Managing Predefined Templates and Macros for a Departmental Speech Recognition System Using Common Software

Chris L. Siström, Janice C. Honeyman, Anthony Mancuso, and Ronald G. Quisling

The authors have developed a networked database system to create, store, and manage predefined radiology report definitions. This was prompted by complete departmental conversion to a computer speech recognition system (SRS) for clinical reporting. The software complements and extends the capabilities of the SRS, and 2 systems are integrated by means of a simple text file format and import/export functions within each program. This report describes the functional requirements, design considerations, and implementation details of the structured report management software. The database and its interface are designed to allow all radiologists and division managers to define and update template structures relevant to their practice areas. Two key conceptual extensions supported by the template management system are the addition of a template type construct and allowing individual radiologists to dynamically share common organ system or modality-specific templates. In addition, the template manager software enables specifying predefined report structures that can be triggered at the time of dictation from printed lists of barcodes. Initial experience using the program in a regional, multisite, academic radiology practice has been positive.

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RADIOLOGISTS have used "canned" reports to supplement free text dictation for many years. Typically, these represented normal examination descriptions developed by individual radiologists, stored in some manner, and inserted into the body of the report by transcriptionists as needed. In the past 3 decades, several paradigms for computer-assisted report generation were developed and used, mostly in academic centers. However, radiologists generally do not make extensive use of structured reporting in routine practice, relying instead on experienced transcriptionists who know their individual reporting styles well. Digital dictation systems with continuous voice to text capability are being adopted rapidly by hospitals. When their departments convert to a speech recognition system, radiologists find that they are spending much more time generating and editing reports. This is especially true if the radiologist assumes sole responsibility for editing the

text produced by these systems without help from transcriptionists. In such cases, innovative use of predefined templates can streamline the reporting process. This requires initial preparation, ingenuity, and changes in work style. Our university radiology practice converted to computerized speech recognition for all reporting (with no human transcription support) about 3 years ago. We have begun to develop procedures for increasing the use and scope of predefined report templates in daily clinical practice. This report describes the reporting infrastructure, a conceptual framework, and specific details of a full implementation of radiology report templates using PowerScribe for Radiology (Lernout and Houspie, Burlington, MA) supplemented with commonly available personal computer database software (Access 97; Microsoft Corp, Redmond, WA).

Two terms will be used extensively below and some clarification is in order. We take the term *template* to mean the outline of a radiology report represented by several lines or paragraphs of text. Usually, there will be a number of places within this text with delimited areas that are meant to be filled in with findings specific to the case in question. This is to be distinguished from a prestored (*canned*) report that consists of complete descriptive text detailing a normal examination or a very common and simple set of abnormal findings. The term *macro* refers to a text fragment ranging in size from one word to a paragraph. A macro may be inserted into the delimited areas in a template and consists of commonly occurring findings relating to a single organ or body area. Macros also may contain descriptions of invasive procedures, examination details, billing codes, or clinical history. Additionally, we will use the phrase *speech recognition system* (SRS) to mean a computerized system for creating text from speech. This to be

From the Department of Radiology, University of Florida School of Medicine, Gainesville, FL.

Address reprint requests to Chris L. Siström, MD, Department of Radiology, University of Florida School of Medicine, PO Box 100374, Gainesville, FL 32610.

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distinguished from the phrase *voice recognition system* that refers to using a person's voice for identification or authentication in a computer system. Finally, the exact meaning of the phrase *structured report* is somewhat ambiguous and evolving. In the strictest sense, one might reserve this particular wording to describe systems that produce medical documents from controlled vocabularies with defined hierarchical construct definitions. Herein, we will use *structured report* rather more generally to denote predefined templates that are edited or *filled in* to create a radiology report document.

BACKGROUND

Our radiology practice is conducted in a full service 577-bed university hospital with 3 nearby satellite outpatient imaging centers. The department also manages radiology services in 2 community hospitals, one located in the same city and one 50 miles away. Approximately 275,000 examinations are performed and interpreted per year at all these sites. The radiologist staff consists of 35 attending faculty, 12 fellows, and 24 residents. Currently, we read all studies except mammograms from a hybrid picture archiving and communication system (PACS) developed in house.^{1,2} All interpretive and procedural reports are generated using the PowerScribe SRS that runs over a Windows NT (Microsoft Corp) network consisting of 2 servers and 40 active reporting stations installed on personal computers that also have the NT operating system. The reporting system is interfaced with our radiology information system (RIS) and through it to the hospital information system (HIS). Both the RIS and HIS are supplied by SMS (Shared Medical Systems, Malvern, PA).

Reporting stations are equipped with barcode readers incorporated into the dictation microphones. After starting PowerScribe and logging in with their individual identification, the reporting physician wands in the barcode(s) for an examination and begins dictation. After completion of each dictation, PowerScribe converts the voice file into text on an editing screen. The dictating radiologist then makes any needed corrections. Once a report has been edited, corrected, and verified, it is "signed," at which time the contents are transferred via the RIS to the HIS where they are immediately available in the online medical record. If a resident is reporting the case, the SRS provides a feature

that allows editing and verification of the report that is then sent to an attending radiologist for final review and electronic signature.

On the full implementation of SRS, the department soon realized a significant decrease in report turnaround times, reduction in the number of missing reports, and improved billing statistics. Additionally, 5 full-time equivalents were eliminated including all transcriptionists, resulting in an immediate yearly savings of about 150,000.00 in the departmental personnel budget. However, considerable negative impact is experienced by radiologists related to the unavoidable fact that recognition of spoken dictation is imperfect. The fidelity of recognition varies between radiologists, dictation stations, and over time. This variability may be troublesome even for the same radiologist working at one reading station during a single day. One significant problem continues to be that small words vital to a report's meaning sometimes are dropped or misrepresented. An example might be: "evidence of metastatic disease" being displayed instead of "NO evidence of metastatic disease" as dictated. Numbers and complex medical terms sometimes are misrepresented as well. Therefore, scrupulous reading and correction of every word in the report always is required.

When surveyed after 2 years of using SRS, radiologists stated that the time required to dictate, edit, and sign a report was at least twice that for traditional dictation with human transcription.³ To reduce time spent on reporting, individual radiologists have begun to use the template and macro capabilities designed into the SRS product. These efforts vary in success and complexity. Many use a few generalized report outlines and dictate relevant contents. Some developed up to 50 specific templates relating to common examination and finding patterns. A few radiologists have produced large and quite complex systems containing several hundred templates, subreports, and macros. These individuals are able to produce almost all their reports with virtually no dictation. Those who developed and use robust and complete personal template and macro definitions report greater satisfaction in working with the SRS.³ Those who rely mostly on free-text dictation continue to find that using the SRS takes them longer than traditional dictation with human transcription. All agree that patient care has improved since adoption of SRS because of significantly reduced report turn-

around times.³ Because conversion to SRS was inevitable in our practice, developing methods for effective management, storage, distribution, and use of predefined reports has been greatly beneficial.

HOW POWERSCRIBE IMPLEMENTS TEMPLATES AND MACROS

PowerScribe has two distinct methods for storing and retrieving predefined text in radiology reports. The first is called a *powernormal*. The generic term for this would be a template. These are defined in an editing function available to each radiologist by typing a key phrase (eg, chest normal) and an expansion (eg, a normal chest x-ray report). During dictation, the radiologist says "powerscribe chest normal." The phrase will be recognized as a powernormal definition, "chest normal" is looked up in the list of definitions, and the expansion text will appear in the editing screen. Powernormals may contain phrases delimited by curly brackets identifying other powernormals. That is to say, they may be nested. Additionally, powernormals can contain text delimited with brackets. In this case, a button on the microphone causes the cursor in the editing screen to jump to each bracketed expression in turn. This allows defining specific parts of a template to be filled in during editing by speaking descriptive text, speaking the keywords of yet another powernormal, typing key strings to be expanded as "glossary terms" (see below), or typing full text with the keyboard.

The other capability offered by PowerScribe is a *glossary term*. The generic name for this would be a macro. Glossary terms are defined in a second special editing function available to each radiologist. They consist of a unique string of characters that defines the key and associated expansion text. Whereas powernormals are activated during reporting by speaking a phrase, glossary terms are activated during keyboard entry. If the user types a string of characters that matches a predefined glossary term, the expansion text appears in a yellow box next to the cursor. Pressing either the tab key or return causes the string to be replaced with the expansion. Although designed to contain words or short phrases, glossary term expansions do not have prohibitive limits to their length.

Using combinations of powernormals, glossary terms, and the bracketed text feature, sophisticated structured report templates can be specified. An

example of such a template for generic abdominal CT scan reporting is depicted in Fig 1. In this template, named report sub parts are followed by bracketed text insertion points. Each instance of bracketed text (including the brackets) is highlighted when the user moves to it with the microphone button. The newly typed characters or spoken phrase will replace the bracketed text. This means that templates can contain hints for dictated contents or the names of relevant macros within each bracketed stopping point as shown in Fig 1.

The implementation of powernormals (templates) and glossary terms (macros) in the current version of PowerScribe is fairly straightforward. Each radiologist defines his or her powernormals and glossary terms within the PowerScribe dictation client with simple editing functions. Many radiologists wish to maintain their key words or strings and expansion texts in a third-party word processor or database. The only way to place these into the PowerScribe program is to copy and paste each one individually. Two separate copy/paste cycles are needed for every powernormal or glossary term, one for the key phrase or string and one for the expansion. This can be time consuming when dealing with large numbers of definitions. There is no provision in current PowerScribe versions (up to 3.0) to produce printed versions of powernormal or glossary term definitions. It is difficult for most people to remember more than 20 powernormal phrases or glossary term strings, and printed lists are very helpful in daily practice.

Using a special interface, local administrators may copy powernormal and glossary term definitions from one individual radiologist's account and append them to another's. Once this is done, there is no easy way to restore the recipient users account to its former state. The administrator can also define "global" powernormals and glossary terms that are available to all users. There currently is no method for defining a set or group of powernormals and glossary terms pertaining to a specific organ system or modality. An individual radiologist needs the ability to use several sets of templates or macros depending what type of work they are doing on any given day. The only option available in the standard PowerScribe implementation is to define all possible expansions either in the global repository or within each radiologists account. With full departmental implementation there may be up to several thousand definitions,

Fig 1. Illustration of a template for general abdominal CT scan reporting. The entire report template is shown to the left. Uniquely named macros are available for insertion between brackets. Upon activation of a macro within brackets the entire string (including brackets) is replaced by the macro expansion text. The radiologist also may dictate or type text at the bracketed insertion points or anywhere in the report.

and this might overburden the network, reporting station memory, and the algorithms for searching trigger phrases or strings.

SYSTEM FUNCTIONAL REQUIREMENTS

To organize a radiology department's template or macro definitions requires a single system with several functions and attributes available to all radiologists. Such a system would store all structured report definitions for the entire department in a single secure repository in standardized format. In a client-server type implementation the master database would reside on a central server while radiologists and administrators access it via front-end interfaces running on individual client workstations connected to the network. These client programs should allow addition, deletion, and modification of the templates on the server with appropriate security precautions. Additionally, users should be able to view or print lists of definitions ordered and filtered so as to be useful to them in reviewing their own definitions, collaborating on shared content, or during clinical reporting.

As described above, each radiologist should be able to define and use his or her own set of templates and macros. The most important additional organizational feature is that of shared sets of templates or macros pertinent to organ system, modality, or practice area. Examples include obstetric ultrasound scan, brain computed tomography, and peripheral angiography. In addition to the key phrases or strings and expansion text, each template or macro should be tagged with an "owner." This replicates the required organizational scheme by defining individual radiologists as well as common organ system/modality areas as "owners." In addition to ownership, each template or macro should be defined by "type," the most obvious of which is a generic normal report for a specific examination. To distinguish examinations done for specific indications requires a second template type, and the description of an invasive procedure represents a third. Many other types can be articulated and defined. To give the system optimal flexibility, these type definitions should be user definable. To aid in reading lists of templates

and macros, a meaningful description is needed. This may be identical to the spoken (powernormal) phrase, although users should be able to specify longer descriptions. For macros (glossary terms) with keys consisting of only a few characters, a meaningful description is especially important. These enhanced organizational features can be implemented by adding "owner," "type," and "description" attributes to each template or macro definition in addition to the key phrase/string and the expansion text.

To aid in using large numbers of templates and macros in routine reporting, a facility to print formatted lists ordered by "owner" and "type" is required. These must be easy to produce and reflect the current contents of the database. For collaboration on shared departmental templates, date stamped printouts of the complete expansions should be available. Finally, there must be an accurate and rapid way to synchronize the contents of the template database with individual user powernormal and glossary term lists contained in the

SRS database. In response to our suggestions, the PowerScribe development team added an administrative function to the SRS product (starting with version 2.5) that allows importing and exporting powernormals or glossary terms via plain text files. The structure of these files is simple, with the first line representing the trigger phrase or string. The subsequent text represents the expansion and ends with a line containing "\$\$\$," a pattern that is repeated for each definition included. The template manager system must be able to import from and export to this file format. Figure 2 shows the general functional requirements of our template manager system in relationship to the PowerScribe SRS as currently implemented.

SPECIFIC IMPLEMENTATION DETAILS

We designed and deployed a database of templates and macros available to all radiologists from any PC over the departmental network. This includes computers in faculty and house staff offices as well as all of the clinical reporting stations. The

Fig 2. General organization of a database system for creation, maintenance, and use of predefined reports for radiology interpretation. Ideally, the database and associated functions would be completely integrated into the SRS and available to all users and administrators.

system was developed with Access 97 (Microsoft Corp). A single record in the main database table (called **TEMPLATES**) represents each powernormal or glossary term (template or macro). The field structure of this table allows implementation of the functional requirements described above by virtue of defining an **OWNER** and **TYPE** for each record. Records in the definition table also contain other fields. These include the **EXPANSION** text, spoken **KEY WORDS** (powernormal phrase), typed **KEY STRING** (glossary term), and a meaningful **DESCRIPTION**. A single definition record may be a powernormal (if it has a spoken phrase), a glossary term (if a key string is defined), or both (if phrase and key string are defined). Other tables include **OWNERS** (individual radiologists or practice areas) and **TYPES** (containing type definitions) each with appropriate field structures. Figure 3 shows the basic data structure of the system.

The template manager client program incorporates password protection for each owner, allowing individual radiologists ability to add, delete, or edit his or her templates and macros. For practice areas, the owner is given a meaningful name (eg, *radchest* for chest x-ray, *ctchest* for chest CT, *ctbrain*

for neuro CT). The password for these "owners" is known to appropriate personnel in each section so that they can maintain these commonly used templates and macros. From the client program, new users can add themselves as owners and they are assigned an initial password. Previously registered users may change passwords. We do not anticipate any need to change the **TYPES** and **OWNERS** tables frequently; therefore, system administrators maintain them by making changes directly to the back-end database tables as requested.

The basic functions of the client program allow radiologists or administrators to create and maintain template/macro definitions in the central database. A scrollable listing of all definitions for the current owner is displayed (Fig 4). Changes can be made to all attribute fields from within this form. Double clicking on the **EXPANSION** column activates a pop-up form (Fig 5) that displays the selected template or macro in expanded form for editing. Double clicking on the **DESCRIPTION** column brings up a pop-up form that enables sorting, searching, deleting, and replicating templates (Fig 6). Individual template or macro definitions may be replicated to the same owner. This

Fig 3. Database structure for the template/macro management system. Table definitions are to the left and sample contents are to the right.

Edit Templates For bodyct ordered by type and description							
sym	kidney donor CT blank	ICD-9 Code: 593.9	kidney donor tomography	☒	6/14/00	1/10/01	
sym	kidney donor CT normal (one renal	ICD-9 Code: 593.9	kidney donor tomography normal	☒	1/1/00	12/29/00	
sym	lymphoma staging / follow up CAP C	ICD-9 CODE: [201.9 (Hod	lymphoma tomography blank	☒	6/14/00	6/14/00	
sym	pancreatitis acute CT blank template	ICD-9 Code: 790.5, 577.0	pancreatitis acute tomography	☒	6/14/00	6/14/00	
sym	pancreatitis chronic CT blank template	ICD-9 Code: 577.1	pancreatitis chronic tomography	☒	6/14/00	11/14/00	
sym	renal stone CT blank template	ICD-9 Code: 788.0, 599.7	renal stone tomography	☒	1/1/00	6/14/00	
sym	stent graft (follow up) CAP CT proto	ICD-9 Code: 441.4	stent graft tomography follow up	☒	6/14/00	9/8/00	
sym	stent graft (new) CAP CT protocol	ICD-9 Code: 441.4	stent graft tomography new	☒	6/7/00	9/8/00	
sym	trauma abdomen / pelvis CT, blank	ICD-9 Code: 958.8	trauma abdomen tomography	☒	6/14/00	6/14/00	
sym	trauma abdomen and pelvis, normal	ICD-9 Code: 958.8	trauma abdomen tomography normal	☒	1/1/00	6/14/00	
tec	abdomen and pelvis CT with contrast	Contiguous axial slices w	abdomen pelvis tomography with	☒	1/1/00	6/14/00	
tec	abdomen and pelvis CT without contrast	Contiguous axial slices w	abdomen pelvis tomography without	☒	1/1/00	1/1/00	
tec	abdominal CT with contrast	Contiguous axial slices w	abdomen tomography with	☒	1/1/00	6/14/00	
tec	abdominal CT without contrast	Contiguous axial slices w	abdomen tomography without	☒	1/1/00	6/14/00	
tec	chest abdomen and pelvis CT with contrast	Contiguous axial slices w	chest abdomen pelvis tomography with	☒	1/1/00	6/14/00	
tec	chest CT with contrast	Contiguous axial slices w	chest tomography with	☒	1/1/00	6/14/00	
tec	chest CT without IV contrast	Contiguous axial slices w	chest tomography without	☒	1/1/00	1/1/00	
tec	examination modifier for pancreatic	Thin section cuts were do	pancreatic protocol modifier	☒	1/1/00	1/1/00	
tec	examination modifier for renal mass	Thin section cuts were do	renal mass exam modifier	☒	1/1/00	1/1/00	
tec	examination modifier for three phase	Thin section cuts were do	three phase liver modifier	☒	1/1/00	1/1/00	
temp	abdomen CT blank	ICD-9 CODE: [INS: ICD-9	abdomen tomography	☒	1/1/00	6/14/00	
temp	abdomen/pelvis CT blank	ICD-9 CODE: [INS: ICD-9	abdomen pelvis tomography	☒	1/1/00	6/14/00	
temp	chest CT blank	ICD-9 CODE: [INS: ICD-9	chest tomography	☒	1/1/00	7/14/00	
temp	chest/abdomen/pelvis CT blank	ICD-9 CODE: [INS: ICD-9	chest abdomen pelvis tomography	☒	1/1/00	6/14/00	

Fig 4. Scrollable list of predefined report definitions for body CT. Note that a single entry may be defined as a power normal, a glossary term, or both by typing a phrase/string in the appropriate cell. Any definition also may be designated for barcode use by checking the box. Double clicking on an expansion brings up a form (Fig 5) for editing. Double clicking on a description brings up a form (Fig 6) for sorting the list, deleting entries, and replicating entries.

Edit Template	
Template Type	sym ☐ Exam by symptom
Description	renal stone CT blank template
Spoken Key	renal stone tomography
Typed Key	
Barcode (check=yes) ☒ v Edit Expansion Text Below v	
ICD-9 Code: 788.0, 599.7	
Indication: Flank pain colic on the [right / left]. Hematuria.	
Comparison: [INS: none/or date]	
Examination: Contiguous axial slices (with spiral technique) were made from the upper abdomen through the symphysis pubis. Neither Intravenous or oral contrast was administered.	
Findings:	
RIGHT KIDNEY/URETER: [INS: findings]	
LEFT KIDNEY/URETER: [INS: findings]	
BLADDER: [INS: findings]	
PELVIS: [INS: findings]	
RIGHT LOWER QUADRANT: [INS: findings]	
OTHER FINDINGS: [INS: findings]	
IMPRESSION: [INS: impression]	
<div>Exit Keeping Changes</div> <div>Exit Discarding Changes</div>	

Fig 5. Pop up form for editing an individual template or macro activated by double clicking in the listing screen over the expansion for "renal stone CT blank template." The expansion text may be viewed and edited as it will appear in a report.

Fig 6. Pop up form activated by double clicking in the listing screen over the description for "renal stone CT blank template." Buttons allow sorting the list in several orderings, replicating the entry to another owner or into the current set, and deleting the current entry.

facilitates creating a new definition by modifying one already present. A template or macro definition also may be replicated to any other owner. This allows sharing definitions between individuals.

The system produces several kinds of printed output. Among these are tabular lists of templates and macros sorted by type for each owner. These are intended for radiologist's reference during dictation. Lists of full text of the expansions with description and trigger phrases or strings may be produced for collaborative development of shared templates and macros. The template manager clients also can export any owner's templates and macros producing a meaningfully named and correctly formatted file (eg, "Jones_John_Power.txt" and "Jones_John_Gloss.txt"). This allows the PowerScribe administrator to import them into that users account. Because the current version of PowerScribe does not allow for defining sets of definitions by organ system or modality, we emulate this feature by allowing users to append additional "owners" to their export file. For example, if Dr John Jones is going to be working in body imaging he would request the system to export his personal definitions and then choose those for body CT and ultrasound for import into his PowerScribe account as shown in Fig 7. When Dr Jones logs on to dictate, both his personal definitions and the body imaging definitions will be available to him. Armed with the printed lists of descriptions and key phrases/strings he can then proceed to use all of the templates and macros in his work.

A feature recently added to the system and successfully used in several practice areas involves the use of barcodes to trigger templates and macros. The microphone supplied with the PowerScribe product has a built-in bar code scanner. This is capable of reading standard Code 39 barcodes.

These are used widely in many industry and government barcode specifications, including the United States Department of Defense. Code 39 is defined in American National Standards Institute (ANSI) standard MH10.8M-1983, and also is known as USD-3 and 3 of 9. A barcode module for Access 97, BarCode/AX (Peernet Inc., Nepean, Ontario, Canada) was incorporated into the project code in the form of a "control" on a printed report definition. Users may now specify any template or macro definition as a barcode in addition to assigning it a spoken phrase (powernormal) or key string (glossary term). Each definition record has a unique identifier number. A printout of barcodes contains descriptions and barcode images of the identifier number. The export to file function adds glossary terms with the unique number and expan-

Fig 7. Screen for selecting sets of templates and macros for export to the SRS. In this case Dr John Jones has selected body CT and ultrasound definitions to be concatenated with his personal set. When finished, 2 formatted text files will be created in a common network directory for import into PowerScribe as powernormals and glossary terms by a SRS administrator.

Fig 8. Sample of a sheet of barcodes representing report templates. Such sheets can be laminated and left at the appropriate reporting stations. Readers integrated into SRS microphones translate the barcode images to numbers and instantly trigger expansion of the stored text.

sion for any definition tagged as a barcode. After importing into PowerScribe as glossary terms, these expansions can be triggered by scanning the appropriate barcode. This technique is useful for several reasons. The user no longer needs to remember the actual key phrase or string needed to activate individual templates or macros. Activating a template or macro using the barcode is virtually instantaneous and is 100% accurate. Furthermore, the radiologist can perform all the steps with the microphone by navigating to bracketed insertion points with the microphone button and bar-coding appropriate contents. Figure 8 shows a sample of a

barcode sheet used for activating report templates for general radiographic examinations. Figure 9 depicts the template manager system and its integration with the PowerScribe SRS, radiologists, and system administrators.

DISCUSSION

Discrete speech SRS became available about a decade ago. Radiology has presented an attractive area for application of this technology. Robbins described preliminary experience with such systems having 1,000- and then 5,000-word dictionaries. In these early experiments, the use of key

Fig 9. Specifics of design and implementation of a template (powernormal) and macro (glossary term) manager with Microsoft Access 97 for use with the PowerScribe digital dictation system. Planned direct integration with the PowerScribe back-end databases would eliminate the need for import/export via text files.

words or phrases to "trigger" text expansion was anticipated.^{4,5} In fact, Dershaw found this to be the only way to use such a system, because free text recognition was problematic.⁶ Hansen et al⁷ was even more pessimistic and articulated the problem of having radiologists spend too much cognitive effort and time with the mechanics of producing a report with discrete SRS. Continuous SRS with large radiology-specific vocabularies and context-sensitive language modeling represents a significant improvement over discrete speech predecessors, and commercial versions are being rapidly brought to market and adopted.⁸⁻¹⁰

Initial experience with full-scale implementation of SRS in various settings leads to several conclusions. These reflect our findings almost 3 years after complete departmental conversion to SRS. There is nearly universal agreement that report turn around times are significantly reduced almost immediately and transcription costs decrease within a year of implementation.¹⁰⁻¹⁴ These benefits come at the expense of increased radiologist effort to edit and verify reports during clinical interpretation, and these tasks may double reporting times even after considerable experience with the systems.^{11,12,14-17} Using templates and macros within the SRS process is vitally important to regaining lost efficiency in routine reporting.^{10,12,14}

Before the advent of continuous SRS, several groups at larger centers experimented with computer-generated radiologic reports. Workers at Johns Hopkins,¹⁸⁻²¹ the University of California,²²⁻²⁴ Harvard,²⁵⁻²⁷ and others^{28,29} have developed and described such systems. Often the scope of reports generated by these systems is limited to a specific practice area, such as musculoskeletal imaging, mammography, or obstetric ultrasound. Different methods for user interaction were used including mark-sense forms, keyboard input, mouse navigation, touch screen input, and voice activation. Using barcodes to quickly input patient demographics or to imple-

ment a structured reporting scheme has been described as well.³⁰⁻³² One major motivation for developing these alternative approaches to traditional dictation and transcription was to shorten report turnaround time by allowing instant report generation at the time of interpretation. It might seem that with widespread use of SRS that this reasoning would be obviated. However, as described above, problems with SRS recognition accuracy cause radiologists to spend considerable extra time on reporting. Predefined report text in the form of templates and macros is reproducibly correct and can help to regain efficiency lost in conversion to SRS.

Our predefined report management system provides a reliable, robust, and content independent framework within which to apply the principals described above to a clinical radiology SRS system. Development of a separate system for storing, editing, organizing, and documenting templates and macros was needed to supplement the basic capabilities offered by our commercial SRS product (PowerScribe). This was accomplished with commonly available software (Microsoft Access) running on the same networked computers used to host the SRS. The obvious next step is to directly connect our template management interface with the PowerScribe back end database. This would allow updates to our templates and macros to be reflected instantly as corresponding pownormals and glossary term entries in the PowerScribe production system. The PowerScribe product development team has expressed interest in these modifications, and we currently are exploring cooperative implementation with them. We have made the current version of the system available via file transfer protocol (<ftp://webster.xray.ufl.edu/pub/sistromc/ufpwr/>) to interested readers for their own use and experimentation. The distribution will include the front-end client and a blank back-end database as well as a file needed to print barcodes.

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