

Process and Delayed Verification Errors In Community Pharmacy

Implications for Improving Accuracy and Patient Safety

*Section 2/Part 1 from A Cognitive Systems Perspective
on Human Performance in the Pharmacy*

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Section Preview

Outcomes for Prototype 1: [Monitoring of Process Errors]

Pharmacists actively monitored their process errors while working over a baseline period of two weeks. Using small booklets, participants recorded a variety of mistakes that are normally made and corrected in the process of dispensing a script. Monitoring of their work occurred for a total of 6-9 hours a week and the time was evenly distributed across early, middle, and late parts of their shifts.

Important outcomes and recommendations were:

- The incidence of process errors was not related to number of scripts filled or pharmacy volume. More process errors, however, were made during the *early parts of a shift* than during the late parts of a shift.
- Ratings of active self-monitoring of process errors showed that it was perceived as 119% more effective in increasing awareness of errors and identifying mistakes than asking pharmacists to be careful and to think about and list ways they could manage error.
- The data revealed an average *Critical Error Ratio* of detected to undetected process errors of 6:1. Thus, for every 6 process errors that occur, 1 mistake can be expected to slip past verification processes. This same ratio also was found in the laboratory simulation data and in a outpatient hospital based field study suggesting that it was not unique to the research protocol of this project.

A useful heuristic or “rule of thumb” based on the data suggested that the 6:1 ratio could be interpreted in terms of 1 hour units. *Thus, one undetected mistake could be expected to get past normal verification processes for every 6 process errors made per hour on shift.*

- A range of *Critical Error Ratios* between 1:1 and 12:1 were examined for pharmacists in the field-sites. The cumulative percentage of all undetected errors increased by 60% as this ratio approached minimum values of at least 5:1-7:1.
- There was about a 50/50 chance that any undetected error would be potentially clinically significant.
- Periodic self-monitoring of process errors should become a regular part of the procedures used to dispense medications. They are a more reliable indicator of when someone is drifting into an error mode than workload or time on task.
- Monitoring process errors during times of the day or week when someone is “not feeling well,” “out of sorts,” “feeling emotional,” or “otherwise not 100%” should be strongly encouraged.
- Integrating the recording of process errors into a computer database for the private use of pharmacy personnel should be explored.

Prototype 1

Self-Monitoring of Process Errors

Overview of Prototype

Process errors are mistakes that occur and are immediately corrected while working on a task. They illustrate two characteristics about correct responding.

- Many sequences of responses that eventually lead to an accurate outcome have one or more errors that were detected and corrected before the sequence was completed.
- Process errors are like a double edged sword. They make our work much more accurate. On the other hand, too many of them may set the stage for some mistakes to slip past the normal processes used to verify errors.

Participants evaluated a prototype for monitoring process errors where they recorded such errors in a small 4.5 x 5.5 inch booklet. Self-monitoring was expected to help pharmacists learn more about the frequency and type of mistakes they identified. And, it was expected to increase awareness and thus focus attention on the task.

Besides its value in increasing awareness, the detection of process errors was one of our performance measures. It allowed us to obtain a baseline of how often mistakes were detected during the process of dispensing scripts. Because the rates at which such mistakes were identified changed as interventions designed to affect them were introduced into the field sites, they provided valuable information about the success of those interventions. Monitoring behaviors is a well-established strategy employed in other settings to identify and correct problem behaviors and to enhance more effective responses.

Illustration of Prototype

Figure 5 on the next page shows a page from the booklet used to monitor process errors. Participants indicated an error by making a [√] or a [/] every time they noticed one. They also recorded the time they began and ended the task and the number of scripts worked on alone or as part of a team.

Procedure for Using the Self-Monitoring of Process Errors Prototype

Records were kept in the 4.5 x 5.5 inch booklet for the early, the middle, and the late parts of a shift on six different occasions throughout the 4 week protocol. Participants had a range of 6-9 hours a week to record their process errors and the time was evenly divided between each part of the shift. *The monitoring task was evenly distributed across each of the four weeks in the research protocol such that every week had half of the pharmacists in one of our protocols monitoring their work.*

Pharmacists were instructed to record a process error as soon as it was safe to do so. We did not want anyone to stop everything they were doing in order to record a correction of an error. Rather, they were instructed to do so during a natural break in the process of working on a particular script [e.g., after talking to a physicians office; after they had corrected a data-entry error; after selecting the correct product if a process error had occurred]. This protocol enabled us to obtain a sample of the types of process errors pharmacists produced in a safe, comfortable, and reliable manner.

Expectations / Research Questions

We expected that pharmacists would be able to record the times they almost made a mistake and corrected themselves. The general questions to be answered were: a.] *What is the frequency with which process errors occur?* b.] *Are process errors related to workload?* c.] *What are the patterns in the types of process errors?* d.] *What is the relationship between detected and undetected process errors?* e.] *How effective was this prototype for increasing awareness and monitoring error.*

Self-Monitoring Process Error Form Prototype

Day ___: Part of Shift [Early] [Middle] [Late]

Time of day you began ___ ended ___

Scripts you helped to fill during this time frame ___

Correcting information to patient on telephone

Correcting script information when copying from a telephone call or FAX transmission

Date-entry changes

Product selection corrections

Count & pour changes

Corrections during normal checkpoints

Counseling patient or answering patient questions

Correcting script after it was placed in "will-call"

Figure 5: A self-monitoring form prototype.

Results

Frequency of Process Errors

Records of process errors from the two-week baseline period were examined for two groups accounting for 24 of the field sites and 51 pharmacists. One set of 12 stores and 24 pharmacists were a control group that only completed the self-monitoring and delayed verification tasks. The second set of 12 field-sites and 27 pharmacists were scheduled to receive written feedback at the end of the baseline period on how well their detection of process errors matched those of other pharmacists. There were no other prototypes in the field-sites during this period of time.

- Pharmacists *dispensed a total of 8,170 medications* during the baseline period.
- Overall, *605 process errors were detected, i.e., 7.4% of the scripts dispensed.*

Additional Support for Findings

- *The percentage of process errors in this study were identical to those recorded in a study conducted in an outpatient pharmacy. Auditors monitored how often pharmacists detected and corrected their mistakes.¹⁴ Out of 3227 scripts dispensed, 232 errors were detected by participants, i.e., 7.2% of the scripts dispensed.*
- *As a further check on the reliability of the field-site information, the correlation between the reports of process errors and scores on a social desirability measure were examined. This measure was part of the psychosocial tests that pharmacists took during their field-site training. It assesses the extent to which people provide responses in line with what they believe are acceptable answers. There was no statistically significant correlation between the percentage of process errors reported and scores on the social desirability measure. Pharmacists provided accurate responses.*
- *The reliability of pharmacist self-report data when guaranteed anonymity and confidentiality also is seen in a recent study conducted by Arthur Andersen LLP.³⁷ In that study, pharmacists estimated the amount of time spent on 9 discrete parts of their jobs. Their estimates varied by an average of -2% from the behavioral measures of how much time was actually spent on each of the nine tasks.*

Results

Relationship of Process Errors to Workload

Table 8 shows the relationship of process errors to workload. Here workload was defined in two ways. One was as a function of the number of hours on shift. The second was in terms of the relative number of scripts the 51 pharmacists worked on individually and/or as part of a team.

Table 8
Percentage of Total Process Errors and Workload

Time on Shift		
<i>Early Shift</i>	<i>Middle Shift</i>	<i>Late Shift</i>
[Hours 1-3]	[Hours 4-7]	[Hours 8+]
9.1%	7.3%	9.8%
Number of Scripts Filled		
<i>Low</i>	<i>Medium</i>	<i>High</i>
[40 -105]	[106 -192]	[193 -327]
11.2%	7.9%	6.1%

The outcomes reported in Table 8 suggest the following two conclusions:

- *There were no significant differences in the percentage of process errors that were detected early on a shift compared to the latter parts of a shift.* Thus, time on shift did not affect the identification and correction of mistakes.
- *Participants detected and corrected more process errors when workload was relatively low than when it was high.* This relationship was just the opposite to what one might assume. If anything, pharmacists were more accurate and thus made fewer process errors while working under conditions of high workload. This finding was statistically reliable.

Additional Support for Findings

Follow-up interviews and a focus group with a total of 15 pharmacists in the sample also suggested that one of their difficult times on the job was when there was little to do. They reported that they *while it was not always easy to do so*, they tended to concentrate more when workload was high.

The observation that errors do not increase with time on task and scripts filled also was compatible with the pattern in the outcomes of another study by the principle investigator. *Pharmacy incident reports within a large corporation were examined.*^{19, 20} In a pilot project designed to increase the reporting of incidents, reports were obtained from several hundred pharmacies representing low [0-900 scripts per week), medium (901-1400 scripts), and high volume (1400-2000+ scripts) outlets.

- The percentage of errors reported over a 3-week period for the median number of prescriptions dispensed were:
 - *Low Volume Stores [.079%]*
 - *Medium Volume Stores [.034%]*
 - *High Volume Stores [.022%].*

The pattern in the outcomes of the pharmacy simulation laboratory also supported the findings in the field-sites. In the lab, each participant worked up to 7 hours on task filling a total of 114 simulated prescriptions. The mean number of process errors detected by each of the 81 participants during the early, middle, and late parts of their shift are presented in Table 9. This data is for the post-training blocks of 90 orders when they had mastered the task and worked at a steady and efficient pace. As was the case in the field-sites, there were no statistically significant differences in the number of process errors reported over the three blocks of time on shift.

Table 9
Mean Number of Total Process Errors and Time on Task

Time on Shift		
Early Shift [Hours 1-2]	Middle Shift [Hours 3-4]	Late Shift [Hours 5-7]
21.6	26.1	18.7

Results

Patterns in Types of Process Errors

There were 605 process errors identified during the baseline period. Table 10 shows the distribution for the process errors across the categories used in the self-monitoring booklet as shown in Figure 5. The information in Table 10 was based on two calculations. One was the mean or average percentage of process errors for each of the 51 pharmacists. The second measure was the percentage of the total number of process errors within each category.

Table 10
Percentage of Process Errors Detected and Corrected

Categories	Mean Percentage Per Pharmacist	Percentage of Total Process Errors
• <i>Correcting Information on Telephone</i>	0.8	4.2
• <i>Corrections When Copying from Telephone or FAX</i>	2.5	8.6
• <i>Data-Entry</i>	12.1	41.3
• <i>Product Selection</i>	2.5	12.5
• <i>Count & Pour</i>	3.9	14.4
• <i>Verification Checkpoints</i>	3.5	14.2
• <i>Counseling Patient</i>	0.7	2.6
• <i>After Script Placed in Will-Call</i>	0.5	2.2

- In both cases, data-entry accounted for the largest number of errors [41.2%] followed by those that occurred during count & pour, product selection and the verification checkpoints. This pattern was similar to that in other field and lab research.^{1,10}

Results

Relationship Between Detected and Undetected Process Errors

The ratio of detected to undetected process errors was of interest. The number of process error detections that places someone in an error mode has practical benefits for pharmacists. Thus, periodically monitoring process errors should help them to determine when an increase in error is likely.

To obtain the most stable estimate, the two-week baseline period data for all of the 36 field-sites and 84 pharmacists were used. A Critical Error Ratio of detected to undetected errors was calculated by obtaining the average ratio for all of the pharmacists. This was done in the following manner:

- The number of process errors identified were classified as detected errors.
- Errors identified in the random checks of Will-Call/Return to Stock items were classified as previously undetected errors.
- The Will-Call/Return to Stock errors detected were either made by the pharmacist conducting the check and/or another member of the pharmacy team. The items checked were randomly selected from *the same baseline of 37 scripts. Thus, the number or percentage of misfills identified provides an estimate of the number or percentage of mistakes associated with everyone on the team.* Thus, this figure was used as the estimate of undetected errors each pharmacist experienced.

The average Critical Error Ratios of detected to undetected errors for the baseline period were:

- For the *combination of miscellaneous and potentially clinically significant undetected errors, the ratio was [6.3:1].* Thus, on average, for about every 6 process errors detected per pharmacist there was one miscellaneous and/or clinically significant mistake that was undetected by normal verification processes.

The actual percentage of each type of mistake was 53% miscellaneous and 47% potentially clinically significant errors reported. A *rule of thumb* based on this data is that there was about a *50/50 chance that any undetected error would be a miscellaneous or a potentially clinically significant one given the protocol of this study for identifying and reporting errors.*

Additional Support for Findings

The *Critical Error Ratio* of 6:1 of detected to undetected errors was compared to outcomes of research outside of the current field-sites as a check on its accuracy. The corresponding data were remarkably similar given the different environments and the way the ratio was calculated.

- In an outpatient pharmacy, auditors recorded the number of times four staff pharmacists corrected themselves over a two-week period. ¹⁴ There were *232 process errors detected and 37 were undetected.* In this study, *the ratio of detected process errors to those that were undetected was [6.3:1].* This ratio is identical to the 6.3:1 ratio obtained from the field-sites in this project.
- The *overall percentage of undetected errors to scripts filled in the latter study was 1.14% (i.e., 37 errors / 3227 scripts dispensed).* This figure also is almost identical to the 1.33% reported earlier in the data from the current project.
- For the participants in the pharmacy simulation laboratory, the overall ratio of detected to undetected process errors for each participant was calculated and a mean ratio for the sample was then obtained. *This ratio of detected to undetected errors in the lab was [5.5:1] or [6:1 when rounded up].* This ratio was *not significantly different* from the average *Critical Error Ratio* obtained in the field-sites.

The similarity of the Critical Error Ratio as well as the percentage of undetected error in this study to other work suggested that the assumptions outlined above for how it was calculated were valid.

“There are No Good Errors!”

We may think that some of the things we do erroneously are of little consequence. However, *the data from this study suggests otherwise*. Even mistakes that are caught such as the process errors monitored in this study are signs of a progressive decline in the cognitive systems ability to function accurately. *And the more often process errors or near misses occur, the more likely a mistake that gets by our internal spell checker will happen. The first signs of the system entering a failure mode is that process errors are detected and corrected. And in small numbers they are probably not as much of a problem as they are when their presence increases. However, the 6:1 ratio of detected process errors to 1 undetected mistake provides pharmacists with a heuristic or rule of thumb for knowing when they are at risk for a mistake getting past them.*

This 6:1 Critical Error Ratio, however, is an average value. Some people may enter an error mode where they are likely to miss a mistake with fewer than 6 self-corrections while others with a higher value. Thus, the changes in the percentage of undetected errors associated with different numbers of self-corrections was of interest. To determine this relationship, the following calculation was made.

- The *total number of undetected errors* [i.e., estimated from those mistakes identified in Will-Call/Return to Stock items] associated with each of the *Critical Error Ratios* between 1:1 and 12:1 was calculated. Then the *percentage of this total number of undetected errors* for each *Critical Error Ratio* was determined; e.g., [Number of Undetected Errors Associated with Each *Critical Error Ratio* / Total Number of Undetected Errors].
- The resulting percentages of undetected errors were then summed across the range of *Critical Error Ratios*. This accounts for 100% of the undetected errors. And, it allows the percentage of total undetected errors associated with each *Critical Error Ratio* to be identified. *This data is shown in Figure 6 below.*
- The chart shows that a significant increase in overall as well as clinically significant undetected errors were associated with *Critical Error Ratios* of 5:1 and higher. Thus, when the number of process errors begins to approach a range of 5-7, the chances of having an undetected mistake occur begins to dramatically increase.

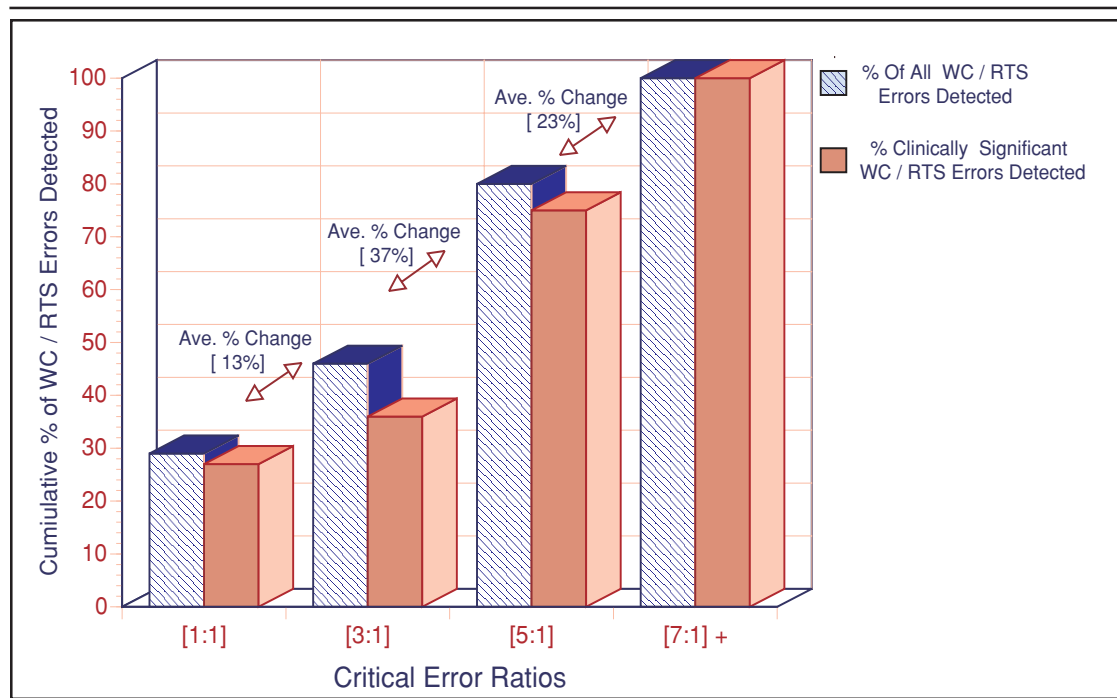


Figure 6: Cumulative percentage of undetected errors [i.e., Will-Call (WC) / Return to Stock (RTS)] mistakes] associated with *Critical Error Ratios* between 1:1 and 7:1 and higher.

Results

Perceived Effectiveness of the Self-Monitoring Prototype

Pharmacists evaluated the self-monitoring prototype in order to assess its ability to increase awareness of the task, the acceptability of the prototype, and its relative advantages and disadvantages. Several characteristics of the self-monitoring prototype were rated and the specific evaluations are shown in Table 11.

Overall, the evaluations in Table 11 suggested that periodic self-monitoring had the following qualities:

- The monitoring prototype was perceived as *relatively easy to use, as increasing awareness of the task*, and was *likely to be acceptable to pharmacists* as an intervention for increasing task awareness and sensitivity to error.
- To put the evaluations in this table into a broader perspective, an overall index of perceived effectiveness was constructed. This index was calculated by the following formula: [i.e., Sum of mean ratings/Total possible score] X 100. A 0% represents the absence of effectiveness and 100% represents total effectiveness.

Using the data in Table 11, the calculation of perceived effectiveness would be [(36/61) x 100]. *It yields an effectiveness ratio for the self-monitoring prototype of [59%]. In comparison, the same ratio for a neutral or placebo prototype was [27%].*

A set of multicolored cards placed in strategic locations in 24 pharmacies were used as a neutral prototype. Pharmacists were instructed to use the cards as a cue to think about things that would improve personal and team accuracy and effectiveness. Suggestions were listed in the self-monitoring booklet. *They were a control for novelty and for expectations that any prototype introduced would be helpful to them.* This placebo was treated like any other intervention and was evaluated just like the others. It is described in Technical Note beginning on page 76 of this report.

- The gain in the effectiveness of the self-monitoring prototype relative to the neutral prototype also was calculated. A *perceived gain of 1.19 was observed.*
- *Overall, the self-monitoring prototype was perceived as [1.19 times or 119%] more effective than the neutral or placebo prototype.*

The information obtained clearly showed that there were advantages to using the self-monitoring prototype relative to only asking people to be careful and to *periodically think of actions* they could take to be more effective and accurate. *The important point is:*

- *Specific actions such as monitoring process errors are needed to backup any conscious intent to be careful.* Without such actions, thoughts about and instructions from others to be careful will not be enough to detect and correct errors.
- Pharmacists in the sites also rated themselves as *more aware of what they were doing even during times they were not required to monitor* their process errors. *There appeared to be a residual effects of doing this task even on a periodic basis.* In the field-sites, for example, pharmacists monitored their errors within a range of 6-9 hours a week. Assuming an average 42 hour week, they paid extra-attention to what they were doing for about 18% of the time they were on shift. This is a relatively small amount of time to spend for the benefits gained.
- When asked what a reasonable amount of time to do this task on an ongoing basis might be, pharmacists reported that a *minimum of 4-6 hours a week* would be needed to benefit from the experience.

In order to check whether there were benefits to additional self-monitoring, we turned to our laboratory pharmacy simulation for an answer. *An added advantage was that we could also test whether the process could be automated and if simply estimating process errors was effective in reducing mistakes.* To examine these issues, self-monitoring of process errors in the pharmacy simulation was accomplished using a computer version of the field-site monitoring form. In response to a computer prompt, participants estimated the number of self-corrections and where in the process it had occurred. The computer prompt was a menu on the screen that asked them to estimate how often they corrected themselves during data-entry, product selection, counting, and final verification.

To explore whether the frequency of estimating self-monitoring made a difference, participants estimated their process errors after every 3rd or 6th order. This amounted to reporting what they were doing about 17-33% of the time they were on shift. All responses were then typed into the computer.

- *There were no statistically significant differences in the percentage or distribution of process errors that occurred regardless of how often participants estimated such mistakes.* Reporting process errors after fewer orders completed (i.e., for 17% of the overall orders) was just as effective as doing so after 33% of the orders were completed. *Yet taking time to estimate their process errors was associated with fewer errors than a control group that did not estimate their self-corrections.*
- *The average number of all errors detected for every 30 orders filled was 4.6 errors when people reported their self-corrections every 6 orders and 5.3 errors when they did so after every 3 orders.* Differences between the groups were not statistically significant. *Doubling the rate at which people estimated self-corrections did not improve accuracy significantly.* A control group that did not estimate process errors made an average of 6.3 total actual errors for every 30 orders competed. This represented a 29% increase in errors over the two groups that estimated their self-corrections.

Table 11
Evaluations of Self-Monitoring Prototype

Item	Anchor Points for Rating Scale	Range of Ratings	Mean Rating for Prototype
• Overall Impression	<i>Unfavorable / Favorable</i>	1-7	4.7
• Ease of Adjustment	<i>Not Easy / Very Easy</i>	1-7	4.7
• Reminder to be Careful	<i>Not Useful / Very Useful</i>	1-7	4.3
• Difficult to Use	<i>Very Difficult / Easy</i>	1-7	4.0
• Helps to Avoid Errors	<i>Infrequently / Frequently</i>	1-7	3.2
• How Much Better Can You Detect Errors	<i>Worse / Better</i>	1-7	4.5
• Interferes With Work	<i>A lot / Not at all</i>	1-7	3.4
• Increase Task Awareness	<i>Not a benefit / Beneficial</i>	1-7	5.2
• What Range of Additional Errors Did it Help You to Identify and Correct		1-5 0%-50%	2.0 [10-20%]
• Percentage of Participants in Favor of Using a Computer to Help with Self-Monitoring [45% "Yes"; 27% "Maybe"; 27% "No"]			

- The important point is that using *computer prompts to estimate* corrections of process errors *also was effective in reducing errors*. And, doing so more often does not guarantee that fewer mistakes will be made. Participant feedback afterwards also showed that such estimates *increased task and error awareness*.

Summary, Implications & Recommendations

- 1.] *The incidence of process errors was not related to workload. The periodic monitoring of process errors was a better indicator of when someone was falling into an error mode than were time on shift and the number of scripts dispensed.*
- 2.] *Self-monitoring alone was perceived as 119% more effective than asking people to be careful and to think about ways they could manage errors and improve the effectiveness of how they worked. It has three desirable effects in a pharmacy:*
 - *By making people more aware of their process errors, the prototype can help to reduce the incidence of such mistakes. This will place fewer demands on the cognitive system and increase productivity. Work already completed will not have to be redone.*
 - *It can increase awareness of process errors that were not previously detected and pharmacy personnel should notice them more often. Thus, a better understanding of the patterns in how, when, and where they are happening should occur.*
 - *Monitoring process errors can stabilize the rate at which such mishaps occur and keep them from getting out of hand.*
- 3.] *The data showed that an average Critical Error Ratio of detected process errors to undetected Will-Call/Return to Stock errors of 6:1. The same ratio was obtained in a outpatient hospital based study as well as the laboratory pharmacy simulation data from this project. The cumulative percentage of all undetected errors increased by 60% as this ratio approached minimum values of at least 5:1-7:1.*
- 4.] *The Critical Error Ratio implies that on average one can expect to have 1 undetected mistake for every 6 process errors that occur. To make the best practical use of this ratio, the unit of time in which 6 process errors could occur before an undetected error would be expected would be helpful [e.g., 6 process errors per shift, 6 process errors for "x" number of prescriptions, 6 process errors per hour, etc.]*

Since the *total number of process errors* that occurred over a 6-9 hour period of self-monitoring was used in the original calculation, the average of 6 process errors in the numerator of the *Critical Error Ratio* translates into a range of 36-54 total process errors associated with this average during this period of time.

Thus, a helpful heuristic or 'rule of thumb' was that on average *6:1 process errors for each hour on shift was associated with 1 undetected mistake getting past normal verification processes*.
- 5.] *Knowing at what times during a shift and under what conditions process errors occurred would be helpful to pharmacists. To obtain such information, every pharmacists should establish a baseline of when they were most vulnerable to process errors.*

To do so, actively monitoring such errors using the forms developed in this study for a minimum of 6 different hours a week over a period of 4 weeks is recommended. The monitoring also should include recordings of conditions in the pharmacy associated with such mistakes.

Taking such actions would help to sensitize pharmacists to the number of times they made mistakes and had to correct them. It also would allow them to identify when such mistakes were more or less likely to occur.

Thus, they might want to keep records of such things as the following:

- time of shift when the mistake happened.
- mental distractions and interruptions present when a mistake was detected and corrected.
- characteristics of the physical environment associated with the process error [e.g. lighting, heat, noise, number of people in the pharmacy]
- number of prescriptions filled up to the point in which the mistake occurred.
- relative level of stress and tension and what the specific stressor was when the process error happened.
- number of patients waiting to have scripts filled.
- amount of time spent on insurance issues or counseling patient when the mistake was detected and corrected.

5.] *Monitoring process errors during times of the day or week when someone is "not feeling well," "out of sorts," "feeling emotional," or "otherwise not 100%" should be mandatory.* The practice would provide an indicator of when pharmacy personnel had drifted into an error mode. Corrective actions such as taking a break or getting help from other members of the pharmacy team could then be initiated.

6.] *Ways to integrate the recording of process errors into a computer database for the private use of pharmacy personnel should be explored.* Pharmacists' ratings of the self-monitoring prototype suggested they would be open to this possibility. The laboratory simulation also indicated that a computer version of the booklets could be developed and used successfully.

What makes this process effective is allowing pharmacists to learn as much as they can from it. Thus, they have more knowledge about how, when, and where process mistakes occur and are in a better position to do something about them. Thus making the process as easy for them to do as possible and providing ways to keep an ongoing record of such things would seem to be desirable. A computer database "for their eyes only" would be a convenient way to accomplish this goal.

7.] There is value in just the process of self-monitoring since it increases task awareness and sensitivity to mistakes. And, in their ratings of this process, pharmacists indicated that it was helpful even during time periods when they were not explicitly recording such errors. The important point here is that monitoring of process errors should be done explicitly since the act of recording focuses attention on the mistake in ways that a more casual "mental recording" of the error would not. Active monitoring develops a deeper understanding of the mistake and the reasons why it happened.

Section Preview

Outcomes for Prototype 2: [Delayed Verification]

Pharmacists checked *random groups* of 25 Will-Call, 12 Return to Stock items, and 100 original scripts and attached labels. Each task was completed on one of three days during the week with half of the sample alternating weeks when they completed the task. Over a two-week baseline period, a total of 1,275 Will-Call, 612 Return to Stock, and 5100 Scripts and Labels were *randomly selected* and checked.

Important outcomes and recommendations were:

- The ability of pharmacists to detect and correct errors on the delayed verification tasks was not affected by workload or the time on shift.
- Delayed verification was perceived as 115% more effective in increasing awareness of errors and identifying mistakes than periodic reminders to be careful and listing ideas for improving accuracy.
- Rates of “*in-store mistakes*” identified were compatible with those reported in the literature. About 4.5% of the scripts checked in Will-Call/Return to Stock contained either a miscellaneous or a potentially clinically significant mistake. The corresponding figure for checks of Scripts and Labels was 2.5%. *Approximately half of the mistakes identified and corrected were miscellaneous errors.*
- Data based estimates of misfills that leave the pharmacy revealed an upper limit of 0.24% of all errors and 0.11% of clinically significant errors [i.e., about 24 and 11 misfills in 10,000 scripts respectively].
- The rates of misfills that leave the pharmacy can be lowered by at least 30% by regular oral counseling of patients. Random checks of both Will-Call and original scripts and labels also would help to substantially reduce the incidence of such errors. To be effective, counseling and additional checks must be done on a regular and consistent basis.
- Delayed verification should be used on a periodic basis within a pharmacy operation for quality control and to help pharmacy personnel identify the patterns in the mistakes present. Personal knowledge is very important for helping the cognitive system to learn from experience and to enhance its ability to detect future mistakes.
- Pharmacists, like other people, are better at detecting errors in prescriptions completed by other pharmacy team members than their own errors. A more formal system of double-checks of completed scripts by two different people is recommended.

Prototype 2

Delayed Verification

Overview of Prototype

Random checks of Will-Call and Return to Stock items as well as checks of original scripts and attached computer labels formed the delayed verification prototype. Any errors detected are undetected process errors that had slipped past normal verification processes. The presence of any mistakes creates a discrepancy between “what I believed” versus “what I observed.” *Encountering such discrepancies is a valuable part of any personal feedback process.* Also, the patterns in any errors found should increase the knowledge one has about misfills, focus attention on the task, and alter the decision making criterion used during verification.

Random checks of such items simultaneously provides an estimate of three things. A 3% delayed verification rate means: a.) that 3% of the scripts checked in the store were inaccurate but initially judged to be correct during dispensing, b.) a given pharmacist is able to identify misfills in 3% of the scripts checked, and c.) there is a 3% chance that each pharmacist in the store will incorrectly verify an incorrect script as correct. Thus, knowing the rate of Will-Call/Return to Stock and Scripts and Label errors provides information about the verification systems within a store as well as the verification capabilities of the individuals involved.

Illustration of Prototype

Figure 7 below shows examples from the pages of the self-monitoring booklet used to record any instances of errors. Note that Will-Call and Return to Stock used the same categories of errors [*i.e., Wrong script in bag; Incorrect directions; Incorrect count/amount; Wrong strength; Wrong Drug*] Checking Scripts and Labels used the following categories: [*Incorrect patient name; Incorrect directions; Incorrect count/amount; Wrong strength; Wrong Drug*]

<p>Prototype Form: Checking “Will-Call” / “Return to Stock” Scripts</p> <p>Day of week check was made: _____ Time of day check was made: _____</p> <p>Approximately how many hours have you worked before making this check? Circle the number of hours below.</p> <p>[1 2 3 4 5 6 7 8 9 10 11 12 13 14 15]</p> <p style="text-align: center;">Misfills</p> <p>Wrong script in bag <input type="text"/></p> <p>Incorrect directions <input type="text"/></p> <p>Incorrect count/amount <input type="text"/></p> <p>Wrong strength <input type="text"/></p> <p>Wrong drug <input type="text"/></p> <p>*If wrong strength or drug, note here or on back of page *Note other mistakes you observed on the form provided</p>	<p>Prototype Form: Checking Prescription Form and Label Discrepancies</p> <p>Day of week check was made: _____ Time of day check was made: _____</p> <p>Approximately how many hours have you worked before making this check? Circle the number of hours below.</p> <p>[1 2 3 4 5 6 7 8 9 10 11 12 13 14 15]</p> <p style="text-align: center;">Misfills</p> <p>Incorrect patient name <input type="text"/></p> <p>Incorrect directions <input type="text"/></p> <p>Incorrect count/amount <input type="text"/></p> <p>Wrong strength <input type="text"/></p> <p>Wrong drug <input type="text"/></p> <p>*If wrong strength or drug, note here or on back of page *Note other mistakes you observed on the form provided</p>
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Figure 7: Examples of the forms used to record misfills during delayed verification.

Procedure for Using the Delayed Verification Prototype

During one week of the two-week baseline period in the field-sites, participants randomly checked 25 Will-Call; and 12 Return to Stock items as well as 100 Scripts and Labels. One of those checks was completed on each of three days. Participants were requested to vary the time of day they performed each check. In addition to the errors listed on the forms, they were asked to list any other errors found on a separate page of the booklet.

Expectations / Research Questions

a.] How often do delayed verification mistakes occur? b.] Is the ability to detect and correct such mistakes affected by workload? c.] What are the patterns in the types of errors observed? d.] Is there a relationship between the ability to detect process errors and to identify misfills during delayed verification? e.] How effective was this prototype for increasing awareness and monitoring errors. f.] Are pharmacists more accurate when checking themselves or others? g.] How many errors leave the pharmacy?

Results

Frequency of Delayed Verification Mistakes

For the two-week baseline period, 51 pharmacists in the 24 field-sites randomly checked 1,275 “Will-Call” items, 612 “Return to Stock” items and 5,100 scripts and attached labels. Each pharmacist evaluated 25 Will-Call items, 12 Return to Stock items, and 100 original scripts and attached labels. There were 85 mistakes detected in Will-Call/Return to Stock, i.e., 42 in the categories monitored and 43 miscellaneous. In the scripts and attached label checks, 131 mistakes were found, i.e., 70 category errors and 61 miscellaneous. Table 12 presents the data from this analysis

Table 12
Average Percentage of Detections of Errors Per Pharmacist in Delayed Verification

	Will-Call	Return to Stock	Scripts & Labels
All Categories of Booklet Errors Checked	2.38	1.89	1.37
Miscellaneous Errors	1.81	3.28	1.20
Total % Detected	4.19	5.17	2.57

Note: Percentages reflect average detections per set of 25 Will-Call, 12 Return to Stock, and 100 scripts and attached labels.

- The differences in the percentages of errors detected and corrected in “Will-Call” and “Return to Stock” were *not statistically reliable*. This finding was expected since the two are identical with return to stock items representing will-call items that were not picked up. This suggests pharmacists reliably evaluated both sets of items.
- A further check on reliability was to correlate the detections during delayed verification with participants scores on a social desirability scale. The latter measure indicates someone’s preferences for providing socially acceptable responses. The two measures were *not* correlated.
- The total percentage of errors reported for Will-Call and Return to Stock were within the 3-5% modal range noted in the literature review in Part I of this report.

The delayed verification data accurately portrayed the frequency with which pharmacists were able to detect and correct mistakes with this prototype. Also, under conditions of anonymity and confidentiality, they were able to do so in an accurate and reliable manner.

It is important to note that *the percentage of mistakes identified were present before the scripts were given to a patient and do not necessarily represent the number of mistakes that left the pharmacy*. Some may have ordinarily been caught through additional checks by pharmacists (e.g., through normal reviews of their completed work), during counseling, or even by patients. At best one can only estimate how many mistakes get by everyone.

Results

Relationship of Delayed Verification Errors to Workload

Table 13 shows the relationship of errors detected in Will-Call [WC], Return to Stock [RTS], and Scripts & Label checks to workload. Since there were no statistically significant differences between them, the data for the Will-Call and Return to Stock measures were combined. Workload was defined in two ways. One was the hour on a shift when the delayed verification checks were made. The second was the prescription volume of stores in the field-sites. Thus, the effects on someone's ability to detect and correct mistakes at different times during a shift as well as when working in a relatively low, medium, or high volume store could be assessed.

Table 13
Mean Percentage of Delayed Verification Errors Detected
and Corrected for Each Pharmacist as a Function of Workload

	Time on Shift			Weekly Store Rx Volume		
	Early [Hrs 1-3]	Middle [Hrs 4-7]	Late [Hrs 8+]	Low <1000	Medium 1000-1800	High >1800
Will-Call / Return to Stock	2.5	2.4	1.4	3.3	1.3	2.3
Miscellaneous WC/RTS	2.7	2.2	1.9	4.3	1.2	2.2
Total	5.2	4.6	3.3	7.6	2.5	4.5
Scripts & Labels	1.3	1.3	1.6	1.0	1.4	1.9
Miscellaneous Scripts & Labels	1.1	1.3	1.0	1.5	1.2	1.0
Total	2.4	2.6	2.6	2.5	2.6	2.9

- *Scripts & Attached Labels*

Workload did not affect the ability of pharmacists to detect and correct errors in random checks of scripts and labels. There were no statistically significant differences in the ability of pharmacists to detect and correct errors as a function of workload. The percentage of errors detected in the checks of scripts and labels was very stable for both the time of the shift the checks were made and as a function of weekly store volume. A statistical analysis of this data confirmed that there were no significant differences in the ability of pharmacists to detect mistakes under these conditions. Apparently participants were able to focus attention on this task in a uniform manner over a shift as well as in stores with different levels of prescription volume.

- *Will-Call/Return to Stock Items*

Compared to the scripts and label data, the average percentage of detections of pharmacists in the combined Will-Call/Return to Stock data was more variable. There was a small trend for more Will-Call/Return to Stock errors to be detected and corrected early on shift than later and for more mistakes to be found in low volume stores than in high volume stores. *A statistical analysis of these trends showed that they were due to chance.* It is likely that the small changes noted here were due to sampling differences. Each pharmacist checked 100 Scripts and Labels but only 25 Will-Call and 12 Return to Stock Items. Larger samples tend to be less variable.

Workload and Delayed Verification

There are two conclusions to be drawn about the relationship of workload and the detection and correction of delayed verification errors shown in Table 13.

- The ability of pharmacist to detect and correct mistakes in Will-Call/Return to Stock items using the delayed verification procedure was *not affected by the time during the shift the checks were made or by store volume*. The data indicate that objective measures of workload such as time on task or how busy a store tended to be were *not factors* in the ability of pharmacists to detect and correct errors using the delayed verification technique.

Two additional things need to be said about the latter point. One is that the pharmacists choose the time of day to make the checks and may have done so during periods when they were not busy. Or, they may have distributed the task across an entire shift to better cope with being busy and completing this task. Pharmacists reported using both strategies but the distribution in what time during a shift the checks were initiated was evenly divided between the first and last half of a shift. About 56% of the checks were initiated during the first part and 44% during the latter half of a shift.

Furthermore, some people may be more susceptible to objective levels of workload than others. And, everyone probably has a limit to how much work and time on task they can take before their ability to detect errors is affected. *All the current data suggests is that such thresholds were not evident among the pharmacists and conditions under which they worked in the current study.*

The reader is reminded, however, that the corporations involved were asked to select from among their better stores and personnel for this study and there is every indication that they did so. Perhaps the pharmacists in this study were more hardy in the face of tension on the job than other pharmacists. If so, their scores on the psychosocial measures used might be different than a larger sample of pharmacists. This will be explored in Section B of Part II of this report.

- The ability of pharmacist to detect and correct mistakes in random checks of original scripts and attached labels was *not affected by the time of shift the checks were made or by store volume*.

Results

Patterns in Delayed Verification Errors

How well pharmacists were able to detect and correct errors using the delayed verification procedure was the major variable of interest. There were, however, two other issues with the delayed verification prototype that were explored. They were:

- The nature of the patterns in the percentage of delayed verification errors .
- The extent to which the ability to detect and correct Will-Call / Return to Stock mistakes was related to the detection of discrepancies when checking scripts and attached labels?

Observed Patterns

The distribution of the detection of errors within each of the categories monitored was of interest. This data is presented in Table 14. Shown are the mean percentage of errors detected by category per pharmacist and the distribution of total mistakes detected for each of the categories. The largest percentage of errors detected per pharmacist were in the miscellaneous category followed by incorrect directions and wrong quantity. *It is important to remember that the numbers in this table represent averages and that the range of detections within a category by participants was typically between 0 and 16%.*

Table 14
Mean Rates of Delayed Verification Errors Detected and Corrected
for each Category of Error Monitored

	% Per Pharmacist		% of Total Error	
	Will-Call / Return to Stock	Script & Label Discrepancies	Will-Call / Return to Stock	Script & Label Discrepancies
• <i>Incorrect Patient Name</i>	NA	1.0	NA	4.9
• <i>Wrong Script in Bag</i>	2.7	NA	3.9	NA
• <i>Incorrect Directions</i>	2.7	1.9	10.2	22.8
• <i>Incorrect Quantity</i>	4.2	2.3	30.5	17.3
• <i>Wrong Strength</i>	3.1	1.0	1.6	3.1
• <i>Wrong Drug</i>	2.7	1.4	3.1	4.3
• <i>Miscellaneous</i>	4.1	2.4	50.8	47.5

Note: The percentages reported in this table are averages based on all pharmacists checking a randomly selected sample for a set of 25 Will-Call and 12 Return to Stock items and 100 Scripts and Labels.

A second pattern of interest was whether or not each pharmacist's ability to detect and correct errors were related to each other. To examine this issue, correlation coefficients were calculated for the overall percentage of Will-Call, Return to Stock, and Scripts and Label detections. We used the 24 stores that served as control conditions for this analysis. The reader is reminded that a correlation coefficient represents the degree to which two things are related. The range is -1, 0, +1 and the larger the value of the coefficient in either direction from zero [i.e., the absence of a relationship], the stronger the association between two things.

- The correlation coefficient between the identification of Will-Call and Return to Stock errors was [$r = +.48$] and the relationship between the latter two measures and Scripts and Label detections were [$r = +.05$] and [$r = +.19$] respectively. Only the association between the Will-Call and Return to Stock measures were statistically reliable.

One would expect such a relationship since the mental processes involved in performing checks in Will-Call/Return to Stock should be identical. *In comparison, other mental capabilities are likely involved in searching for mistakes when pulling scripts and labels.*

Results

Process Errors and Delayed Verification Detections

Are pharmacists who detect process errors also good at detecting delayed verification mistakes?

To examine this issue, the percentage of process errors each pharmacists reported was correlated with the percentage of times they detected a mistake in Will-Call/Return to Stock items

- *No relationship was found.* The average correlation between detecting process errors on one week of the protocol and delayed verification errors on the other week was [$r = .07$]. *The same results were obtained in the pharmacy simulation lab. Outcomes indicate two things:* a.) Doing well detecting errors on one task was no guarantee of being able to detect errors on the other. b.) The cognitive factors involved in detecting Will-Call or Scripts & Label errors are *not the same* for identifying process errors.

Additional Field-Site Support for Reliability of Findings

- As was the case with the process error data, there was no statistically significant correlation between a measure of social desirability tendencies and the percentage of errors detected in random checks of Will-Call, Return to Stock, or Scripts and Labels. Thus, as a group, participants tended to report what they observed rather than what they thought or believed they should report.

Results

How Effective was the Delayed Verification Prototype Perceived?

- Similar questions to those used to evaluate the self-monitoring prototype were used with the delayed verification task. That data is reported in Table 15 below.

Table 15
Evaluations of Delayed Verification Prototype

Item	Anchor Points for Rating Scale	Range of Ratings	Mean Rating for Prototype
• Overall Impression	<i>Unfavorable / Favorable</i>	1-7	4.4
• Ease of Adjustment	<i>Not Easy / Very Easy</i>	1-7	4.7
• Reminder to be Careful	<i>Not Useful / Very Useful</i>	1-7	4.5
• Difficult to Use	<i>Very Difficult / Easy</i>	1-7	3.1
• Helps to Avoid Errors	<i>Infrequently / Frequently</i>	1-7	3.3
• How Much Better Can You Detect Errors	<i>Worse / Better</i>	1-7	4.7
• Interferes With Work	<i>A lot / Not at All</i>	1-7	3.0
• Increase Task Awareness	<i>Not a benefit / Beneficial</i>	1-7	4.8
• What Range of Additional Errors Did it Help You to Identify and Correct		1-5 0%-50%	3.0 [20-30%]

- The *Perceived Effectiveness Index* for the combined Will-Call/Return to Stock and Scripts & Labels delayed verification prototype also was calculated [i.e., Sum of mean ratings/Total possible score, i.e., 61] X 100. *This value for delayed verification was 58%. The gain in effectiveness relative to the placebo condition was 1.15 or 115%.*

Compared to the self-monitoring of process errors prototype, the *Perceived Effectiveness Indices* were equivalent for both prototypes (i.e., 59% versus 58%) and both were perceived at least 1.15 times (or 115%) more effective than then the neutral or placebo prototype.

- *While the overall ratios were the same, there were some differences between their evaluations.* Delayed verification was perceived as producing a 20-30% increase in detecting additional errors versus the 10-20% range for the self-monitoring prototype. The self-monitoring prototype on the other hand was rated as easier to use. Also, participants reported that the delayed verification prototype was not always easy to use or integrate into their work-flow. When pressed for time, the random checks became “something else they had to do.” A range of 15-25 Will-Call items and 50-100 Scripts and Labels were seen as an acceptable number of checks to do.

Reference Point Study in the Literature

- The data from the delayed verification task were compatible with that reported in the pharmacy research literature. *The rates of mistakes detected in Will-Call and Return to Stock items were within the modal 3-5% range of errors to prescriptions filled reported in the literature and discussed in Part I of this report.*
- *In the current study, 45.5% of the mistakes reported by pharmacists in their checks of Will-Call and Return to Stock were potentially clinically significant. This figure is somewhat higher than one finds in other pharmacy literature where between 20-40% of the mistakes caught by auditors are clinically significant.*
- On the other hand, the number of clinically significant mistakes in this study *slightly underestimates* those that were present in this sample. Only things that were likely to occur frequently and that might produce problems for patients were monitored. The selection of what to list in the booklet was made in consultation with pharmacists and pharmacy researchers.

Consequently, anything not listed in the booklet was classified as a miscellaneous error. *Included in this category are some mistakes that other studies consider to be clinically significant. They include:* prescription vials missing or in wrong bag, patient name incorrect on prescription label, directions changed incorrectly, wrong dosage form dispensed, excessive refills dispensed, and patient's name missing from label.

- Such considerations in mind, when the number of miscellaneous mistakes listed are added to errors monitored in the booklet, the percentage of the undetected errors that were clinically significant was 48.1%. The total represents a 3.4% increase from the 45.5% reported without the additional miscellaneous data entered.

Results

Accuracy of Checking Orders Completed by Self or Others

Delayed verification also was employed in the laboratory simulation with a twist. Sixty simulated prescriptions that were completed were rechecked by all participants. Among the prescriptions verified, there were 30 orders the participant had completed earlier and 30 orders that someone else had finished. A maximum of 18 errors were distributed among the 60 orders. This verification task is very challenging since participants know that errors will be present but they do not know when they will appear and how many a given simulated prescription will have.

Our interest was whether people were more accurate verifying their own work or the work of others. The latter is an issue in any pharmacy since one or more members of a team may handle or take primary responsibility for filling a prescription. Thus, during final verification, a pharmacist checks work that may have been completed by another member of the team. How accurate someone was checking orders they had completed versus someone else was of interest.

To accomplish the latter goal, three measures of detection were used. They were:

- *Simple Percentage of Correct Judgments*
This is a traditional way of indicating how good someone was at identifying correct and incorrect orders. It is the percentage of times someone can accurately make such judgments.
- *Sensitivity*
Represents our ability to *avoid judging flawed orders as correct*. Sensitivity is high when "false negative" judgments are low.
- *Specificity*
How well someone *avoids labeling* otherwise correct scripts or orders as incorrect. Specificity is high when "false positive" judgments are low.

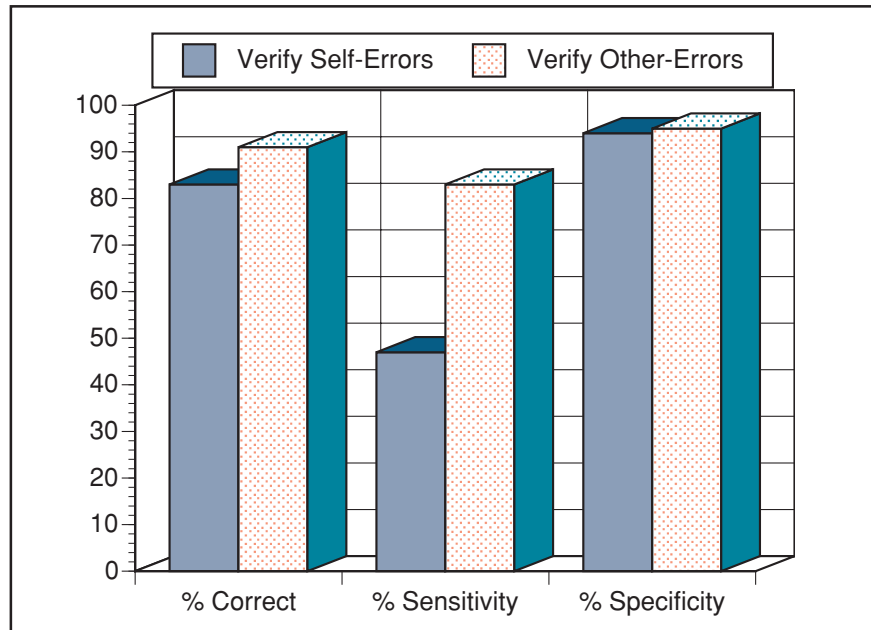


Figure 8 : Accuracy in verifying simulated prescriptions.

A simple measure of accuracy does not identify “false-negative” or “false-positive” problems. Thus it obscures any problems people have in performing accurately. In a pharmacy, *the “false-negative” issue is more important because it affects patient safety*. Too many “false-positives,” however, can lead to rechecking work that is otherwise accurate and a drop in efficiency occurs. The relationship among the three indicators of error in the pharmacy simulation laboratory are shown in Figure 8.

- The % Correct and % Sensitivity measures in this figure clearly show that participants were *much better at identifying the mistakes of others* than they were their own. The differences in the percentages in each case were statistically significant.
- Specificity was not affected by whether one’s own or someone else’s orders were being checked. That is, participants were good at recognizing orders that were correctly filled. The problem was in identifying the flaws in orders they had completed.

The discrepancy in sensitivity [i.e. avoiding “false-negatives”] noted in the laboratory (i.e., 43% self versus 80% other) *in absolute values* would not apply to a pharmacy. They reflect the small number of errors participants experienced in a complicated research protocol. As will be shown later, sensitivity rates on a “verification only” task in the laboratory simulation are within 1% of those in the literature.

However, *the general pattern that people have a more difficult time finding errors in their own work* is likely present in independent and chain pharmacies. *Pharmacists have reported similar problems in interviews and focus groups* conducted by the principle investigator over the past several years. Sometimes it was easier for them to find mistakes in scripts others had devoted more time and energy in completing than their own. Furthermore, pharmacy personnel routinely correct each other while working, suggesting that people are sensitive to the errors of others. The important point in the data reported here is that there is no reason to expect that the ability to detect one’s own errors and those of others are the same. There are several implications of this data:

- Pharmacists who work alone may be at some additional risk for missing errors. They need to know this and to be encouraged to engage in other checks of their work such as those involved in a delayed verification prototype.

- Whenever possible pharmacy personnel need to check each other's work. This often occurs naturally during the dispensing process but it is not always structured into it.

The deliberate double checking of each other's work needs to be structured into final-verification processes and any checks of Will-Call/Return to Stock items and Scripts and Labels.

People miss more errors when checking their own work because of cognitive biases to gain closure on a task and to seek information to confirm what they already believe. *When making final checks, a pharmacist is not an impartial judge of what he or she sees for the following reasons:*

- Seeking closure allows us to form a complete and neat picture out of the information. In doing so, people use prior experiences to "fill in the gaps" in their knowledge and perceptions. In a pharmacy, products that are similar to what is ordered or perhaps more frequently and recently experienced are substituted for what is needed.
- Confirmation biases lead to selective attention to information that matches what we expect to be there. Thus only confirming evidence is sampled.

Together the two biases allow pharmacists to see what they believe is there rather than what is actually present. They are more prone to do this with work they completed than with someone else's. In effect, *pharmacists can only bring a "fresh pair of eyes" when judging the work of others.*

Results

Number of Undetected Errors that Reach Patients

Overall accuracy rates miss important parts of the underlying patterns in errors. In effect they only provide partial information about what is going on. And, they do so only for the parts of the dispensing or checking process that is being observed. *The errors undetected by pharmacy personnel that eventually find their way to patients cannot be calculated from a simple percentages of accuracy.*

In hospital settings, for example, dispensing error rates and checking error rates of 3-6% have been observed.³⁸ *To estimate the "undetected error rate" for what reaches patients, one multiplies the dispensing error rate by the checking error rate.* Thus, if 3% of doses are dispensed incorrectly and 6% of dispensing errors are missed during the checking process, the *overall undetected error rate is 0.18%, i.e., 0.03×0.06 .*

How many undetected errors in a chain pharmacy find their way into the hands of patients? If additional checks are made after final verification during dispensing, i.e., additional checks of Will-Call, checks of Scripts & Labels, periodic reviews of work completed, --the formula above can be used. It provides an estimate if at least one additional check is made after dispensing. The steps involved and the assumptions made are shown in Table 16 on the next page.

- The estimated undetected rate of *all errors reaching patients* was [0.24%] of prescriptions filled. The corresponding rate for *clinically significant errors* was [0.14%]. One can expect about 24 and 14 of such errors respectively for every 10,000 scripts filled. *These figures are best thought of as an upper limit given the points below.*
- *The percentages above assume minimal counseling by pharmacists and no further checks on errors.* Based on the literature and the results of the survey pharmacists completed, such assumptions are not warranted. About 11% [observed] - 30% [pharmacist estimates] of mistakes are caught during counseling. And, pharmacists routinely have second thoughts about scripts filled and recheck their work. Or, they may review the work completed at the end of a day.

Such things would lower the error rate. Assuming a 30% detection rate during counseling, then a reduction in the number of undetected errors would be expected to fall to 17 overall errors in 10,000 scripts. The number of potentially clinically significant mistakes would be reduced to 11.

Table 16
Theoretical Calculation of Rates of Undetected Errors that Reach Patients

Step 1: Determine the Dispensing Error Rate

Dispensing error rates were obtained from the percentage of errors recorded in random checks of Will-Call/Return to Stock items in this study. The latter are mistakes that were present but missed when pharmacists checked scripts during final verification.

- That overall dispensing error rate was [4.7%] [c.f., Table 12]
- The potentially clinically significant rate of error was [2.7%]

Step 2: Determine the Checking Error Rate for One Additional Check after Script is Considered Ready for the Patient [e.g., A check of Will-Call items]

This had to be estimated since we only know how many errors were not detected during final verification. The number of additional mistakes present in the scripts after final verification during dispensing is not known with a high degree of certainty. The checking error rate is often calculated by presenting pharmacists with artificial errors in a mix of prescriptions they must check. Thus, the research literature was consulted.^{35,36} *The average range of checking error rates is 5-7% of prescriptions checked.*

- A conservative but historical average of 5% was used.

Step 3: Calculate the Undetected Error Rate Using the Formula:

Undetected Error Rate = Dispensing Error Rate x Checking Error Rate

- *Undetected Rate of All Errors = [0.24%]*
Dispensing Error Rate [.047] x Checking Error Rate [.05]
- *Undetected Rate of Potentially Clinically Significant Errors = [0.14%]*
Dispensing Error Rate [.027] x Checking Error Rate [.05]

Note: The 2.7% is taken from the 2.1% average based upon the data reported in Table 12 + 0.6% derived from 13 miscellaneous errors in this study that are normally placed in a potentially clinically significant category in other research.

The dispensing and checking error rates represented in Table 16 and the undetected error rates are compatible with those observed in the research literature. That literature is largely hospital based and the correspondence of the data based upon retail pharmacy field-sites is remarkable. *Even more so is the fact that in our verification only task in the pharmacy simulation lab the average checking error rate observed was 7%.* This figure also was very close to the average range observed in the hospital pharmacy literature. And, it is identical to the 6.9% checking error rate reported in a recent hospital based study.³⁸ As another example, the historical mean detected-error rate for the dispensing process observed in hospital based studies is 4%.³⁸ The average rate in for the field-sites reported in the current research project was 4.7%.

Again it appears that accurate and inaccurate performance of pharmacists reflects human competencies and failings. And, there appears to be some stability across inpatient, outpatient, independent and chain pharmacies as well as within the confines of our pharmacy simulation lab.

Summary: Implications & Recommendations

- *The ability of pharmacists to detect and correct errors on the delayed verification tasks was not affected by workload or the time on shift.* This was also true of the simulated pharmacy laboratory where participants verified a total of 180 orders exclusively over a 7 hour shift [i.e., between 25-26 per hour]. In the laboratory simulation, *participants were on average 92.4% accurate in their judgments.* Their rate of accuracy did not vary significantly over different points in time on shift or after checking increasing numbers of orders.

As a comparison, pharmacists in the field-sites reported that the Will-Call/Return to Stock scripts they checked *were on average 95.7% accurate* and such judgments were not related to time on shift or number of scripts they had filled. Thus, the fact that the pharmacists only checked 37 Will-Call/Return to Stock items and 100 Scripts and Labels does not explain why workload or time on shift did not affect such judgments. *It appears that human beings on tasks that are self-paced such as those in our laboratory and in a pharmacy are able to adjust the pace at which they work to maintain reasonable levels of accuracy.* There are probably levels of workload that would affect their ability to continue to do this but those rates were not present in the current project.

- *Delayed verification was perceived as 115% more effective in increasing awareness of errors and identifying mistakes than periodic reminders to be careful and listing ideas for improving accuracy.* While the task was initially perceived with some skepticism, most participants began to see its value. Fitting it into a busy workday was an issue for some but not all participants. What some pharmacists did was to set aside an entire day to complete the required checks. The distribution of the task over an entire day made it less bothersome and again illustrated how people on a self-paced task are able to distribute workload if necessary.
- *Rates of “in-store mistakes” identified were compatible with those reported in the literature.* About 4.5% of the scripts checked in Will-Call/Return to Stock contained either a miscellaneous or a potentially clinically significant mistake. The corresponding figure for checks of Scripts and Labels was 2.5%. *Approximately half of the mistakes identified and corrected were miscellaneous errors.*
- *Data based estimates of misfills that leave the pharmacy revealed an upper limit of 0.24% of all errors and 0.14% of clinically significant errors [i.e., about 24 and 14 misfills in 10,000 scripts respectively].* The rates at which misfills leave the pharmacy can be lowered by at least 11- 30% by counseling patients. Taking the time to complete random checks of both Will-Call items and original scripts and labels also would help to reduce such errors as would actively encouraging patients to ask questions and to call problems to a pharmacist's attention. Patients are a missing link in the feedback loop needed to reduce misfills. *Gently encouraging them perhaps with incentives to participate more would help them as well as the pharmacist.*
- *Delayed verification should be used on a periodic basis within a pharmacy operation for quality control and to help pharmacy personnel identify the patterns in the mistakes present.* Experiencing recurring patterns helps the cognitive system to identify errors better over the long run. It also is important to at least randomly check Will-Call items and Scripts and Labels because of the number of scripts that contain errors that have the potential to leave the pharmacy.
- Pharmacists, like other people, are better at detecting errors in prescriptions completed by other pharmacy team members than their own. *A more formal system of double-checks of completed scripts by two different people is recommended.*

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