Development of the PDA Support Systems for Community Preventive Medicine Services

Polun Chang* Shiao-Chi Wu[1] Pesus Chou[2] Hong-Jen Chang[3]
Chieh-Min He Yi-Chein Chang[4]

Institute of Health Informatics and Decision Making, National Yang-Ming University, Taipei, Taiwan, 112, ROC
[1]*Institute of Health and Welfare Policy, National Yang-Ming University, Taipei, Taiwan, 112, ROC*
[2]*Community Medicine Research Center, National Yang-Ming University, Taipei, Taiwan, 112, ROC*
[3]*Bureau of National Health Insurance, Department Of Health, The Executive Yuan, Taipei, Taiwan, 106, ROC*
[4]*Department of Medical Radiation Technology, National Yang-Ming University, Taipei, Taiwan, 112, ROC*

Received 3 January 2002; Accepted 20 November 2002

Abstract

Field study is a fundamental research and service model in the public health. It requires mobility and information processing and management, which could be potentially fulfilled by the personal digital assistant (PDA). However, the applications of PDA in the public health still are not popular enough, compared with so many in medicines. The purposes of this study were to develop a package of PDA applications for the field services in the community preventive medicine and to examine the potentials of PDA in the public health. We used commercial development tools as well as Basic-like programming languages, NS Basic and VB, to specially make main applications: questionnaire maker and viewer, GIS, pocket book of the interviewees, a web site of information center for to support the off-line browse by PDA, and a conduit to backup data to the desktop Access database. Though we accomplished the design of functions required in this study, we found many practical difficulties which were highly related to the "user interface" issue. We also found that the real value of PDA comes from its ability of connecting to the backend information systems through synchronization. Due to its simplicity and affordability, the Palm-based PDA was recommended for the use in the Public Health. It is necessary to do further evaluation studies for better understanding and realizing the empirical values of PDA.

***Keywords*:** PDA, Information Support Systems, Community Preventive Medicine, User Interface Design

Introduction

Field study or service is the fundamental activity in pubic health. It is highly featured the information processing and management. However, the use of information support systems in pubic health has been lagged behind in the information technology development trend. When advanced computers and sophisticated statistic packages were used to analyze epidemiological or clinical data, we always saw that the raw data were collected and processed in a very traditional and inefficient way. Research teams were sent to field to collect data with low-end tools, such as paper questionnaire and handbooks, and then coded manually latter. It is very typical for a public health field service or study to take months to make data available for analysis.

This time-consuming processing of data collected from the field makes us to consider the potential values of using personal digital assistant (PDA) because the mobility and information management capability of PDA were just fit for public health field study or service [1]. However, the use of PDA in health care is still in a very early stage because of the novelty of the technique. When a dozen of papers were found in the HealthStar database since 1995 using the keyword of "personal digital assistant," only one of them was related to the public health service, in which the PDA was simply used to record the time and patterns of occupational pollution events [2], others were greatly applied to medical care services [3-11]. A similar pattern was observed in the general use of PDA. In some PDA web sites, though more than 300 free or shareware applications were available under the title of Medical/Health Care, few of them were directly related to the public health purposes [12-13].

Therefore, this study was intended to develop a representative PDA application package in the public health domain, take the community preventive medicine services as our intended applied scenarios, and examine the issues to

* Corresponding author: Polun Chang
Tel: +886-2-28267238 ; Fax: +886-2-28286544
E-mail: polun@ym.edu.tw

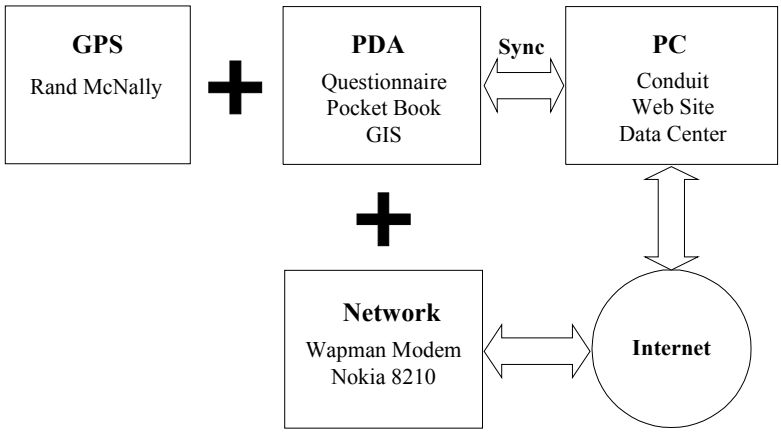

Figure 1. The system structures of PDA application package for the community preventive medicine services

understand the PDA effectiveness in public health. The integration of PDA applications with the desktop information systems was also seriously considered in order to improve the entire information management efficiency and effectiveness of community preventive medicine services. The network connection was also planned to make the PDA as the information exchange platform between the field teams and the headquarters.

Materials and Methods

The Scenarios of Community Preventive Medicine Services

The hypothetical project to be used to invent PDA application package was a community elders' preventive screening and life quality survey developed by the Community Medicine Research Center (CMRC) in National Yang-Ming University. The Yang-Ming Crusader, a student club for public health services, has traditionally conducted this survey. The questionnaire in this survey is composed of 11 categories-demographic data, physical examination, hypertension, personal medical history, family history, pregnancy & childbirth history, life quality, falling, nursing care, health care utilization & satisfaction and sleeplessness. It includes 69 long questions with up to 300 items of information. This is a very typical long questionnaire in public health.

The Crusader members were responsible for interviewing the elderly on an individual base to collect data and to chat with them, which was part of this survey. Each interviewing squad was composed of one senior and one junior members. It took about one and half hours to finish one copy of interview. The resulting data would be checked up to see if they were complete or not. All questionnaires, filled by crusaders, were handed to the CMRC after the mission was done. Data would then be coded by out-sourcing. This process from mission planning to data ready for analysis typically took several weeks.

System Designs and Materials

The structures of PDA application package in our scenario (Figure 1) included two parts: PDA with auxiliary facilities and desktop information systems. We chose Palm as the PDA platform due to its simplicity, affordability, and easiness of finding resources on the web.

The main PDA application was about the questionnaires, which were designed by the commercial questionnaire development tools, ThinkDB 2.5 & ThinkDB Desktop 2.5 [14], and by a tailor-made system using BASIC-like programming language, NS Basic 2.04 [15]. The ThinkDB Desktop was capable of synchronizing the data collected by the ThinkDB questionnaire to Access 2000 database.

The second PDA application was the PDA GIS. Since the PDA GISs on the market could not fulfil specific needs, so we decided to design our own PDA maps of Kin-Men County [16]. We chose the MapIt 2.5 with the HandMap map reader to design the map [17]. Bmp files of Kin-Men couinty were obtained by scanning a local map to cerate the GIS maps. The PDA maps were used with the PDA GPS to provide the field geographical information [18].

The third application was the customer-made pocket book reader. We used the MakePDB to transfer the CSV files (comma separated, which could be easily generated in Excel) from the desktop to Palm databases [19] , and wrote the PDA reader using NS Basic 2.04. We also wrote a small PDA program to generate an index database from the sequential one created by the MakePDB. This approach could create various PDA pocket books. A pocket book of personal information for the interviewees was developed in this study.

The critical program on the desktop information systems, conduit [20], was to synchronize data between the data in PDA and the databases on the desktop. It was formulated by using the COM-based conduit development tool kits provided by the Palm Inc. with VB 6.0. A database management program was also designed by using VB to save data uploaded from the PDA to Access 2000 database.

We also designed a web site to keep all updated information for the Pendragon Browser in PDA to read off-line [21]. PDA would automatically download the selected contents from the web site after pressing the hotsync button whenever connected to the web. This appeared to be an effective way to keep the information in PDA updated. We selected the

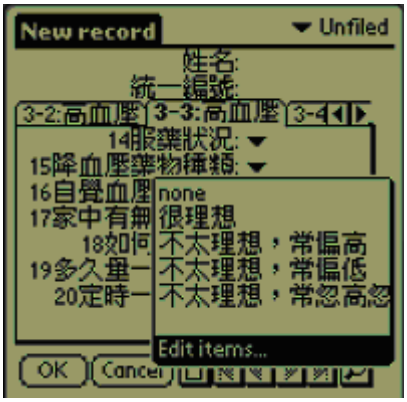

Figure 2. The sample screen of ThinkDB version of questionnaire on hypertension

Figure 3. The sample screen of 「天問」© questionnaire development tools

WapMan PDA modem and the Nokia 8210, which was capable of infrared transmission, to provide the field squad to connect to the Internet. The digital modem service would need to be activated when the cell phone connection model was used.

Results

PDA Questionnaire

Questionnaire was designed by two development tools: commercial and custom-made ones. The former was the ThinkDB version (Figure 2), in which contents were regrouped into 7 individual sub-questionnaires in 72 forms due to the question number constraint per questionnaire in ThinkDB and the too small size of PDA screen, which resolution was only 160x160, to fit in. For the NS Basic version, we designed general-purposed questionnaire development tools, which were 「問天」© and 「天問」©. The former was the questionnaire maker (Figure 3) and the latter, questionnaire reader and data collector (Figure 4). These tools were designed after we experienced many problems from using commercial ones. Our tools were in Chinese, supporting questions skipping and practically no question number limit in one single questionnaire. These are all important attributes for the questionnaire used in public health.

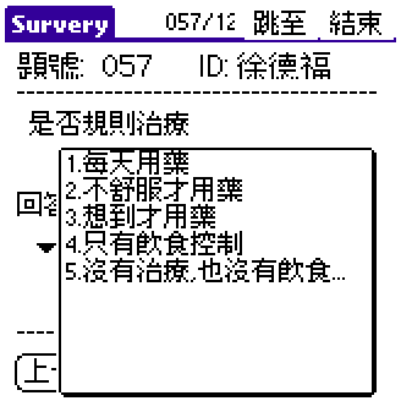

Figure 4. The sample screen of 「問天」© version of questionnaire on hypertension.

Figure 5. The sample screen of GIS for the Kin-Men county

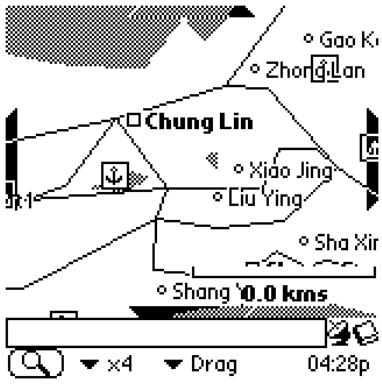

Figure 6. The sample screen of GIS for the Chung-Lin town in the middle Kin-Men

PDA GIS

Figure 5 shows the top layer of our custom-made Kin-Men county map. The example of lower layer for more detailed demographic information was shown in figure 6, which was the Chung-Lin town in central Kin-Men. Eight different scales of map layers can be made. The radar icon in the right bottom corner of screen indicates the activation of GPS. The MapIt doesn't support double-byte characters and all texts on the map are in English.

Figure 7. The sample screen of custom-made pocket book for the interviewees. There are four sections in this screen on interviewee's personal information. Within each section, only one specific information could be seen at one time. For example, in the second section, only the interviewee's address was shown. His telephone number and date of birth were kept hidden but could be displayed if the corresponding button was clicked. This design was intended to represent so many information in one PDA screen.

Figure 8. The sample screen of PDA web-based information downloaded from the designated web site

PDA Pocket Book

The PDA pocket book (Figure 7) stored the personal information regarding the interviewees. The interviewers can look up and take notes. This new information can then be uploaded in real time to keep the personal database in back end system updated. This technique can be applied to design various kind of pocket handbooks or references.

Internet Information Downloading

Figure 8 shows the contents of a hypothetical web site after being connected to the headquarter homepage. The contents are hyperlinked too. To save the time of downloading, the contents in our test web site were prepared as text-based. This design is useful for the mobile interviewer to keep updated by connecting the web through mobile phone. However, it took extra work to setup the network.

PC Database Management

The data collected by PDA were sent to the desktop Access 2000 databases (Figure 9). When the users pressed the hotsync button on the PDA, the HotSync manager in PC would be activated and then run the programmed conduit to bake up data from PDA to PC Access 2000 database file, vice versa. This mechanism could significantly shorten the time for analysis from weeks down to minutes.

Discussions and Conclusions

In our study, the efficiency of having data for analysis by using PDA questionnaire seemed very impressive. We tested various approaches and tools to design PDA questionnaires to support the hypothetical field interview in the community preventive medicine. The data collected in PDA was then uploading to the desktop Access 2000 databases through our COM-based conduit. It took around one day for a person without either PDA experiences or information technology backgrounds to design a long PDA questionnaire like ours, including the time to learn the systems, to fine-tune each question format and to assure the accurate logical flow among related questions. It took around half hour for another user to complete answering one PDA questionnaire. Then, it only used less than one minute to connect to Internet and to upload data back to the back end desktop databases. As a matter of fact, we believe the effectiveness, besides efficiency, could also be far improved if some control codes, which were used to check the validity of data or to generate an immediate alert back to the PDA for specific conditions, could be programmed into the process of synchronizing PDA with PC.

However, we found one very challenging issue which better solutions would need to be figured out before PDA could be practically useful. That is the user interface design.

We encountered two problems while maneuvering the PDA systems: the small screen size of PDA and the difficulty of entering Chinese texts. The typical size of PDA screen is only 160x160 and makes it difficult to display too many information in one single screen. We could either keep the complete contents of original questionnaire at expense of increasing screen numbers, or cut each sentence in short to make the questionnaire concise. The former strategy would make the user hard to track the working position in screen jungles, but the latter might cause part of key information to be lost. Both strategies still had the same problem of how to effectively organize so many PDA screens for a long questionnaire.

Moreover, the PDA way to input Chinese characters appeared to be not so pleasant. The Graffiti is one of the most creative inventions in PDA and is designed to help users enter texts and numbers in an efficient way. Many simplified characters could be written in the two small square areas in the bottom of PDA touch screen. The systems would then recognize the writing with a very high accuracy rate after the users made practices a while. However, though this design works for recognizing English characters, it is improper for entering Chinese characters. There are some commercial

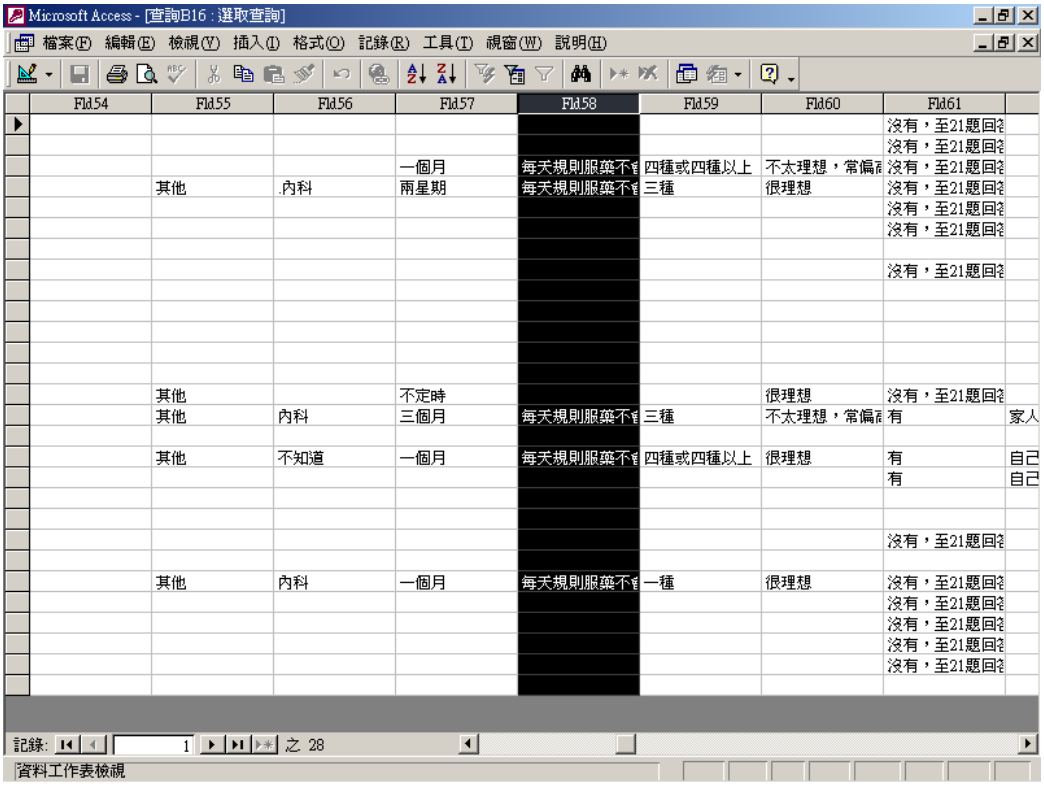

Figure 9. The sample screen of Access 2000 database after the survey data from PDA was uploaded to the desktop after synchronization

applications capable of well recognizing the Chinese handwriting [22][23]. But, all take time. The handwriting might just not be a practical way for entering Chinese texts in field. A more creative way, instead of handwriting, for Chinese input would need to be developed.

These two problems might be solved by techniques like usability engineering, which could provide a set of effective principles and methods on designing useful and easy-to-use user interfaces [24-26]. Therefore, a special set of effective principles for PDA might be more important than the selection of development tools, such like ThinkDB, SurveyMate[14], or Pendragon Form 3.1[21], in creating useful PDA questionnaire.

PDA appears to be a good candidate to provide communication between the field service staff and the headquarters. Tested with mobile phone and modem, we set up a mechanism to provide the hypothetical field service staff to keep PDA information updated by downloading from a designated web site and then browsing the contents offline. To equip the PDA, which features information processing, with the communication capability would greatly enhance the productivity of field service staff in public health. There is no wonder that new products combining two techniques, PDA and communication, has caught people's attention [27][28].

We believe the use of PDA to connect to the Internet, no matter through WAN or LAN, mobile phone, traditional modem or wireless modem, is the best value of using PDA. Through the connection, could not only the field service staff's productivity be improve by keeping updated of critical information and uploading the data in no time, but could also the researcher's productivity in the back end center become better. This could improve the monitoring, planning, and responding capability of the back end headquarters. It would then be a waste if the PDA were treated only as a tool for keeping personal information. This makes the design of conduit as a basic skill for any PDA developers.

Serving as a pocket book is PDA's another benefit. We found it was easy to created pocket e-library such as references, books, guidelines, or notes for the PDA users to carry with, no matter using free or shareware tools, such as HandBase [29] or the one we designed by ourselves. It is not surprising that the PDA pocketbook applications, such like drug reference, enjoy the greatest market growth, compared to other applications [12-13].

We are a little bit conservative on the values of PDA GIS. Our results showed that it was still impractical and useless because of its lack of necessary accuracy. Low resolution of screen combined with the errors of GPS signals constrains its reliability of position information.

In this study, we selected Palm-based PDA, instead of WinCE-based one. Though the WinCE has far more functions such like providing multimedia information, Internet connection, better integration with desktop applications like Office, its expensive costs and many-but-not-so-practical functions make it a less attractive choice for us. We believe the Palm-based PDA is a better candidate for the use in public

health due to its simplicity and affordability. Moreover, both the larger development groups and far many free or shareware software further expand the values of Palm-based PDA.

In conclusion, we are optimistic on the potential of palm-based PDA in public health. We created some key applications without too much difficulty for the field services in community preventive medicine. The future real challenge in PDA will be its interface design and its great benefit would be its connection with the back end information center to make the information processing and exchanging in real time. Of course, further evaluations need to be conducted to help better understanding the effectiveness of PDA in public health and the ways to improve it.

Acknowledgements

Part of this study was supported by the grants in 2000 from the Department of Health, The Executive Yuan, Taiwan/ROC under the project: The Development of PDA Support Systems for the Community Medicine Services in Kin-Men; and from the Asia Vision Company under the project: The Study and Planning of Advanced Primary Care Service and Community Health Management Modality. Appreciate the participation and help from Miss Suwen Liou.

References

[1] Connect Anywhere, PC Magazine, July 20, 1999, Available from: URL: http://www.zdnet.com/products/stories/reviews/0,4161,2290801,00.html, Accessed Jan 24, 2002.

[2] M. Brauer, R. D. Hirtle, A. C. Hall, T. R. Yip, "Monitoring personal fine particle exposure with a particle counter", *Journal of Exposure Analysis & Environmental Epidemiology*, 9:228-236, 1999.

[3] J. Luo, R. Hales, D. Hilty, C. Brennan, "Clinical computing: electronic sign-out using a personal digital assistant", *Psychiatric Services*, 52:173-174, 2001.

[4] A. C. Roth, M. A. Leon, S. M. Milner, R. L. Herting, A. W. Hahn, "A personal digital assistant for determination of fluid needs for burn patients", *Biomedical Sciences Instrumentation*. 34:186-190, 1997.

[5] R. G. Duncan and M. M. Shabot, "Secure remote access to a clinical data repository using a wireless personal digital assistant (PDA)", *Proceedings / AMIA Annual Symposium*, 210-4, 2000.

[6] J. Reponen, E. Ilkko, L. Jyrkinen, O. Tervonen, J. Niinimaki, V. Karhula, A. Koivula, "Initial experience with a wireless personal digital assistant as a teleradiology terminal for reporting emergency computerized tomography scans", *Journal of Telemedicine & Telecare*, 6:45-49, 2000.

[7] B. A. Macke, M. Hennessy, M. M. McFarlane, M. J. Bliss, "Partner notification in the real world: a four site time-allocation study", *Sexually Transmitted Diseases*, 25:561-568, 1998.

[8] H. M. Tseng, B. Tiplady, H. A. Macleod, P. Wright, "Computer anxiety: a comparison of pen-based personal digital assistants, conventional computer and paper assessment of mood and performance", *British Journal of Psychology*, 89:599-610, 1998.

[9] G. Arnone, A. Bianchi, B. Della Pietra, R. Sernicola, E. Sparacino, R. Vitolo, "Easy Medic: an Internet application for the general practitioner", *Journal of Telemedicine & Telecare*. 4 Suppl 1:93-94, 1998.

[10] A. C. Roth, M. A. Leon, S. M. Milner, R. L. Herting Jr., A. W. Hahn, "A personal digital assistant for determination of fluid needs for burn patients", *Biomedical Sciences Instrumentation*, 34:186-190, 1997.

[11] S. M. Eyestone, "Information technology in the foxhole", *Topics in Health Information Management*, 16:20-31, 1995.

[12] The Handango Homepage – PDA Software Downloads, Available from URL: http://www.handango.com/, Access Jan 24, 2002.

[13] Available from URL: http://home.kimo.com.tw/kru24/soft.htm, Access Jan 24, 2002.

[14] The thinkingBytes Palm Database Software for PalmOS, Available from URL: http://www.thinkingbytes.com/, Access Jan 24, 2002.

[15] The NS Basic Corporation, Available from URL: http://www.NSBasic.com/, Access Jan 24, 2002.

[16] 台灣通路公司, Available from URL: http://www.gis.com.tw/, Access Jan 24, 2002.

[17] The HandMap Network, Available from URL: http://www.handmap.net/, Access Jan 24, 2002.

[18] The Rand McNally Company, Available from URL: http://www.randmcnally.com/, Access Jan 24, 2002.

[19] Available from URL: http://www.secoast.net/~jdebros/, Access Jan 24, 2002.

[20] The Palmsource, Available from URL: http://www.palmos.com/dev/tech/conduits/, Access Jan 24, 2002.

[21] The Pendragon Software Corporation, Available from URL: http://www.pendragonsoftware.com/, Access Jan 24, 2002.

[22] Available from URL: http://www.palmaster.com.tw/, Access Jan 24, 2002.

[23] 杜氏工作室 CJKOS(Chinese, Japanese, Korean Operation System) 程式下載區, Available from URL: http://www.dyts.com/en/cjkos.html, Access Jan 24, 2002.

[24] J.S. Dumas and J. C. Redish, A Practical Guide to Usability Testing, Bristol, England: Intelect, 1999.

[25] D. J. Mayhew, The Usability Engineering Lifecycle: A Practitioner's Handbook for User Interface Design, San Francisco, CA: Morgan Kaufmann Publishers, 1999.

[26] L. L. Constantine and L. A. D. Lockwood, Software for Use: A Practical Guide to the Models and Methods of User-Centered Design, Boston, MA: Addison-Wesley Pub Co, 1999.

[27] The Handspring Treo Communicator, Available from URL: http://www.handspring.com/products/treo/signup.jhtml;jsessionid=LPJZFAE0GCRMVQFIAE1CFE4AVAATKIV0, Access Jan 24, 2002.

[28] The Nokio 9210 Phone Model, Available from URL: http://www.nokia.com/phones/9210/, Access Jan 24, 2002.

[29] Available from URL: http://www.ddhsoftware.com/, Access Jan 24, 2002.

社區預防醫學服務個人數位助理支援套件之開發

張博論* 吳肖琪[1] 周碧瑟[2] 張鴻仁[3] 何捷民 張煜杰[3]

國立陽明大學衛生資訊與決策研究所
[1]國立陽明大學衛生福利研究所
[2]國立陽明大學社區醫學研究中心
[3]中央健康保險局
[4]國立陽明大學醫學放射技術學系

收件日期 2002 年 1 月 3 日；接受日期 2002 年 11 月 20 日

摘 要

田野調查與服務是公共衛生的重要工作，而新興個人數位助理(Personal Digital Assistant, PDA)正符合其在機動與資料蒐集方面的需求。但相較於醫療應用上的發展，PDA 在公共衛生領域上的應用仍相當有限。本研究的目的便在開發公衛工作的 PDA 支援套件，並討論其應用潛力與挑戰。

本研究針對社區預防醫學調查工作開發出一套以 PDA 支援套件爲主，配合工作站與網路的資訊支援系統。開發工具含 Pendragon Forms, HandMap Pro, Mapit, MakePDB, Pendragron Browser 開發套件與 NS Basic 程式設計語言。開發功能含問卷調查、地圖、隨身參考與記錄手冊、網路資訊交換，並以 VB 開發桌上端相配合之同步與資料庫管理程式。

研究結果顯示上，在核心問卷部份我們設計的兩種版本中，第一種使用商業開發軟體，在外觀上雖較簡潔，但在處理題數多、題目長、依情境跳選答題的問卷上功能相當受限。第二種則爲因應前項困難所自行開發的問卷設計與執行工具，在設計上，每一畫面僅包含一個題目，相當簡潔；在電子地圖上，依需要製作了金門地區的電子地圖；在第三項隨身參考與記錄手冊上，我們自行開發受訪對象個人資料與記錄觀察手冊；在網路資訊交換方面，我們使用將網站資訊下載至 PDA 然後離線瀏覽之模式；在後端資料庫管理上，我們則利用 Palm 公司提供的同步程式開發工具開發 PDA 資料上傳 VB 資料庫管理應用程式，然後存到 Access 2000 資料庫。

對於 PDA 在提升公衛資料管理或服務效率與成效上的潛在貢獻，我們相當樂觀。不過未來要能真正發揮其實用價值，突破「界面設計」限制，提高可用性，將是首要課題，而其真正應用價值則需能和後端資料中心結合。而以 Palm 爲平台的 PDA 因其簡單、價格經濟，相當適合公衛應用。至於 PDA 特殊的界面與操作方式，系統實用性的實證檢視，則將是未來研究重點。

關鍵詞： PDA、資訊支援系統、社區預防醫學、使用者界面設計

* 通訊作者：張博論
電話：+886-2-28267238；傳真：+886-2-28286544
電子郵件信箱：polun@ym.edu.tw