Controlled Medical Vocabulary in the CPR Generations

A CMV capability becomes progressively more important as computer-based patient record systems move to advanced-generation capabilities. There are various CMV functions that can map to Gartner's defined CPR generations.

Medical text plays a vital and pervasive role in the delivery of healthcare. It is the standard method by which humans exchange medical concepts and information in documents ranging from progress notes to discharge summaries, and prescriptions to procedure reports, as well as hundreds of other types of documents. In the past, computers have been unable to effectively participate in the use of this medical information and have had a limited role in its generation. The role of a controlled medical vocabulary (CMV) is to provide a linguistic and semantic infrastructure representing a consistent framework to support the exchange of information between humans, between automation systems and across the human/machine interface. In this manner, a CMV plays a key role in enabling humans and automation systems to more-effectively use medical text to support the processes of healthcare.

A CMV is a core capability of a computer-based patient record (CPR) system as defined by Gartner. Here, we define the capabilities of a CMV required for the five CPR generations defined by Gartner. The other eight CPR core capabilities are:

- Clinical documentation and data capture (see "Clinical Documentation in the Enterprise CPR")
- Clinical display — including the clinical dashboard (see "The Clinical Dashboard Is Another Key CPR System Element")
- Clinical workflow (WF; see "Workflow Evolution Within the CPR Generations")
- Order management — including physician order entry (see "Order Management Is a Core Capability of a CPR System")
- Clinical data repository (CDR; see "The Clinical Data Repository Provides CPR's Foundation")
Clinical decision support (CDS; see "Clinical Decision Support: Core Capability of Evolving CPR")

Support for privacy

Interoperation (see "The Gartner 2004 Criteria for the Enterprise CPR")

Currently, most CPR systems are at Generation 2, but several Generation 3 systems are expected to be available by year-end 2004. For advanced CPR generations (Generation 3 and above) the combination of CMV, CDS and WF become key to the CPR system’s capability to implement knowledge management capabilities (see "Knowledge Management and the CPR System").

A CMV (see "Defining 'Controlled Medical Vocabulary'") supports medically relevant concepts, terms, codes and relationships. CMV services are delivered using a vocabulary server (Voser). The Voser exposes a set of CMV functions as a series of application programming interfaces (APIs). This approach makes the CMV accessible to any software component in the CPR or its environment that requires such services. In most cases, a set of terminologies — for example, Systematized Nomenclature of Human and Veterinary Medicine (SNOMED), International Classification of Diseases-Ninth Edition (ICD-9) and Current Procedural Terminology-Fourth Edition (CPT-4), with cross maps between their terms — is required. The Voser supports functions that supply the answer to questions such as "What is the standard (canonical) term for heart attack," "Provide the ICD-9 code for appendicitis" and "Is congestive heart failure a circulatory problem"?

The CMV/Voser combination should be capable of providing vocabulary services for all of the subsystems of a core CPR system, as well as those in the CPR environment. It should come into play whenever an application needs information concerning a medical term or concept. It also should be equipped to accept terminology updates as they become available.

The use of a CMV is important because it makes it possible for CPR systems to understand and intelligently process medical information while continuing to store that information in a form (medical terms) that permits humans to interact with the same data. Some examples may be in order:

- A user might want to write a CDS rule that should be triggered for all antibiotics. It is neither feasible nor desirable for the rule itself to try to keep track of all antibiotics. Rather, new antibiotics, as they are added to the clinical environment, should be incorporated into the semantic network of the CMV with a link from the new antibiotic to the
The general concept of antibiotic. When the CDS rule is evaluated, the CMV/Voser can supply a list of all antibiotics to ensure that the rule executes properly.

- A user may enter a query against information in a data warehouse (which has received its data from the CDR) asking to retrieve all cases of “heart attack.” If the CMV has been used to classify the information in the data warehouse, then the query should successfully retrieve all cases — whether the physician described them as heart attacks or myocardial infarctions.

- A user might wish to see a list of all medical conditions relating to the circulatory system. The CMV can provide a comprehensive answer by using a search algorithm to explore its semantic network.

- A billing system may need to obtain the proper CPT-4 code to bill for a procedure. The Voser can be queried with the procedure description and the CMV can provide the mapping to the corresponding CPT-4 code.

**CMV Functions Across the CPR Generations**

Here is a description of the CMV functionalities needed to achieve each level of capability according to Gartner's definitions of the generations of CPR systems:

- **Generation 1, the Collector:** No CMV capabilities required. Generation 1 CPRs essentially function as a CDR and have very limited automated capabilities for handling medical terms.

- **Generation 2, the Documentor:** Limited CMV capabilities exist (for example, map terms into canonical terms, generate billing codes) and are generally hard coded into applications. In Generation 2 environments the CPR must support the ability to generate standard code sets such as ICD-9 and CPT-4.

- **Generation 3, the Helper:** At this level of CPR system the CMV must exist as an architecturally separate component. The care delivery organization must be able to use it to explicitly manage concepts, terms and relationships, as well as cross-mapping these to standardized encoding schemes.

It is advantageous for the CMV and Voser to be supplied by a commercial CMV vendor, although proprietary CPR-vendor-developed systems can still succeed. The use of a commercial CMV product relieves the CPR vendor of significant development and support burdens, allowing the vendor to focus on adding direct value for clinicians in the CPR environment. In Generation 3 CPRs, applications such as CDS and WF have a significant degree of CMV.
interaction. A standard API functioning on a separate Voser creates an efficient environment to support the vocabulary needs of these and related software components. At this level, the CMV/Voser combination must support elementary tools to enable terminologies to be updated and to resolve resulting conflicts. The CMV must be capable of comparing proposed CMV content to current content, establishing the semantic consistency of new content and keeping track of changes that are made to the CMV.

- Generation 4, the Colleague: At this level of CPR the incorporation of a commercial vocabulary system is essential. A true Voser is required at this level to support the interacting vocabulary needs of the Generation 4 CPR environment. The Voser must permit users to interactively explore the vocabulary’s semantic network, maintain local vocabulary variations, incorporate new content, handle versioning issues and provide real-time responses to queries for vocabulary services. To support the full spectrum of CPR functions, the main CMV must exhibit “decompositional completeness” (see Note 1). The CMV also will play a significant role in supporting the WF and CDS support capabilities of the system. Emerging functions to support the practice of evidence-based medicine (EBM), such as automated care guideline protocols, also will use CMV capabilities. The CMV must include full support for manual vocabulary updates and the resolution of vocabulary semantic conflicts.

- Generation 5, the Mentor: At this level a full suite of vocabulary services is required. This includes the capability to support a full range of real-time vocabulary services, as well as being able to receive automated updates from vocabulary authorities. The CMV must support nearly all of the industry-standard coding systems. The Voser management system will need to support automated integrity checking of the CMV’s semantic network and be able to provide automated support for the full range of functions needed to implement EBM. The CMV will be combined with capabilities such as WF, CDS, EBM, natural language processing and continuous speech recognition to provide an environment where all types of clinical input — typing, speech, menu picks and external documents — are fully and efficiently incorporated into the CPR system’s functions. This will form the basis for the CPR system’s capability to support a full range of knowledge management activities.

Key Facts:

- Medical text is ubiquitous and a CMV is essential for automation systems to use this text effectively.

Note 1

Decompositional Completeness
A "decompositionally complete" CMV must contain atomic representations of all pre-coordinated terms that it contains. If the CMV contains a pre-coordinated term such as "spiral fracture of the left ulna," then it must include primitive terms for each of those elements — spiral fracture, left and ulna. Furthermore, there must be a convention that describes how to use these primitive elements to create a post-coordinated term with the identical semantic content as the pre-coordinated term. A CMV that exhibits decompositional completeness enables applications, such as medical natural language processing, to function properly despite the existence of pre-coordinated terms that differ in form from the specific terms that may be created by a CPR system user (for example, "ulnar spiral fracture, left").
A robust CMV becomes progressively more important as CPR systems become more advanced.

A CMV will work in conjunction with WF and CDS to make true knowledge management possible within a CPR system.

**Bottom Line:** Vocabulary services form one of the distinguishing features of the various generations of computer-based patient record systems defined by Gartner. As Generation 3 CPR systems begin to emerge in the market by year-end 2004, the need for strong controlled medical vocabulary support will become increasingly evident. Care delivery organizations considering the purchase of a CPR system must ensure that their vendors have adequate CMV functionality and have clear strategies to continue enhancing those capabilities as their systems evolve toward the advanced generations of the Gartner CPR generation model.

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<thead>
<tr>
<th>Acronym Key</th>
<th>Description</th>
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<tbody>
<tr>
<td>API</td>
<td>application programming interface</td>
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<tr>
<td>CDS</td>
<td>clinical decision support</td>
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<tr>
<td>CPR</td>
<td>computer-based patient record</td>
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<td>CMV</td>
<td>controlled medical vocabulary</td>
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