Understanding Usage Patterns of Handheld Computers in Clinical Practice
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ABSTRACT
Handheld computers are commonly used in clinical practice and often considered invaluable by physicians. Though full of promise, the technology is still costly and literature assessing its real use in clinical practice remains scarce. In an effort to better understand how Personal Digital Assistants (PDA) can be utilized as clinical tools, we designed a study that closely monitored the use of a selection of handheld applications by a cohort of interns in a service of Internal Medicine. Information gathered about actual use of the mobile applications offers valuable insights on usage patterns of tools that promise to become an important part of our clinical practice in the years to come, and will hopefully help guide future developments.

INTRODUCTION
Personal Digital Assistants (PDA) are finding their way in the pockets of an increasing number of physicians that have learned to benefit from their ability to store, organize and quickly retrieve large amounts of information in a small and easily portable form factor. Health professionals were early adopters of handheld technologies, quickly recognizing their potential use in a clinical setting. Potential applications cover a wide array of functions including drugs and medical reference, patient tracking, electronic prescription and clinical score calculators.

METHOD
Design: In January 2001, Palm OS-based PDAs (model: Handspring Visor Deluxe) were distributed to 102 physicians (interns and residents) of 2 Internal Medicine clinics at the Geneva University Hospital (HUG). Devices were considered personal property and could be taken home after work. They were not replaced if lost or damaged.

Medical applications: PDAs were loaded with locally developed medical applications covering a wide range of clinical reference material and medical calculators. AdaptIR: Renal failure drug dosage calculator, based on principles by DettliÆ

Antibiothérapie: Electronic version of the Guide to Antimicrobial Therapy edited by the Infectious Disease Division of the HUG.
Breviaire: Electronic version of the swiss pocket drug reference booklet edited by Documed SA.
Fiches: Reader of peer-reviewed clinical notes edited and reviewed on a web application available on the hospital intranet.
MedCalc: Medical calculator designed for rapid and easy calculation of common equations used in internal medicineÆ.

Data collection: Access to medical applications generated log data (date and time of use, name of user, name of application, type of action performed, ID of accessed data) that was temporarily stored on the device and uploaded to an online database when users docked their PDA on public synchronization cradles. Synchronization served the double purpose of collecting usage logs and updating medical information stored on the devices. Users were encouraged to synchronize at least once a month. Upon analysis, logs were consolidated into "sessions". A single session was created out of every log entry generated by the same user, using the same application within a short time span (not exceeding one minute). Such sampling methodology appears to be a good approximation of a single-concept oriented session. Entry and exit questionnaires were also used to assess user satisfaction.

Statistics: We used a t-test to compare means of continuous variables. Linear regression was used to evaluate the learning in the first period of use. Repeated anova has been used to assess correlation between usage and rotation. All analyses were performed with Intercooled Stata for Windows 6.0. All statistical tests were two-sided.

RESULTS
During the period ranging from January 2001 and July 2001, a total of 41489 log sessions could be retrieved for 92 physicians (characteristics below). 10 participants were excluded from analysis because of incomplete data (leave of absence, illness, battery-related loss of data on the device).

<table>
<thead>
<tr>
<th>Subjects included in the study :</th>
<th>n=92</th>
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<tbody>
<tr>
<td>Male : female ratio :</td>
<td>53 : 39 (1.36 : 1)</td>
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<tr>
<td>Mean age (years) :</td>
<td>32.8 (SD = 4.84)</td>
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<tr>
<td>Prior use of PDA :</td>
<td>24 (27%)</td>
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Table 1: Characteristics of the study population
First days of use: Initial evaluation phase was an assessment of the use of the handheld for the first 50 days following distribution (figure 1). This was an important validation of the logging mechanism, as we expected an initial peaking in use, due to the novelty effect.

Our data confirms that users go thru an initial "discovery phase" where they explore the functionalities of their new tools. Once this testing and learning activity is over, typically after a two-to-three-day period, log activity tapers off and reaches a plateau as interns begin to use applications on an occasional basis during their clinical activities.

Daily usage: Log data was also used to determine peaks of activity during a typical day of work (figure 2). As expected, access to applications peaks during morning rounds and in mid-afternoon when interns are undertaking clinical activities. What’s more surprising is the level of residual activity during off-hours.

Per-application analysis of the logs was precious to determine which kind of tools were most frequently used. Figure 3 gives a pretty clear picture of the relative usage of each application of our offering (Hotsync referring to the synchronization process).

Our log mechanism allowed us to retrieve rich information about the use of medical applications. Aside form date and time, exact nature of the accessed information was recorded. This is illustrated in table 2 that shows the top 5 formulas requested by users in the medical calculator MedCalc.

<table>
<thead>
<tr>
<th>Formula</th>
<th>Percent of total use</th>
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<tbody>
<tr>
<td>Creat. clearance (Cockroft)</td>
<td>11.1 %</td>
</tr>
<tr>
<td>Body Mass Index</td>
<td>7 %</td>
</tr>
<tr>
<td>QTc</td>
<td>4.8 %</td>
</tr>
<tr>
<td>FENa</td>
<td>4.5 %</td>
</tr>
<tr>
<td>Creat. clearance (measured)</td>
<td>4 %</td>
</tr>
</tbody>
</table>

Table 2: Top five in the medical
Usage in different rotations: Finally, we performed an Anova analysis that shows that physicians use differently their Palm according to their current rotation. We classified all rotations in four groups according to their type (outpatients, ward, specialized consultation and intensive clinics). After adjustment for age and prior use of PDA’s, Palm’s usage is significantly higher while physicians were in wards (p=0.01, 95% CI 5.29 - 38.86) and ambulatory rotations (p<0.001, 95% CI 15.82 - 51.45).

![Figure 2: Mean usage pattern during a 24-hour shift, total sessions per hour](image)

DISCUSSION

Our design allows for objective, precise and almost real-time data collection on the use of handheld applications in our institution. Long-term analysis of this information is important for a variety of reasons:

To guide development of new applications. Development and technical support of medical applications takes up a significant share of the total cost related to handheld computers deployment in a hospital such as ours. Log analysis represents a precious feedback mechanism for both developers and content providers and may be one of the most effective ways to guide future developments.

To attract funding. In addition to development costs, distributing handheld computers to interns or residents that often are on a short-term employment contract can prove expensive and may discourage deciders in big medical institutions to consider PDA-based technologies. Being able to easily produce reliable data on the actual use of the devices can be decisive when discussing deployment budgets. Moreover, prescription-related data can easily be extracted from log data files and sold in a form or another to the pharmaceutical industry.

Identify potential users. As we’ve been able to point out, patterns of use of our handheld medical applications were not uniform. Log analysis is a great way to identify people...
that will benefit the most from the technology and avoid ineffective distribution of devices, thus bringing down total costs.

It can be argued that our data suggests that daily usage rates of our handheld applications were relatively small (41489 log sessions for 92 users during 210 days = 2.14 sessions/user/day). This relatively small but constant rate has to be put in perspective with the usage rate of other clinical tools or reference material, and to the huge satisfaction rate we got from our participants and interest we generated from those that weren't included in the study.

Deeper understanding of the data extracted from log analysis could certainly be obtained thru interviews with end users, discussing specific points. This time and resource-consuming undertaking hasn't been completed in our study yet.

CONCLUSION

Handheld technologies are without a doubt a promising tool that will even grow more attractive as wireless capabilities mature. Future large-scale deployments of handheld solutions, because of the total cost involved in such operations, will nevertheless need to be based on solid evaluation tools in order to guarantee the financial and logistic investment they represent.

REFERENCES

9. MedCalc, Medical calculator for Palm OS. http://medcalc.med-ia.net

ACKNOWLEDGEMENTS

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