Direct Text Entry in Electronic Progress Notes

An Evaluation of Input Errors

C. R. Weir[1, 2], J. F. Hurdle[1, 3], M. A. Felgar[1], J. M. Hoffman[1], B. Roth[1], J. R. Nebeker[1, 3]
[1] Geriatrics Research, Education, and Clinical Center (GRECC),
Veterans Administration Salt Lake City Health Care System, Salt Lake City, Utah, USA
[2] Department of Medical Informatics, University of Utah, Salt Lake City, Utah, USA
[3] Department of Internal Medicine, University of Utah, Salt Lake City, Utah, USA

Summary

Objectives: It is not uncommon that the introduction of a new technology fixes old problems while introducing new ones. The Veterans Administration recently implemented a comprehensive electronic medical record system (CPRS) to support provider order entry. Progress notes are entered directly by clinicians, primarily through keyboard input. Due to concerns that there may be significant, invisible disruptions to information flow, this study was conducted to formally examine the incidence and characteristics of input errors in the electronic patient record.

Methods: Sixty patient charts were randomly selected from all 2,301 inpatient admissions during a 5-month period. A panel of clinicians with informatics backgrounds developed the review criteria. After establishing inter-rater reliability, two raters independently reviewed 1,891 notes for copying, copying errors, inconsistent text, inappropriate object insertion and signature issues.

Results: Overall, 60% of patients reviewed had one or more input-related errors averaging 7.8 errors per patient. About 20% of notes showed evidence of copying, with an average of 1.01 error per copied note. Copying another clinician's note and making changes had the highest risk of error. Templating resulted in large amounts of blank spaces. Overall, MDs make more errors than other clinicians even after controlling for the number of notes.

Conclusions: Moving towards a more progressive model for the electronic medical record, where actions are recorded only once, history and physical information is encoded for use later, and note generation is organized around problems, would greatly minimize the potential for error.

Keywords

Medical records systems, computerized; quality control; decision support techniques; communication; evaluation studies

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Introduction

Medical Communication as a Risk Factor

Accurate and clearly-written communication in the medical record is essential to preventing patient injury and in promoting accurate billing and clinical decision making. The recent Institute of Medicine (U.S.) report "To Err is Human" estimated that as many as 98,000 people die each year in the United States because of medical errors (1). Illegible, incomplete, and inaccessible provider narratives can be a significant source of error and frustration. Direct provider entry into a computerized patient record system is viewed by many as the solution to communication problems (2-5). Electronic notes have been found to be more complete, to contain more relevant patient factors, and to document more appropriate clinical decisions than paper records (6). In particular, the inclusion of physician narratives in the electronic medical record makes electronic records superior to paper records by increasing access, team collaboration, and coordination (7).

Although electronic note entry may solve or obviate many of the problems associated with paper records, it will also create new problems and new risks to patient safety. Electronic note entry occurs in a variety of forms, including typing, dictation, forms-based scanning, and voice recognition. Each of these modalities is associated with specific types of errors. Traditionally, the surveillance systems of quality management, quality assurance, and risk management assess errors in paper records through chart review. These systems focus on the presence (or absence) of specific content that supports billing, informed consent, adequate oversight, and quality of care. With the advent of direct text entry into electronic notes, new types of surveillance mechanisms need to be developed to monitor the new types of errors. Traditional quality assurance activities may not be sufficient in an environment where notes are entered directly by providers. The objective of this study is to examine the incidence of input errors related to direct text entry for progress notes in a provider-entry environment in order to inform efforts of preventing and reducing such errors.

Direct Text Entry

Direct text entry (typing) of notes is perhaps the least favorite method of notes generation by providers. In order to make the method palatable to busy clinicians, typing-assist functions are often added, such as copying and pasting functions, templates, and automatic object insertion (e.g., clinical values are brought in from other parts of the electronic chart). The resultant ease with which text material can be handled raises the likelihood of a new class of errors, errors that would not be seen in a paper chart.

Although a goal of electronic records is increased availability, accurate communication may diminish for several reasons. First, the usual method of skimming notes and medical material works well with paper but is difficult to mimic in an electronic format. Second, notes might be copied from previous notes (by the same author or by an-

other author), resulting in diminished reader confidence in the both the validity and centrality of the content if the duplication is obvious. When the same content appears day after day on a patient, readers begin to doubt the utility of the material. Third, information, such as laboratory results or vitals that are automatically inserted as text may look the same as typed text, causing authors to not attend to its timeliness or even realize it is there (8). When this occurs too often, readers begin to doubt the accuracy of note content. To reduce these kinds of errors in information flow, it is essential to identify the degree to which new typing-assist functionality is used *appropriately*. New surveillance schemes can then be established for the electronic record, with subsequent alteration of the note generation system if required (9).

The errors of interest in our study were those related to direct text entry, in other words *documentation* errors related to input. Specifically we examined: 1) the incidence of copying, template use, and imbedded-object use, and 2) the relationships between these functions and misinformation in the chart. This paper does *not* address whether the material in the note matches the clinical reality of the patient. For example, a note that indicated "Potassium is normal" when serum potassium was, in fact, highly elevated was not an error we studied. However, if the text fragment "Potassium is normal" was copied into a note containing other text indicating an abnormal potassium level, then a copying error would be noted. Although mode-of-entry has been shown to affect clinical error rate (10), mode-of-entry is not a focus of this study. Here we present the results of a systematic assessment of the documentation error incidence in a randomly selected sample of charts.

The VA Information Processing Environment

The Department of Veterans Health Administration (VHA) released its Computerized Patient Record System (CPRS) nationally in 1998. Implementation was organized through workgroups across 22 national regions. The CPRS is a fully-integrated electronic medical record that supports direct provider order entry, notifications/alerts, laboratory data, radiology reporting, medication status, appointment scheduling, problem list, consultations, intelligent clinical reminders, and all forms of text material (including progress notes, health summaries, and procedural reports). It uses a distributed architecture, with a legacy database (MUMPS) backend supporting an object-oriented front-end (Delphi).

CPRS allows notes or portions of notes to be freely copied and pasted. It also allows for the imbedding of placeholders ("objects") that are filled-in automatically by the computer with data stored elsewhere in the electronic record (e.g., lab values, current medications, the problem list, vital signs, some patient demographics, some reports, and some kinds of free text). A user can create templates, precompiled boilerplates that can contain both text and imbedded objects. CPRS does not support the capture of data from the free text for later use in decision support.

Early experience with CPRS suggested that there might be problems with the very typing-assist functions designed to encourage provider acceptance of direct note entry. For example, some users reported that notes were often exact replicas of each other. We were concerned that there might be significant, invisible disruptions to accurate information flow. Thus this study was conducted to formally examine the incidence of documentation errors related to copying, as well as other documentation errors associated with the use of objects and templates.

Methods

Site

The site of this study is a 110-bed, tertiary-care, Veterans Administration medical center located in a large urban setting. The site is associated with a medical school and serves as a training location for residents and students across all disciplines. Attending physicians and residents supervise the notes of interns and students. Notes written by students require co-signatures. At this center, providers were mandated to use electronic order and progress note entry. Physician-generated narratives include history and physicals, consults, discharge summaries, and daily progress notes. Other clinical staff enter electronic notes as well, including nurses, physical therapists, occupational therapists, respiratory therapists, and clinical pharmacists. Notes from all of these disciplines were included in the study. In CPRS addenda can be written and attached to a specific progress note. Addenda are useful when attending physicians want to indicate that they have read and agree with the note of a resident or when a group note is being constructed. Nearly all physician notes are typed directly by the physician. Dictation and subsequent uploading is supported, but those clinical areas (e.g., the emergency room) using dictation are few.

Subjects

Sixty patients were selected randomly from all 2,301 inpatient admissions in the 4-month period ranging from August through December of 2000. Patients who stayed less than a day were excluded from the study. Housestaff (interns and residents) turn over completely every July and then rotate at varied schedules throughout the year. During the study period, the housestaff were fairly stable. All services and clinical roles were included, with the exception of the operating and recovery rooms (notes from these areas are not stored in CPRS). Altogether the 60 patients had a total of 2,316 narrative notes and addenda, for an average of 39 narratives per patient. This study examined only the regular notes (n = 1,891), excluding addenda. The average length of stay per patient was 8.6 days.

Evaluation Criteria

The evaluation criteria were initially developed by a group of clinicians familiar with CPRS who also have a strong background in medical informatics. The group consisted of two physicians (one with formal in-

formatics training), two PharmDs, and a Ph.D social psychologist with a background in nursing. The focus of the criteria was to evaluate the impact of typing-assist functionality on documentation errors. Two non-clinical research assistants established the final evaluation criteria using an iterative pilot process. The process included independent assessment of a small set of records, group discussion of assessment disagreements, and criteria revision. Although the research assistants were not clinicians they were familiar with medical language. This process was repeated until the criteria became stable. The list of criteria is described in Table 1. Once the criteria were established, 20 notes were reviewed independently and the degree of interrater reliability was assessed. Cohen's kappa was computed across each category and was very high, ranging from 0.80 to 1.00 (Table 1). The kappa metric controls for chance agreement and is a useful measure of interrater consistency (11).

Table 1 Evaluation categories for note assessment

Category	Description	Kappa
Copying	If a note was copied from any previous notes, the exact text from each was highlighted. Copying was classified as to whether it was from a note written by the author or a note written by another. Across both categories, the degree of copying was ranked into one of 3 levels of alterations: *Copied Note in Full, Copied Note With Small Changes,* or *Copied Note With Substantial Changes*.	1.0
Copying Error (within any copied note)	A copying error was defined as an error that clearly resulted from copying, including, but not limited to errors in reference to timed material (e.g., "today the patient walked for the first time" repeated for 3 days, or "the patient is afebrile" while the vital signs clearly showed a fever). Clinical errors, such as failing to monitor potassium when a patient was on Lasix were NOT part of the assessment.	0.84
Wrong Patient	The name of the patient in the text does not match the name on the heading.	1.0
Patient Name	The patient's name was not documented directly in the text. (Y/N)	1.0
Patient Age	The patient's age is incorrectly documented in notes.	1.0
Inconsistent Text	Text within a note that clearly contradicts the meaning of another part of the note, e.g., "X-Ray results were normal" with "X-ray showed significant pulmonary infiltrates."	0.80
Outdated Vital Signs	Vital signs that are captured as an object are greater than 24 hours old.	1.0
Authorship Problems	The person who signed the note either copied another signature or was not the author of the note.	1.0

Note: Kappa results indicate the degree of agreement between the two raters independently assessing 20 notes.

Note Assessment

All notes were printed and the reviewers read each note at least three times. Initially, the note was examined for evidence of copying from a previous note. A second pass was made if similarity of phrasing, content, or form was found to be at least 50% identical. The original text and the secondary text were highlighted and the degree of change was evaluated. *Copied Note in Full* required that the copied note consist of the exact content of the original note. *Copied with Small Changes* required that the note consist of basically the same content as the original with only a small numbers of changes and no important additions, or consist of the same text with a change in formatting. Small changes might include changes in dates or text like: patient is "very alert" versus "moderately alert." A note was categorized as *Copied Note with Substantial Changes* when the copied note consisted of the same basic content as the original note but with a large number of new data items added that were important to the understanding of the patient's current status, progress, or medical course. An example of this type of note is one that includes clearly copied data in the areas of vitals, labs, and subjective impressions but that also includes new text describing sensory, vascular, and wound assessments. On the third pass the note was examined for inconsistent text, incoherent text, outdated objects, or errors in signatures.

The case-review method makes it relatively easy to spot text copied from one point to another within one chart because the phrasing and structure of sentences would be identical. Because the study used only a small fraction of the patients admitted during the study period, it was not possible to assess copying *across* patients. Using manual review, it is not possible to scan hundreds of other charts looking for text similar to a given note. Automated methods may someday be of use in future studies.

Errors fell into two broad categories: copying and non-copying. *Copying errors* were inconsistencies of text or timing that arose *because* of the act of copying. Inconsistent text was information in the text that contradicted other parts of the same note. For example, a note could read in one section that "the lungs were clear" but then say that the "lung sounds showed significant rales" in another section of the same note. Inaccurate timing would result when the content of a copied note contained time sensitive data that was not adjusted after the copy was made. For example, the following narrative was copied from a note each day over for four days:

Table 2 Incidence of copying by note origin and amount of change (% of copied notes, n = 372)

	No Change	Small Change	Large Changes
Own Note	6 (1.61%)	32 (8.60%)	219 (58.87%)
Other's Note	1 (0.27%)	7 (1.88%)	107 (28.76%)
TOTAL (of 372)	7 (1.88%)	39 (10.48%)	326 (87.63%)

"Pt. had episode of recurrent ataxia yesterday, MRI/MRA was done this afternoon and was negative." Will keep pt. over weekend for observation.

Because the author did not edit the time-sensitive information after copying the note for the new day, the information is erroneous. Two copying errors would have been counted for each of the last three days.

Non-copying errors were documentation errors not clearly associated with copying. These included inserting an outdated patient-data object (e.g., labs from a previous admissions), not correcting signature problems, entering erroneous patient details (e.g., name, age), and failing to mention the patient by name in the note. The first two are especially relevant informatics issues. In CPRS, historical patient data can be automatically inserted into a note by an imbedded object, for example vital signs that are automatically pulled into the patient's admission note template by an imbedded "vitals" object. If the admission vital signs have not been already entered into CPRS by the time the note is created, the values inserted could be months old. Although the date comes with the object when it is inserted, it is often overlooked by the note's author. Signature problems occurred because maintaining the data that support electronic signatures is a challenge. Providers are linked to a encrypted code (i.e., their electronic "signature"). When a provider completes a note, the computer prompts for this signature code. Based on the code entered, provider details like name and role (e.g., student, intern, resident, attending) are stamped on the note. Creating and keeping up-to-date the database of names and roles is a daunting task for a teaching hospital.

Results

The percentage of all notes with at least one documentation error was 84%. The average number of documentation problems per patient was 7.8 (not including signature errors). The source of the errors is described below.

Copying

Overall, 19.7% (372/1891) of notes showed some form of copying, either from the same author or another author. Across 60 patients, 43 had at least one copied note (72% of patients, 8.7 copied notes on average). Table 2 shows the degree of changes made when notes were copied. Inspection of the table indicates that the most prevalent pattern of copying was an author copying his/her own previous note and making substantial changes. This pattern is expected, as the same provider is seeing the patient repeatedly, but the number per patient seems high. The large number of notes copied from another author is more problematic as the timeliness and conclusions of the copied text may not be fully understood by the copier. Since only intra-chart copy errors were examined, these numbers are conservative.

Copying Errors

Within the 372 copied notes, there were 374 documentation errors, averaging 1.01 error per copied note. The overall error incidence was the same for copied and non-copied notes, but within the group of copied notes the amount of change and the source of the copied the material influences the probability of an error, as shown in Table 3. Note that the incidence of errors varied across both the source of copying and the amount of change. A Kruskal-Wallis test comparing the median number of errors between notes where no changes were made, small changes were made and large changes were made was significant ($X^2_{(df=2)} = 9.56$; $p < .008$). Inspection of the mean rankings between groups indicates that making no changes or small changes resulted in the largest number of errors (Mean Rank = 209.89, 217.94 and 182.24) for "No Change", "Small Change" and "Large Change" respectively.

Table 4 shows that the incidence of copying varied across clinical role. Overall, MDs wrote 35% of all the notes, yet they were responsible for 50% of the copied notes. Nurses wrote about 27% of all notes, but were responsible for only 21% of the copied notes. Therapists wrote the next largest group of notes, about 17% of all notes written, generating 8% of all copied notes. The pattern of copying errors also varied across roles. The MDs made overall 89% of the total number of copying errors (131/148) as compared with the nurses who made less than 1% (2/148).

Table 3 Mean number of errors per note across note origin and amount of change. Number of notes per cell is in the parenthesis

	No Change	Small Change	Large Changes
Own Note	3.17 (n=6)	0.47 (n=32)	0.19 (n=219)
Other's Note	0.0005 (n=1)	1.14 (n=7)	0.60 (n=107)

Non-copying Errors

Across all 1,891 notes, there were a total of 2,481 non-copying errors or 1.3 documentation errors/note. These documentation errors arose from a variety of sources and each is listed below.

Wrong Patient. Of all 1,891 narrative notes, only 5 were clearly on the *wrong patient*. This number is a conservative estimate, since the name of the patient was usually not included in the text by the author (CPRS stamps the name on the note after signing but the wrong patient could have been selected at the outset). The judgment of the raters was based on clear, unequivocal evidence that the note belonged to another patient (e.g., completely different problems).

Inconsistent text may have important clinical consequences as the text may state opposite conclusions about selected signs and symptoms. Overall, there were few non-copied notes that displayed inconsistent text (n=29). *Incomplete text* was less of a problem and refers to dangling sentences or garbled sentence structure. In both areas, physicians were the most frequent contributors as they authored 80% of all notes with inconsistent text and 61% of notes with incomplete text, as Table 5 illustrates.

Outdated imbedded objects are pulled in from another part of the chart and the last recorded item is pasted in the note. Twenty-seven notes had *vital signs* that were older than 24 hours of the time of writing. The average age of the old vitals was 29.5 days with a range of 2 to 530. This long period suggests that the vitals were being pulled from an outpatient visit. This would happen if the admission nurse failed to enter the vital signs before the admission note was written. Nurses were responsible for about 37% of the notes with outdated vitals; physicians were responsible for the remaining 63%.

Signature Identification. Across all of the notes, many electronic signatures (53%) failed to appropriately reflect the credentials and/or title of the author. These problems ranged from not having the title or credentials of the author to not having either items for the co-signer(s).

Table 4 Incidence of copying notes with and without errors across clinical role

ROLE	Number of Notes (n=1891)	Number of Copied Notes (n=372)	Number of Copying Errors (n=148)	Mean Number of copying errors per note (n=372)	Mean Number of non-copy errors per note (n=2481)
Physicians	685 (36%)	187 (50%)	131 (89%)	1.9	0.85
Nurses	545 (29%)	79 (21%)	2 (1%)	0.03	1.82
Therapists	321 (17%)	31 (8.33%)	0 (0%)	0.03	1.67
Medical Students	102 (5%)	42 (11%)	7 (5%)	0.17	0.62
Social Workers	73 (4%)	0 (0%)	0 (0%)	(0)	1.45
Pharmacists	49 (3%)	31 (8.33%)	7 (5%)	0.23	1.39
Other	116 (6%)	2 (1%)	1 (0%)	0.5	1.18

Templates. Many of the paper templates (i.e., fill-in the blank forms) that were in use prior to the introduction of CPRS were imported "as is." On screen, these forms can be very long, up to 5 pages in length. Overall, there were 408 notes based on templates (22% of the total). Table 6 displays the percent of total templated notes by each clinical role. Nurses were by far the greatest users of the templates, creating 60% of the total templated notes.

To determine the degree to which templates were incomplete, reviewers counted the number of possible fill-in items on the template, the number of items actually filled in, and the number not filled in. The relative likelihood (displayed by the role of the note author) of items being filled in is displayed in Table 6. Across roles there was little difference in the proportion of items left blank, and all were quite large indicating that the CPRS format for templates was equally problematic for everyone. Having to search screen after screen of empty fields in a templated note impedes information transfer.

Table 5 Percent of notes with inconsistent text by type of provider (% of notes involved)

ROLE	Inconsistent Text (n=29)	Incomplete Text (n=28)
Physicians	23/29 (79%)	17/28 (61%)
Nurses	3/29 (10%)	2/28 (7%)
Therapists	0/29 (0%)	2/28 (7%)
Medical Students	0/29 (0%)	3/28 (11%)
Social Workers	2/29 (7%)	1/28 (3%)
Pharmacists	1/29 (4%)	2/28 (7%)
Other	0/29 (0%)	1/28 (4 %)

Table 6 Proportion of templated notes used by different clinical roles (% of notes involved)

ROLE	Percent of Templated Notes by Role (n=408)	"Fill-in" Items per Note, by Role	Percent Items Left blank, by Role
Physicians	66 (16%)	1609 items in 66 notes, avg. = 24	209/1609 (13%)
Nurses	246 (60%)	16,683 items in 246 notes, avg. = 68	3632/16683 (22%)
Therapists	6 (1 %)	234 items in 6 notes, avg.= 39	29/234 (12%)
Medical Students	0 (0%)	0 notes	NA
Social Workers	18 (5%)	300 items in18 notes, avg. = 17	36/300 (12%)
Pharmacists	5 (1%)	263 items in 5 notes, avg. = 53	21/263 (8%)
Other	67 (17%)	3, 061 items in 67 notes, avg. = 46	556/3,061 (18%)

Discussion

This study demonstrates that direct entry (typing of electronic documentation) by clinicians can result in significant documentation or data entry error. Overall, 60% of patients had one or more data entry errors in their records, and the average number of data entry errors per patient was 7.8. The vast majority of patients had at least one copied note. Although copying of notes was quite prevalent, copying itself did not increase the probability of a documentation error, unless copying was done with no changes. The type of errors focused on in this study was admittedly narrow, but the purpose of the study was to determine how the new typing-assist functionality affected the accuracy of documentation. Data entry errors of this type are to be distinguished from errors that result from recording the wrong clinical information or from inaccurate assessment of the patient.

The utility of imbedded objects, templated text, and copying and pasting capacity greatly enhances acceptance of direct typing entry by providers. However, this enhanced capacity brings with it new challenges for patient safety. These typing-assist functions challenge four normative expectations regarding information flow in medical settings. The first expectation is that the information typically provided in a progress note is what is minimally necessary to record. Writing by hand encourages succinctness. With the capacity to copy large amounts of data, progress note length can be as long as 8-10 pages and include a great deal of data found elsewhere. The result is that the readers searching for information have to change the way they search. As it stands, much information may simply not be read. The second normative assumption is that progress notes correctly reflect the decision-making process of the provider. Notes that contain a great deal of clinical information extracted from other areas of the chart by copying or templates may obfuscate the thoughts of the reader. As two well-known authors in informatics wrote recently regarding the clinical record:"[it] strives to remain as true-to-life as possible, by capturing not only syntactic meaning but also semantic interpretability (12)." To address both the "necessary-minimum" concept and the "decision-making continuity" concept, we recommend setting limits on the sizes of templates, reviewing templates currently in use for length and utility (item by item), deleting blank items in templates, and a creating a structured way of copying and pasting that would discourage unedited copies.

The third normative expectation is that progress note data are temporally relevant and accurate. In the paper record we are accustomed to records where information is recorded as needed, each datum following the previous as a function of time. A reader knows that the second note was written prior to the first and the information contained in the second note is later than the first. Although electronic notes are time-stamped in CPRS (it is known when they were signed), the reader may not actually know when the note was written. If they contain copied information readers cannot be sure that the timing of the information coincides with the timing of the note. Finally, because readers can filter notes by author and title before selecting a note to read, it may be less likely that the notes are read in chronological order. We recommend altering index sorting and filtering software in way that encourages chronological review (or warns when chronological order is violated).

Finally, medical records are usually reviewed using a ”skimming” and “skipping” process in order to synthesize large segments of information. If the record design is familiar, well laid out, and the reader an expert in the field, the reader is able to correctly infer substantial information rapidly and with little in-depth reading (13,14). CPRS allows the view of the medical record to become inconsistent and disjointed, so a reader's ability to review the patient's history using a “skimming” paradigm is limited. We recommend rethinking the electronic presentation of the chart content in ways that reflect problem-oriented thought processes.

Future work in this area will need to pay closer attention to process issues and the interaction of clinical care with the process of documentation (15). Generally, people perform better with fewer errors if all the data needed to support a decision or task can be viewed on one page together and data entry is a seamless component of workflow (16). Having a computer anticipate which data are relevant and which should be recorded would require a very advanced decision support tool, one that could infer importance of content and level of expertise of the reader. While this is a grand challenge for informatics, CPRS could do far more in integrating the various components of a medical record with the task of the user.

Instead of pursuing strategies to facilitate the construction of written progress notes, a more progressive model of the medical record should be developed that is not dependent on the metaphor of paper progress notes. One can imagine several ways to minimize the error potential of word processing features: smarter templates (e.g., automatic pasting of results and orders into pertinent templates, with updates that are both time and context sensitive); encoded history and physical data (e.g., eliminating re-typing and pasting by using the original instantiation); and a problem-oriented data display and documentation process.

Conclusion

Electronic free text notes promise to improve the quality of patient care because data access is enhanced, text is readable, and notes are often more comprehensive. However, typing-assist short cuts result in disruptions of the normative flow of information and introduce a high incidence of documentation errors in the medical record. In our study of a fairly typical CPRS implementation (an electronic medical record system in use by one the world's largest health care networks) each patient had on average of 7.8 documentation entry errors per admission. Copying, inconsistent text, automatic object insertion and electronic signature problems were the major source of these problems. Several enhancements could reduce these kinds of errors, including minimizing template use and size; reviewing templates for utility; introducing structured copying and pasting, and re-engineering problem-oriented data display.

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Correspondence to:
Charlene Weir, Ph.D.
Associate Dir. Education and Evaluation, GRECC (182)
VA SLCHCS
500 Foothill Blvd.
Salt Lake City, UT 84148, USA
E-mail: Charlene.Weir@med.va.gov