# A Comparison of a Printed Patient Summary Document with its Electronic Equivalent: Early Results

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**Abstract**
*Clinicians are always searching for efficient access to clinical data. The Regenstrief Medical Record System has a printed report that fills this niche: Pocket Rounds. Handheld computers may offer an alternative, but it is unclear how effectively a handheld computer can display such data. We surveyed residents and students on the general medicine services for their opinions regarding Pocket Rounds. Those with handheld computers were given access to an electronic version of Pocket Rounds – e-Rounds. We surveyed the subjects who used e-Rounds for their opinions on the electronic format and how it compared to paper. Users' overall satisfaction with Pocket Rounds was 5.8 on a seven-point scale. User's overall satisfaction for e-Rounds was 5.6 on a seven-point scale. The most useful function was retrieval of lab data for both modalities. The results suggest that the electronic format is a viable alternative to paper. Further evaluation is needed, and we plan a prospective controlled trial to study this further.*

**Background**
Increasingly, physicians have been using handheld computers (HHC) to assist them with patient care. However, there is a dearth of medical literature addressing the applicability of an HHC in the clinical setting[1]. A broad literature review reveals several studies that have compared an existing paper modality directly with an electronic counterpart. These range from tongue-in-cheek comparisons[2], to fairly rigorous scientific evaluation[3-10]. The latter includes using HHC to collect data from subjects directly[6-8], having trained observers using HHC to record data[3,5,10] and using HHC for viewing and evaluation of various types of data. [4,9]

One experienced medical software engineer used to say "It's got to be better than paper" when asked about the most important requirements for clinical information systems. Many of these studies suggest that HHCs equal or exceed their paper counterparts with respect to utility, accuracy and acceptance for certain applications such as those listed above.

One commonly noted disadvantage of HHC is their small screen size. We wanted to explore how effectively an HHC could display large patient data sets in the clinical setting.

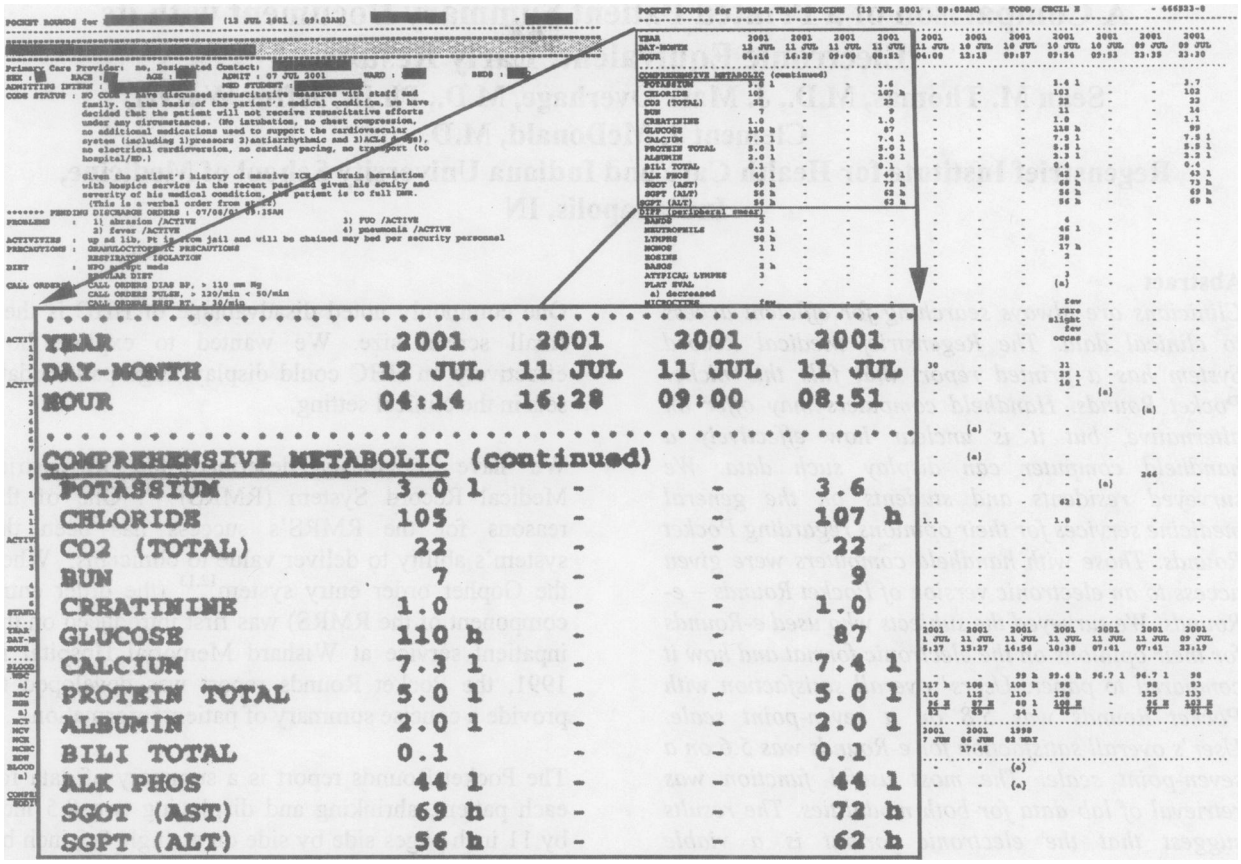
We have previously described the Regenstrief Medical Record System (RMRS) [11]. One of the reasons for the RMRS's success has been the system's ability to deliver value to clinicians. When the Gopher order entry system[12,13] (the order entry component of the RMRS) was first introduced on the inpatient service at Wishard Memorial Hospital in 1991, the Pocket Rounds report was developed to provide a concise summary of patient information.

The Pocket Rounds report is a summary of data for each patient, shrinking and displaying two 8.5 inch by 11 inch pages side by side on a single 8.5 inch by 11 inch sheet of paper in landscape orientation. An example Pocket Rounds report is seen in Figure 1. Pocket Rounds includes demographic data, vital signs, problem lists, medications, reminders, last daily note, orders and lab and other test results. It is an excellent example of a complex clinical data set with a large amount of information.

Residents and staff physicians at Wishard Memorial Hospital (WMH), a 260 bed tertiary care public hospital, print Pocket Rounds each day, fold them in half and carry them in their lab coat pocket. Users can specify batch-printing jobs, allowing them to print out the reports automatically, at a specified time and printer as well as printing them on demand. Printing Pocket Rounds for a physician's panel of patients typically required about 5 minutes.

We set out to define the acceptance and opinions regarding Pocket Rounds. Additionally, we wanted to explore if an HHC could display such a large clinical data set in a useful fashion that would be efficient for users. We carried out a before/after evaluation of Pocket Rounds reports delivered on paper versus the same content delivered via HHC.

1067—5027/01/$5.00 



| | | | | |
|---|---|---|---|---|
| YEAR | 2001 | 2001 | 2001 | 2001 |
| DAY-MONTH | 12 JUL | 11 JUL | 11 JUL | 11 JUL |
| HOUR | 04:14 | 16:28 | 09:00 | 08:51 |
| COMPREHENSIVE METABOLIC (continued) | | | | |
| POTASSIUM | 3.0 l | - | - | 3.6 |
| CHLORIDE | 105 | - | - | 107 h |
| CO2 (TOTAL) | 22 | - | - | 22 |
| BUN | 7 | - | - | 9 |
| CREATININE | 1.0 | - | - | 1.0 |
| GLUCOSE | 110 h | - | - | 87 |
| CALCIUM | 7.3 l | - | - | 7.4 l |
| PROTEIN TOTAL | 5.0 l | - | - | 5.0 l |
| ALBUMIN | 2.0 l | - | - | 2.0 l |
| BILI TOTAL | 0.1 | - | - | 0.1 |
| ALK PHOS | 44 l | - | - | 44 l |
| SGOT (AST) | 69 h | - | - | 72 h |
| SGPT (ALT) | 56 h | - | - | 62 h |

**Figure 1.** An example Pocket Rounds report.

## Methods

*Study Participants*

Subjects for the study were recruited from the general medicine services at WMH. There are 10 general medicine teams at WMH, with 8 of the teams consisting of three medical students, two interns, one resident and one staff. The other two teams consist of one intern shared between both teams and two staff physicians. The total number of residents and students is 49. All students and clinicians on the medicine services were invited to participate in the study via email. Additionally, we made announcements about the study at a weekly meeting held to solicit opinions regarding the RMRS. Subjects who owned an HHC and agreed to participate were assisted in configuring their HHC to access the electronic report by one of the authors (ST).

*Preparation of e-Rounds*

We created the electronic version of Pocket Rounds (e-Rounds) by having the RMRS generate reports in hypertext markup language (HTML) documents and store them on a dedicated Web server hourly. We used the enterprise version of AvantGo® to deliver the reports to the HHC. AvantGo® provides a method to deliver content from the World Wide Web and a browser for viewing the data to either HHCs running the Palm operating system or Windows CE/PocketPC. A diagram of the architecture is shown in Figure 2.

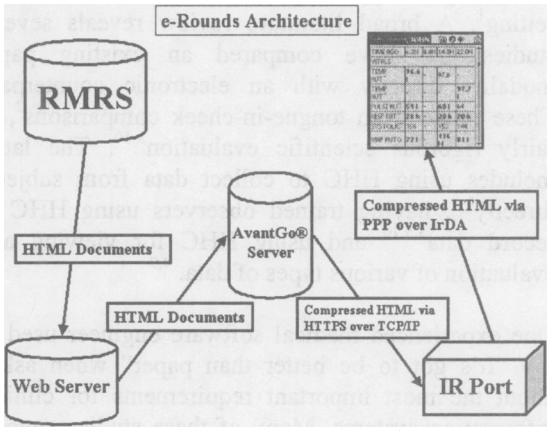



**Figure 2.** RMRS: Regenstrief Medical Record System; HTML: hypertext markup language; HTTPS: Hypertext Transmission Protocol, Secure; PPP: Point-to-Point Protocol; IrDA: Infrared Data Association.

Our decision to support as many platforms as possible dictated our system design. Providing cradles for all HHC platforms was not practical. We used an infrared (IR) port that could connect to any HHC platform. The IR port was located in a central location, and it would be easy to extend the system by simply plugging more IR devices into the existing Ethernet infrastructure.

The AvantGo® server software allowed us to create users and groups so that the setup required on the user's HHC was minimal. The IR device connected directly to the AvantGo® server through the WMH Ethernet network to deliver e-Rounds to the HHC. Example screen shots from a Palm OS® HHC and a PocketPC® are shown in Figures 3 and 4 respectively.

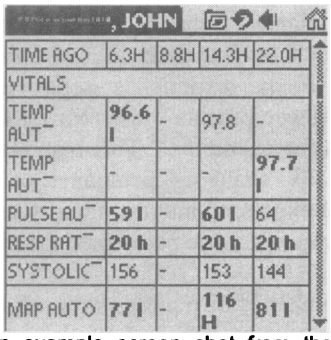



**Figure 3.** An example screen shot from the Palm OS® version of e-Rounds showing recent vital signs.

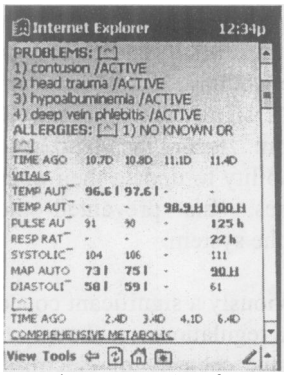



**Figure 4.** An example screen shot from the Pocket PC® version of e-Rounds showing recent vital signs.

*Security*

Security was a fundamental concern with this project. Both the AvantGo® server and the Web server were behind our institution's firewall. The AvantGo® server was the only computer that was allowed to access the documents on the Web server. Subjects that wanted to use their HHC needed to have an account on the Regenstrief AvantGo® server. The investigators controlled these accounts. Additionally, the AvantGo® server encrypts data both when retrieving from the Web site and when sending to the HHC using secure socket layers.

*Data Sources*

Pocket Rounds: Subjects were asked to fill out a 13-question survey regarding pocket rounds during three of the weekly feedback meetings. The survey asked about ease of use, most frequently used data, and characteristics of use. Additionally, data was collected from the RMRS regarding the subjects' printing of Pocket Rounds for the time period of 1/20/2001 – 2/19/2001.

e-Rounds: Subjects were given a 10 question survey regarding specific aspects of e-Rounds. Questions asked about opinions regarding usability, speed and comparisons with Pocket Rounds. We also collected data regarding how often the subjects "synced" their HHC from the AvantGo® server log files.

*Data Evaluation*

Data was entered into a spreadsheet and descriptive statistics were computed for numeric results. Comments were entered as well, and general impressions were synthesized from these data

**Results**

*Pocket Rounds*

Twenty-nine subjects completed the survey on Pocket Rounds. These data show that most users printed pocket rounds once a day and only sometimes more frequently. Laboratory data was consistently judged the most important data on Pocket Rounds with medication lists and vitals signs second and third most important respectively. There was less agreement regarding importance thereafter. Most used Pocket Rounds either in preparation for rounding or during rounds. The importance for day-to-day patient care was judged 6.1 +/- 0.8 on a 7-point scale with other uses such as for a to-do list judged to be less important. Overall satisfaction was 5.8 +/- 1.0 on a 7-point scale. Of those who own an HHC almost 13 of 15 (87%) used the Palm OS. Of those who stated that they don't currently own an HHC, 5 of 13 (38%), plan on buying one.

The printing logs showed that users had a varied pattern of printing Pocket Rounds. Besides medical students, residents and staff physicians, nurses, dieticians and social workers have printed Pocket Rounds. A total of 5315 Pocket Rounds printing jobs were performed during one month. Due to how the system logs print jobs, each instance could represent one or more patient report. Staff, residents and medical students printed the report an average of 18 times per month. Generally, users printed Pocket

Rounds on a daily basis, although some users printed every other day. A small number printed more frequently, as many as 90 times in a month.

*e-Rounds*

Thirteen HHC users expressed interest in trying e-Rounds. Nine had an HHC that easily connected to e-Rounds and were included in the study. The other four had various difficulties with their HHC and were excluded.

We collected responses from eight of the nine e-Rounds users. Overall, users were satisfied with e-Rounds, with a score of 5.6 +/- 0.8 on a 7-point scale. The majority felt that getting e-Rounds was quicker than Pocket Rounds, and seven of the eight preferred e-Rounds. Results were mixed for ease of data retrieval with one being neutral, four slightly preferring e-Rounds, and three slightly preferring Pocket Rounds. Users of e-Rounds were similar to Pocket Round users in that lab data, vital signs and medication orders were the most useful data. All eight respondents listed these data as the three most important (although in different order).

Although seven of the eight subjects stated that they synced their HHC at least once a day, the server log data did not bear this out. Five of the eight synced at least once per day, while the other three synced at least twice during the study.

Six of the eight subjects used Palm OS powered devices and the other two used Windows CE machines. There was no difference in responses between these two groups.

**Discussion**

This study showed that physicians find Pocket Rounds to be a valuable resource on the general internal medicine wards at WMH. Data retrieval is most important with lab results, medication lists and vital signs being the most important data. They report printing Pocket Rounds at least once a day, and use it both before rounds and while rounding. The RMRS' printing logs supported these data. These users were also interested in an electronic version of Pocket Rounds.

Overall, we observed a positive response to e-Rounds. Subjects used e-Rounds for similar tasks as Pocket rounds, and seven of the eight users preferred e-Rounds over Pocket Rounds. This preference for e-Rounds needs to be interpreted within the limitations of our study. We had a small number of subjects. Since the e-Rounds users had invested personal funds to purchase an HHC, they were certainly predisposed to HHC technology. These limitations almost certainly bias the findings in favor of e-Rounds.

Our findings regarding important types of data of both Pocket Rounds and e-Rounds are similar to the findings of Sittig, et al[1]. Their study showed that review of test and drug regimens ranked equally high in using an HHC. Drug-drug interaction checking ranked slightly higher numerically in their study.

Subjects were interested in similar changes to the content of both Pocket Rounds and e-Rounds. Bacterial culture results and the ability to personalize the content were common requests for both modalities.

We were surprised that more clinicians didn't take advantage of the availability of e-Rounds. Informal discussions suggested that a large number would be interested but then few users followed through. This is similar to the experience reported for other informatics developments – the "MEDLINE Button" at Columbia for example. [14] This may also be due to the continually changing personnel of the wards. Subjects that expressed interest initially may not have been on service when we performed the pilot.

We had a number of difficulties with e-Rounds. Since our intention was to keep e-Rounds independent of platform, we did not optimize the report for the Palm devices' smaller screen. Optimization for a specific platform may have made data easier to view via e-Rounds. Of those that had HHC but could not connect to e-Rounds, outdated operating system software was a significant problem. Certain HHCs, such as the Palm IIIe and the HandSpring devices, do not offer the ability to update their operating system. In some cases, this prevented the user from connecting to the system.

Security is obviously a significant concern, especially given HIPAA regulations. Although there is much concern with the security of electronic data, paper certainly presents potential breakdowns in confidentiality. Paper reports can be left in public places, left in the printer or mistakenly picked up by others. Users are reminded that Pocket Rounds are confidential patient data, and must be treated as such. Misplacing a $300 machine is less likely in our opinion. It is clear that both modalities present security and confidentiality issues that we need to consider.

If e-Rounds replaced Pocket Rounds, the Institution would save a significant amount of paper. With 5300 reports being printed each month, and a conservative

estimate of 10 pages per report, e-Rounds could save 636,000 sheets of paper in a year.

It is tempting to jump on the bandwagon of this new technology. We have shown that there may be a place for the HHC instead of a printed report, but we need a more vigorous evaluation. We plan to continue our exploration by evaluating naïve users on their use of Pocket Rounds and e-Rounds in an upcoming crossover trial.

**Acknowledgement**: Supported by the National Library of Medicine Medical Informatics Training Grant 1T15LM07117-04 and National Library of Medicine Contract N01-LM-9-3542.

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