologies into SNOMED CT may improve concept representation beyond what was found in this study.

One of the problems in this exercise was in the identification of all relevant concepts for terms that could be expressed multiple ways, that is, the identification of appropriate synonyms for the relevant concepts. With a concept-oriented system, synonymy is addressed formally and has a formal process in place to identify and correct redundancy. This assures that all concepts and corresponding synonyms are mapped to a single preferred code [52–54]. Using concept representation to track guideline adherence assumes existence of a concept-oriented system. A concept-oriented view of a knowledge-based system supports both definitional knowledge and intelligent vocabulary management tools [55]. Zeng and Cimino [55] demonstrated the usefulness of the Medical Entities Dictionary (MED), a knowledge-based system, for aggregating concept-oriented views of the CPR. Concept-oriented views were generated from queries in which patient data were organized around clinical concepts such as diagnostic strategies

and therapeutic goals as a proposed solution to information overload at the point-of-care.

One concern identified with the concept-oriented view is that different health care providers may disagree on the significance of problems and on the problem-data links necessary for creation of concept oriented views. A possible advantage of using a concept-oriented method to track guideline adherence is that national consensus exists around standard adherence measures such as the CMS and JCAHO core measures and those data necessary to track adherence. Core quality measures could potentially be used as the organizing framework from which decisions are made to prioritize problem-data links.

5. Conclusion

Our analysis suggests that the evolving standardized terminologies are not yet adequate for representing all concepts necessary for electronically tracking guideline adherence. The standards set forth by AHRQ related to the evaluation of quality in health care are an important first step towards electronic monitoring of quality. The measures put forth by CMS and JCAHO are evidence that there is movement towards the the AHRQ goal of "enabling the user to quantify the quality of a selected aspect of care by comparing it to a criterion" [49]. Recently, CMS and JCAHO have combined their heart failure guideline adherence measures (after completion of the evaluation described in this paper), representing further movement towards precisely defining guideline adherence concepts and measures. However, even given precise definitions of numerators, denominators, and inclusion and exclusion criteria as they exist currently in the joint CMS/JCAHO guideline adherence measures, data elements and how they will be represented with evolving terminologies need to be defined more precisely before adherence tracking can be done electronically on a grand scale. Through this evaluation, it was noted that given current obstacles, matching guideline concepts with CPR concepts is problematic (even before looking at the actual coding). Interagency agreement on guideline adherence measures, as was achieved through the CMS and JCAHO collaboration described above represents one step towards a solution. An additional recommended solution is for guideline developers to identify how such information is documented in a CPR as part of the guideline development process. A final recommendation is that similar processes occur locally as an integral component of the clinical pathway development process. This would foster consensus on precise measures of clinical pathway adherence, define related concepts and identify those concepts necessary for generation of data, information and knowledge as a fundamental part of the pathway design process.

Acknowledgments

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