Advanced Terminology Systems

Submitted by:

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***Background and Definitions***

* The primary motivation for standardized terms in nursing is the need for valid, comparable data that can be used across information system applications to support clinical decision-making and the evaluation of processes and outcomes of care.

 **The Vocabulary Problem**

* The failure to achieve a single, integrated terminology with broad coverage of the healthcare domain
* Reasons for the vocabulary problem in health and nursing informatics:
* The development of multiple specialized terminologies has resulted in areas of overlapping content, areas for which no content exists, and large numbers of codes and terms
* Existing terminologies are most often developed to provide sets of terms and definitions of concepts for human interpretation, which computer interpretation as only a secondary goal

**Concept Orientation**

**The Semiotic Triangle**

* Concept (i.e., thought or reference) – unit of knowledge created by a unique combination of characteristics – a characteristic is an abstraction of a property of an object or of a set of objects
* Object (i.e., referent) – anything perceivable or conceivable
* Term (i.e., symbol) – verbal designation of a general concept in a specific subject field – a general concept corresponds to two or more objects which form a group by reason of common properties

**Evaluation Criteria Related to Concept-Oriented Approaches**

* Atomic-based – concepts must be separable into constituent components
* Compositionality – ability to combine simple concepts into composed concepts
* Concept permanence – once a concept is defined it should not be deleted from a terminology
* Language independence – support for multiple linguistic expressions
* Multiple hierarchy – accessibility of concepts through all reasonable hierarchical paths with consistency of views
* Nonambuiguity – explicit definition for each term
* Nonredundancy – one preferred way of representing a concept or idea
* Synonymy – support for synonyms and consistent mapping of synonyms within and among terminologies

\* A single concept may be associated with multiple terms (synonymy); however, a term should represent only one concept.

***Components of Advanced Terminology Systems***

 **Terminology Model**

* A terminology model is a concept-based representation of a collection of domain-specific terms that is optimized for the management of terminological definitions. It encompasses both schemata and type definitions
* Schemata incorporate domain-specific knowledge about the typical constellations of entities, attributes, and events in the real world and, as such, reflect plausible combinations of concepts
* Type definitions are obligatory conditions that state only the essential properties of a concept

**Representation language**

* Terminology models may be formulated and elucidated in an ontology language
* Ontology languages represent classes (also referred to as concepts, categories, or types) and their properties (also referred to as relations, slots, roles, or attributes)
* Ontology languages are able to support, through explicit semantics, the formal definition of concepts in terms of their relationships with other concepts
* They also facilitate reasoning about those concepts

**Computer-Based Tools**

* A representation language may be implemented using description logic within a software system or by a suite of software tools.
* Includes:
* Management and internal organization of the model
* Reasoning on the model (e.g. automatic classification of composed concepts based on their formal definition
* Facilitate transformation of concept representations into canonical form or support a set of sanctions that test whether a proposed composed concept is sensible
* Generations:
* First-generation – consist of a list of enumerated terms, possibly arranged as a single hierarchy; serve a single purpose or a group of closely related purposes and allow minimal computer processing
* Second-generation – include an abstract terminology model or terminology model schema that describes the organization of the main categories used in a particular terminology or set of terminologies
* Third-generation – support sufficient formalisms to enable computer-based processing; also referred to as formal concept representation systems

***Advantages of Advanced Terminology Systems***

* Allow much greater granularity through controlled composition while avoiding a combinatorial explosion of precoordinated terms
* Facilitate two important facets of knowledge representation for computer-based systems that support clinical care: (a) describing concepts, and (b) manipulating and reasoning about those concepts using computer-based tools

***Advanced Terminological Approaches to Nursing***

 **ISO 18104:2003**

* Motivated in part by a desire to harmonize the plethora of nursing terminologies around the world and to integrate with other evolving terminology and information and model standards
* Potential uses include to:
* Facilitate the representation of nursing diagnosis and nursing action concepts and their relationships in a manner suitable for computer processing
* Provide a framework for the generation of compositional expressions from atomic concepts within a reference terminology
* Facilitate the mapping among nursing diagnosis and nursing action concepts from various terminologies
* Enable the systematic evaluation of terminologies and associated terminology models for purposes of harmonization
* Provide a language to describe the structure of nursing diagnosis and nursing action concepts in order to enable appropriate integration with information models

 **GALEN Program**

* Can be used in a range of ways, from directly supporting clinical applications to supporting the authoring, maintenance and quality assurance of other kinds of terminologies
* GRAIL (GALEN Representation and Integration Language) – an ontology language for representing concepts and their interrelationships – the source material for the construction of terminology models
* Two integrated sets of tools are used in the development of a GRAIL model:
* A computer-based modeling environment – facilitates the collaborative formulation of models; it allows authoring of clinical knowledge at different levels of abstraction
* A terminology server – a software system that implements GRAIL; performs a range of functions:
* Internally managing and representing the model
* Testing the validity of combination of concepts
* Constructing valid composed concepts
* Transforming composed concepts into canonical form
* Automatically classifying composed concepts into the hierarchy
* Also used to deliver the model for use by clinical applications and other kinds of authoring environments
* Motivation for applying GALEN to nursing
* The desire to meet the requirements of users of clinical applications
* The need to provide a reusable and extensible model of nursing terminology
* GALEN does not seek to replace existing nursing terminologies; rather, it seeks to contribute to the development of those terminologies, to supplement them, to allow comparison among them, and to make them available for describing day-to-day nursing care.

 **SNOMED RT**

* SNOMED Reference Terminology (TR) is a reference terminology optimized for clinical data retrieval and analysis
* Concepts and relationships in SNOMED are represented using modified KRSS (Knowledge Representation Specification Syntax) rather than GRAIL
* Concept definition and manipulation are supported through a set of tools with functionality such as
* Acronym resolution, word completion, term completion, spelling correction, display of the authoritative form of the term entered by the user, and decomposition of unrecognized input
* Automated classification
* Conflict management, detection, and resolution
* SNOMED RT has been used as a foundation for a new terminology system SNOMED Clinical Terms (CT) – possess both reference terminology properties and user interface terms

Implementing and Upgrading Clinical Information Systems

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***The Clinical Information System (CIS)***

* Provide nurses knowledge of many aspects organized for effective and efficient healthcare delivery.
* Assists clinicians with data necessary for decision-making and problem solving
* Must serve the organization and the patient in much the same way an efficient healthcare delivery system involves all appropriate departments in establishing healthcare delivery processes
* Major CIS requirement for nursing are:
* Administer a nursing department
* Assist the management of nursing practice
* Assist nursing education
* Support nursing research
* Can be designed as a stand-alone system, a subsystem of a larger system, or an integral part of the healthcare organization’s overall information system
* Any CIS or single application design/ implementation or upgrade must complete the eight phases of implementation:
* Planning
* System analysis
* System design / system selection
* Development
* Testing
* Training
* Implementation
* Evaluation

***The Planning Phase***

* Begins once an organization has determined that an existing need or problem may be filled or solved by the development of a CIS

 **Clinical Information System Committee Structure and Project Staff**

* The nursing administrator, in conjunction with the information system’s management team, works to develop a committee structure and participation to best guarantee the success of the project
* Transition management is a series of deliberate, planned interventions undertaken to assure successful adaptation/ assimilation of a desired outcome into an organization. (Douglas and Wright, 2003)
* A three-tiered committee approach is recommended to accomplish the design, implementation, or upgrading of a complete CIS – a steering committee, a project team, and departmental teams.

**Clinical Information System Steering Committee**

* Charged with providing oversight guidance to the selection and integration of a new CIS into the organization
* Generally includes representatives from the following areas:
* Hospital administration/ hospital finance
* Nursing administration
* Medical staff
* Information systems department at the director or manager level
* Major ancillary department (laboratory, radiology, pharmacy, dietary, medical records/ patient registration, patient accounting)
* Health information management (medical records)
* Legal affairs
* Outside consultants (as needed)
* Other appointed members (as needed)

**Project Team**

* Led by an appointed project manager and includes a designated team leader for each of the major departments affected by the system selection, implementation, or upgrade proposed
* Objectives:
* Understand the technology and its restrictions, if any, of a proposed system
* Understand the impact of intradepartmental decisions
* Make decisions at the intradepartmental level for the overall good of the CIS within the organization
* Become the key resource for their application
* Goal: improve patient care
* Project manager: responsible for managing all aspects of the project; must have good communication, facilitation, organizational and motivational skills to be successful; must have fulltime dedication to a large-scale design or implementation project.

**Department Team**

* Charge of the departmental teams
* To thoroughly understand the department’s information needs
* To gain a full understanding of the software’s features and functions
* To merge the new system’s capabilities with the department’s operations
* To assist in the system testing effort
* To participate in developing and conducting end-user education
* To provide a high level of support during the initial activation period of the new system
* Physician involvement early in the planning process is recommended to ensure understanding of the information needs of the medical staff relative to patient documentation.

 **Planning**

* In the American Society for Testing and Materials (ASTM) standards, the planning phase is referred as the project definition.
* Commercial software developers and consultant rank this phase as the most critical factor in the selection of a system, even more important than the system itself.
* This phase is critical whether a system is actually being developed or existing commercial systems are being evaluated for selection
* Involves the following steps:
* Definition of the problem and/or stated goal
* Feasibility of the study
* Documentation and negotiation of project scope agreement
* Allocation of resources

 **Definition of the Problem**

* Includes a description of how the system will be evaluated.
* May also include increased processing capabilities, saving in processing time, decreased costs, or increased personnel productivity

 **Feasibility Study**

* Is the preliminary analysis to determine if the proposed problem can be solved by the implementation of a CIS r component application
* Helps identify the information needs, objectives, and scope of the project
* It highlights whether the proposed solution will produce usable products and whether the proposed system’s benefits outweigh the costs.
* Includes a high-level description of the human resources required and how the selected system will be developed, utilized, and implemented
* Describes the management controls to be established for obtaining administrative, financial and technical approvals to proceed with each phase of the project.
* Includes the following topic areas:
* Statement of objectives – constitute the purpose/s of the system; all objectives are outcome-oriented and are stated in measurable terms
* Environmental assessment – defined in terms of the support it provides to both the mission and the strategic plans of the organization
* Determination of the program needs/ needs assessment – outlines the high-level information required by the users
* Determination of the Scope – establishes system constraints and outlines what the proposed system will and will not produce
* Development of a project timeline/ project workplan – providing an overview of the key milestone events of the project
* Recommendations

**Documentation and Negotiation of a Project Scope Agreement**

* Includes the scope of the project, the application level management requirements, the proposed activation strategy for implementing the CIS or application, and the technical management and personnel who will maintain the equipment
* Becomes the internal organization contract of the project
* Defines the short and long term goals, establishes the criteria for evaluating the success of the project, and expands the workplan further

**Allocation of Resources**

* Last step in the planning phase is determining what resources are required to successfully complete the project scope agreement

**The Key Role of the Nurse Administrator**

* The active involvement of the nurse executive is considered a critical success factor of any CIS implementation or upgrade.

***The System Analysis Phase***

* Second phase of developing a CIS
* Is the fact finding phase
* Foundational to the actual system design

 **Data Collection**

* Collection of data reflecting the existing problem or goal.
* Refining of the project scope agreement
* Creation of a Workflow Document
* Assimilates data collected into logical sequencing of tasks and subtasks performed by the end users for each goal or problem area, it includes:
* A list of assumptions about the process
* A list of major tasks performed
* A list of subtasks and steps accomplished
* Sources:
* Written documents, forms, and flow sheets
* Policy and procedure manuals
* Questionnaires
* Interviews
* Observations

 **Data Analysis**

* Provides the data for development of an overview of the nursing problem and or stated goal defined in the project scope agreement
* Tools used:
* Data flowchart
* Grid chart
* Decision table
* Organizational chart
* Model

 **Data Review**

* Focuses on resolving the problem and or attaining the goals defined in the feasibility study based on the best method or pathways derived from the workflow documents and the functional design.
* The careful analysis of end-user requirements and potential solutions has been proved to reduce the cost of design and implementation

 **Benefits Identification**

* The overall anticipated benefits from the system are documented in this step
* The benefits reflect the resolution of the identified problem, formulated and stated in quantifiable terms

 **System Proposal Development**

* The proposal is submitted to a projects steering committee for review and approval
* The system document should answer these four questions:
* What are the major problems and or goals under consideration?
* How will the proposed CIS solution correct or eliminate the problems and or accomplish the stated goals?
* What are the anticipated costs?
* How long will it take?
* Format should be:
* A concise statement of the problems and or goals
* Background info related to problem
* Environmental factors related to the problem
* Anticipated benefits
* Proposed solutions
* Budgetary and resource requirements
* Project time table

***The System Design Phase***

 **Functional Specifications**

* Uses the functional design document developed in the system analysis phase of a CIS and builds on the design by forumulating a detailed description of all system inputs, outputs, and processing logic required.

 **Technical Specifications**

* The technical personnel work closely with the project and departmental teams to ensure the technical components of the proposed system work in concert with technology and end-user needs and to assist in the development and implementation plan
* Technical Manager- He is required for the coordination of efforts in for major areas:
* Hardware
* Application Software
* Interface Systems
* Conversions

 **Implementation Planning**

* The last step; it is to establish a detailed implementation plan.
* The implementation workplan should entail the following info:
* Personnel
* Timeframes
* Costs and budgets
* Facilities and equipment required
* Development or Implementation tasks
* Operational considerations
* Human-computer interactions
* System test plan

***The Testing Phase***

* The system, whether newly developed or commercially available, must be tested to ensure that all data are processed correctly and the outputs are generated.
* Testing verifies that the computer programs are written correctly and ensures that when implemented in the production environment, the system will function as planned.
* When commercially available software is being implemented, three levels of testing are recommended. The first level is often called a function test. During this round of testing, the departmental teams and verify the database, ensuring that correct data have been entered into the files and table. The expected departmental reports are reviewed to assure correctness and accuracy. Multiple interaction of functional test often occurs until the department team is confident about the system profile and setup. As more users interact with the new system, previous unfound problem may surface. Evaluation of the severity of the newly discovered problems and the corrective action required is an ongoing process during implementation

***The Document System***

* Preparation of documents to describe the system for all users is an ongoing activity, which development of the documentation occurring as the various system phases and steps are completed. Documentation should begin with the final system proposal. Several manuals are prepared: a user’s manual, a reference manual, and an operator’s maintenance manual. These manual provides guides to the system components and outline how the entire system has been programmed or define.

 **User Manual**

* User’s manual highlights how to use the system and describes what outputs the system can produce. With commercially available software, the vendor’s user’s manual helps establish the organization’s training manual.

 **Reference Manual**

* Reference manual is used by the project team members to understand how the system works. It describes what data are input, how the data base process the data, and the mechanism used to generate outputs.

 **Operator’s Maintenance Manual**

* Enables operators to keep the system up and running by providing the functional and technical specifications needed for the system. Manual must be written in sufficient detail such that users and operators understand how the system was developed, how it operates, and how it can be maintained, updated, and repaired.

***The Training Phase***

* Is essential to train the end user on how to use the system properly. A CIS will function only as well as its users understand its operation and the operation streamline the work.
* All users of the new system or application must receive training. Training takes place before and during the activation of a new system. After system implementation, refresher of a new system. Training Is most effective when hands on instruction is provided. Training guides or manuals explain the system.
* Training takes place before and during the activation of a new system. After system implementation, refresher courses as well as new employee introductory training on the use of the new systems are often provided by the institution.
* Training is more effective when on hands on, interactive instruction us provided. Training guides or manuals explain the system; however, retention of the information are increased if the learners are able to interact.

***The Implementation Phase***

* Organizes all the steps into a detailed plan describing the series of events into detailed plan describing the series of events required to begin using the system or application in the production or live environment and details the necessary computer and software.
* Four activation approaches are possible: (1) parallel, (2) pilot, (3) phased-in, (4) big bang theory. The timing of the conversation activity and the activation of all interphase require particular coordination between the technical staff and the project terms.

***The Evaluation Phase***

* Describes and assesses, in detail, the new system’s performance. Using the criteria established in the planning and system design phase.
* To evaluate an implemented hospital information system, many principles are important for CIS. One authority suggests evaluating duplication of efforts and data entry.
* Evaluating the system is the final and ongoing step in implementing process. This evaluation component becomes a continuous phase. The system is assessed to determine whether it continues to meet the needs of the users. The totally implemented system will require continues evaluation to determine if upgrading is appropriate. The formal evaluation should be conducted by an outside evaluation team to increase the objectivility level of the finding. Informal evaluations are done on a weekly basis.

 **Cost Benefits Analysis**

* Is necessary to determine if the system is worth its price. The cost benedif relates system cost and benefit to system design, level of use, timeframe and equipment costs. Each of these costs must be assessed in relation to benefits derived. Such as evaluation can be helped determining the future of the system.

 **Upgrading Clinical Information Systems**

* May be undertaken for a number of reasons. Software vendors often provide enhancements and upgrades to their system. New application features may be developed by the vendor and become available to the organization. Upgrading a system as a result of the addition of a new subsystems and technology often occurs. However when upgrading, require close evaluation. New technologies are an important consideration; the following new technologies may be considered:
* bedside/point of care wireless device
* workstation
* multimedia presentation
* decision support
* artificial intelligence
* neutral networks
* integrated system architecture
* interfaced network
* open architecture

 **Workstation**

* Becomes the mode to gain access to the multiple applications. The user does not have to know or understand what type of hardware or software he or she is accessing, only that there is access to a broad array of information. The security and confidentiality issues raised by open architecture system are being handled with the installation of security servers, registration centers to register use of information, and/or protocols requiring authorization.

 **System Issues**

* As new technologies are evaluated and upgrading is the considered, the design team or departmental team is considered, the design team or departmental team must reassess the original function requirements with the excising hardware may exist. As far as possible, the team needs to determine if a subsystem can be added to the working system. New functions might be required, necessitating the procurement of additional hardware