ABSTRACT.

Background. Personal digital assistants (PDAs) are being increasingly used in medical practice. Although they have been touted as having the ability to improve efficiency and safety, little is known about pediatricians’ use of and attitudes about PDAs.

Objective. Our goals were to 1) determine the percentage of pediatricians using PDAs and computers, 2) determine perceived strengths and weaknesses of PDAs, and 3) explore characteristics associated with beliefs and use.

Design/Methods. Pediatricians (2130) were selected randomly from the American Medical Association Physician Masterfile of US-licensed physicians. All participants were mailed a survey along with a prepaid return envelope and a $1 incentive. Up to 3 mailings were sent per participant.

Results. Of eligible participants, 63.2% returned a survey. There were no significant differences between respondents and nonrespondents with respect to sex, type of practice, and present employment. Thirty-five percent of respondents currently use PDAs at work, and 40% currently use PDAs for personal use. Of those using PDAs, the most commonly used applications were for drug reference (80%), personal scheduling (67%), and medical calculations (61%). Few pediatricians are currently using PDAs for prescription writing (8%) or billing (4%). Users of PDAs were more likely to be male (adjusted odds ratio [AOR]: 2.29; 95% confidence interval [CI]: 1.64–3.19), in an urban community (AOR: 1.81; 95% CI: 1.30–2.55), in training (AOR: 2.64; 95% CI: 1.58–4.42), not in private practice (AOR: 1.47; 95% CI: 1.03–2.11), and a more recent graduate of medical school (AOR: 1.04 per year; 95% CI: 1.02–1.06). When controlling for covariates, those using PDAs were more likely to believe that PDAs can decrease medical errors (AOR: 2.22; 95% CI: 1.46–3.38) and increase efficiency (AOR: 2.40; 95% CI: 1.96–3.71). When compared with nonusers, users were less likely to view the small screen size (AOR: 0.53; 95% CI: 0.37–0.77) or system speed (AOR: 0.47; 95% CI: 0.26–0.84) as a problem but were significantly more likely to view memory as an issue (AOR: 3.48; 95% CI: 2.30–5.25).

Conclusions. More than one third of pediatricians are using PDAs in clinical practice. There seems to be a general consensus among users that they have the potential to improve patient safety and streamline care. Future studies should explore means to utilize their potential.

ABBREVIATIONS. PDA, personal digital assistant; AMA, American Medical Association; AOR, adjusted odds ratio; CI, confidence interval.

PORTABLE information technology is increasingly being used in clinical practice. Personal digital assistants (PDAs) have the ability to allow clinicians to enter and access data both remotely and at the point of care. PDAs have been reported as a means to document patient encounters and procedure logs,1–4 provide decision support,5,6 and access clinical information wirelessly and securely.7 Applications have been developed to record and store patient information, calculate appropriate drug doses, provide databases of important information, and offer other forms of bedside data support.8 More significantly, recent studies have documented the potential of PDAs to affect the quality of patient care.9,10 Automated wireless alerts have been used to prevent medical errors and alert clinicians to critical lab values as soon as they are available;10 point-of-care information has improved the quality of antibiotic prescribing.11 A PDA-based patient record and charting system showed some benefit in improving the accuracy of documentation in resident progress notes in a neonatal intensive care unit.9 Rigorous studies documenting benefits and harms of PDA use, however, are unfortunately not available in large numbers.

Information about PDA use in the lay press abounds; little is known, however, about the actual use and practice patterns of physicians using them. Although others have attempted to estimate use and perceptions among different groups, these prior studies have been hampered either by selective sampling or because they have been issued by industry and thereby are potentially biased.12 Other investigations have been published as news reports or press releases but without the scrutiny of peer review.13–15 Little information exists that accurately summarizes the beliefs of pediatricians concerning PDA strengths and weaknesses, and even less is available that describes the differences between users and nonusers. Such information is essential to the planning of future applications and systems, because the effectiveness of programs and systems depends on user acceptance of them.16,17

We undertook this research to 1) determine the percentage of pediatricians using PDAs and comput-
METHODS

The American Medical Association (AMA) Physician Masterfile is recognized as the most complete and accurate list of licensed physicians in the United States. We sampled 2130 pediatricians from this masterfile through Direct Medical Data (Skokie, IL), which manages and distributes data from the masterfile through a licensing agreement with the AMA. The sample was completely random, with no oversampling or adjusting. We estimated that, if we had a response rate of 50% yielding 1000 responses, we could estimate the prevalence of PDA use with 95% confidence with an interval of ±3%. Resident physicians were included in the sample.

All participants were mailed the survey along with a cover letter, prepaid return envelope, and a $1 incentive. The cover letter assured all recipients that participation was voluntary and responses would remain anonymous. Recipients were instructed to return the survey unaanswered if they chose not to participate. Those not responding were contacted and resent the survey up to 2 additional times at 1-month intervals between July and September 2002. This study was approved by the University of Washington Institutional Review Board.

Survey

The survey took ~5 minutes to complete. The initial questions asked recipients to indicate whether they use a PDA at home or work and whether they use a computer at home or work. If they used a PDA, they were asked to provide its make and model and what applications they used at work. We also asked them to indicate potential strengths of PDAs to improve health care and impediments to their use through a 5-point Likert scale ranging from 5 ("strongly agree") to 1 ("strongly disagree").

The rest of the survey consisted of 6 questions asking participants to supply their percent of time in general versus specialty practice, year of medical school graduation, training status, gender, primary practice description, and primary practice community.

Statistical Analysis

We used multivariate logistic regression to assess relationships between demographic and professional characteristics and attitudes about PDAs. Multivariable models were adjusted for covariates chosen a priori, including sex, year of graduation, training status, specialty distinction, practice setting, and practice location. When comparing users to nonusers, we grouped Likert responses into 2 groups: "agree" (5 and 4) and "disagree" (3, 2, and 1). We did this because we wished to compare those that "agreed" with the statements to all others. We performed calculations using the STATA 7.0 statistical package (STATA Corporation, College Station, TX).

RESULTS

Sample

Of the 2130 mailed surveys, 164 were returned by the post office with no forwarding address, and 91 were returned by nonpracticing physicians. These were excluded from subsequent analyses. From the 1875 remaining eligible participants, we received 1185 surveys, yielding a response rate of 63.2%. Because of missing data, not all totals equaled 1185. There were no significant differences between respondents and nonrespondents with respect to gender and type of practice as defined in the AMA Physician Masterfile. Respondents, on average, had graduated from medical school 1 year later than nonrespondents (P < .02). Demographic data on survey respondents are presented in Table 1.

Use of PDAs

Of those responding to the survey, 35% currently use a PDA at work, and 40% currently use a PDA for personal use (Table 2). Of note, an additional 9.6% indicated that they had used a PDA in the past but no longer considered themselves users. The majority of those using PDAs chose one running the Palm operating system (Palm Pilot, Handspring Visor, or Sony Clie) system (89.7%), with most of those remaining (8.9%) choosing to use a PDA running the PocketPC operating system (Casio Cassiopeia, Compaq iPaq, or HP Jordana).

Of those using PDAs, the most commonly used applications in the work setting were for drug reference (80%), personal scheduling (67%), medical calculations (61%), and computerized texts (38%). Few pediatricians are currently using PDAs for prescription writing (8%) or billing (4%) (Fig 1). In analyses adjusting for potential differences in other major personal and practice characteristics, a number of predictors of PDA use remained independently significant. PDA users were more likely to be male (adjusted odds ratio [AOR]: 2.29; 95% confidence interval [CI]: 1.64–3.19), practice in an urban community (AOR: 1.81; 95% CI: 1.30–2.55), be in training (AOR: 2.64; 95% CI: 1.58–4.42), and not be in private practice (AOR: 1.47; 95% CI: 1.03–2.11). For every year later that a respondent graduated from medical school (ie, 1986 vs 1985), their use of a PDA increased significantly (AOR: 1.04 for each year later; 95% CI: 1.02–1.06). Those graduating medical school in the last 5 years were much more likely to use PDAs in practice than those who graduated >5 years ago (62% vs 29%; P < .001).

Pediatricians’ Perceptions of PDAs

In general, users were somewhat more likely to feel that PDAs have greater potential to improve health care than nonusers (Fig 2). On a 5-point Likert scale, both users and nonusers felt that the greatest potential lay in their ability to increase access to information (means: 4.5 for users and 4.0 for nonusers).

TABLE 1. Demographic Data on Survey Respondents

<table>
<thead>
<tr>
<th>Demographic Data</th>
<th>Percent of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>52</td>
</tr>
<tr>
<td>Medical school graduation after 1985</td>
<td>53</td>
</tr>
<tr>
<td>In training (resident or fellow)</td>
<td>17</td>
</tr>
<tr>
<td>In a private-practice setting</td>
<td>55</td>
</tr>
<tr>
<td>Urban community</td>
<td>51</td>
</tr>
<tr>
<td>Average time spent in generalist practice</td>
<td>88</td>
</tr>
</tbody>
</table>

TABLE 2. Pediatricians’ Use of PDAs and Computers

<table>
<thead>
<tr>
<th>Computer/PDA Use</th>
<th>No. of Respondents (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ever used a PDA</td>
<td>580 (50.9)</td>
</tr>
<tr>
<td>Currently use a PDA at work</td>
<td>397 (34.9)</td>
</tr>
<tr>
<td>Currently use a PDA for personal use</td>
<td>453 (40.0)</td>
</tr>
<tr>
<td>Currently use a computer at work</td>
<td>846 (74.2)</td>
</tr>
<tr>
<td>Currently use a computer for personal use</td>
<td>957 (84.3)</td>
</tr>
</tbody>
</table>
ers). Respondents also felt that PDAs had the potential to decrease medical errors (means: 4.2 for users and 3.8 for nonusers) and improve efficiency (means: 4.2 for users and 3.6 for nonusers). With respect to barriers to the use of PDAs, nonusers felt that each of the potential weaknesses was more of an impediment than users (Fig 2). The greatest impediments were felt to be the difficulty of data entry into a PDA (means: 3.4 for users and 3.7 for nonusers) and the small screen size (means: 3.1 for users and 3.6 for nonusers).

When adjusting for covariates, a number of these potential benefits and perceived barriers were found to be significantly associated with use of a PDA. Users were more likely to believe that PDAs can decrease medical errors (AOR: 2.22; 95% CI: 1.46–3.38) and increase efficiency (AOR: 2.40; 95% CI: 1.56–3.71). When compared with nonusers, users were less likely to view as a problem the small screen size (AOR: 0.53; 95% CI: 0.37–0.77) or system speed (AOR: 0.47; 95% CI: 0.26–0.84) but were significantly more likely to view memory as an issue (AOR: 3.48; 95% CI: 2.30–5.25).

**DISCUSSION**

Our study indicates that more than one-third of pediatricians are currently using PDAs in their clinical practices. In analyses adjusting for differences in personal and practice characteristics, we found that users were more likely to be male, in training, practicing in a nonprivate setting, in an urban community, and later graduates of medical school. Both users and nonusers agreed that PDAs have the potential to decrease medical errors, although users were more likely than nonusers to believe in the PDA’s potential to decrease medical errors and improve efficiency. Users were also more likely to view the limited memory of a PDA as an issue and less likely to view small screen size or system instability as an impediment to use.

This study is subject to the typical limitations of self-report surveys, such as response bias and an inability to establish a causal relationship between differences in personal and professional characteristics and pediatrician attitudes. However, we had a response rate of 63.2%, which is considerably higher than the mean for published survey studies of physicians. Furthermore, respondents were not significantly different from nonrespondents with respect to gender and type of practice as defined in the AMA Physician Masterfile. It is also possible that responses to surveys do not reflect actual practice. However, our questions were simple and straightforward, and the potential for social desirability in responses seems low. Finally, some of our differences were quite small, although they reached statistical significance. How clinically relevant these differences are is unknown.

Millions of dollars are spent every year on new and, for the most part, untested technologies. Much of this money is spent unwisely on systems and software that ultimately are not acceptable. More than 30% of computer systems built internally by corporations for their employees are either canceled
or rejected after completion. Without well-designed trials we cannot tell if the use of any information technology carries actual benefits or even harms. Although there is a growing body of literature about PDAs and their uses, little of it is evidence based. We hope that this study helps to provide some answers and a foundation for future investigations.

The effectiveness and usefulness of future applications and systems certainly depends on user acceptance of them. Our results suggest that concerns about screen size and system speed are 2 factors that significantly separate users from nonusers. Such information may be useful to those designing PDAs that may be more widely accepted by pediatricians. According to our results, there seems to be a general consensus that PDAs can improve access to information. There also seems to be a belief, especially among users, that PDAs can contribute to a reduction in medical errors. Additionally, a majority of users are using applications for drug reference and medical calculations. Medication errors have been found to be the most common type of medical error in the pediatric inpatient setting. Therefore, it may be wise for future studies to examine the ability of PDAs to reduce medication errors through the use of existing or new drug-prescribing or error-checking applications. Because such programs already have widespread acceptance among PDA users, they may have a higher probability of showing a significant improvement in care.

Although a minority of pediatricians overall are using PDAs, a majority of recent medical school graduates are using them. According to the adopter categories described by Rogers, pediatricians have likely passed the “early adopters” stage and gone into the “early majority” stage. This could have additional implications on how quickly pediatricians as a whole continue to adopt this technology. It is likely that the overall percentage of pediatricians using PDAs will rise significantly in the next few years as more-recent graduates adopt their use and less-recent graduates retire. If current trends continue, in the near future the PDA may be a commonly used tool in the practice of pediatrics. Studies to evaluate the potential benefits and harms of PDA use are warranted.

ACKNOWLEDGMENTS

Support for Dr Carroll was provided by the Robert Wood Johnson Foundation.

We thank Frederick P. Rivara, MD, MPH, for helpful suggestions in the preparation of this manuscript.

REFERENCES

CHANCE BLINDNESS

“Consider this scenario: if you were watching a circle of people passing a basketball, and someone dressed in a gorilla costume walked through the circle, stopped to beat his chest, and exited, of course you would notice him immediately—wouldn’t you? Simons and the psychologist Chris Chabris filmed such a scene and showed it to people who were asked to track the movement of the ball by counting the number of passes made by one of the team. Approximately half of the participants failed to notice the gorilla. . . . Focused on tracking the ball’s movement, people are blind to what happens to unattended objects and thus do not encode the sudden change.”

Schacter D. The Seven Sins of Memory. Houghton Mifflin; 2001

Submitted by Student