Benefits of Personal Digital Assistance in Decreasing Prescribing Errors: Preliminary Experience from a Tertiary Care Hospital

Tzong-Luen Wang, MD, PhD; Hang Chang, MD, PhD

Abstract

To prevent errors made during the prescription of drugs, we try to understand if the personal digital assistance (PDA) can have such benefits. Between January 1 2001 and March 31 2002, we surveyed the prescription orders from the intensive care units (ICUs) of a 961-bed teaching hospital and also prospectively analyzed any potentially serious prescribing errors. The PDA was introduced into prescription system in January 1 2002. Before the use of PDA, the total prescribing errors are 1,505 among the overall 144,481 orders (1.04%). Those errors can be categorized into five main factors, including work environment (670 events, 44% of total errors), team problem (190, 13%), individual factors (410, 27%), task problems (147, 10%) and patient factors (88, 6%). After the PDA era, the incidences of total prescribing errors decreased significantly compared to those before PDA use (0.58% vs. 1.04% before PDA, $P<0.001$). Further analysis revealed that the decline in errors due to problems of work environment (31%), team (4%) and tasks (5%) were the main contributing factors. As to the real incidences, there were significant decline in the factors concerning physical environment (0.3 ‰vs. 0.7 ‰, $P<0.05$), staffing (0.3 ‰vs. 2.1 ‰, $P<0.001$), communication (0.0 ‰vs. 0.4 ‰, $P<0.05$), responsibility (0.1 ‰vs. 0.6 ‰, $P<0.05$), protocols (0.0 ‰ vs. 0.4 ‰, $P<0.05$) and no routine pathways (0.3 ‰vs. 0.7 ‰, $P<0.05$). In conclusion, the PDA can diminish at least half of the common factors affecting prescription errors and also decrease half of the incidences. *(Ann. Disaster Med 2002;1:20-28)*

Key words: PDA; prescribing error; critical care

Introduction

Prescribing errors remain an essential issue in hospital management, even in disaster medicine. Because the prescribers are human, they will never make no errors, especially in a chaos environment such as in mass casualty or disaster. In the past, the response to such

From Department of Emergency Medicine, Shin-Kong Wu Ho-Su Memorial Hospital, Taipei, Taiwan
Address for reprints: Dr. Tzong-Luen Wang, Department of Emergency Medicine, Shin-Kong Wu Ho-Su Memorial Hospital, 95 Wen-Chang Road, Taipei, Taiwan
TEL:886-2-28389425 Fax:886-2-28353547 E-mail:M002183@ms.skh.org.tw

mistakes has been to focus on personal ces. However, the systems in which people work also contribute to errors. Findings of studies of industrial errors, and from the discipline of human psychology, have resulted in development of frameworks to analyze the sources of errors. Accordingly, Reason[1] has developed a flowchart that has been applied to medical error.[2]

Prescribing errors are the most common type of avoidable medication error, and are hence an important target for improvement.[3,4] In the UK and the USA, the Department of Health is committed to reducing by 40% the number of serious errors involving prescribed drugs, by 2005.[5-6] To achieve such a reduction in mistakes, Dr. Dean et al. ever conducted a prospective pilot study to understand the frequency and cause of errors after defining prescribing errors, measuring their incidence,[8] and aiming to understand their causes. They found that the hospitals, to reduce prescribing errors, should train junior doctors in the principles of drug dosing before they start prescribing, and enforce good practice in documentation. They should also create a culture in which prescription writing is seen as important, and formally review interventions made by pharmacists, locum arrangements, and the workload of junior doctors, and make doctors aware of situations in which they are likely to commit errors. Their study accountability, whatever the circumstan- also revealed that the problem of work environment and team accounted for 45% and 13% of total errors.[8]

With the advancement of electronic medical records, a well-informed clinician can respond to specific patient needs in a knowledge fashion and may therefore avoid possible errors such as those in prescription. Portable devices such as personal digital assistance (PDA) may further assist the physicians to access all available information including patients' data and drug database under any environments. The aim of our study was to investigate if using PDA could reduce the prescribing errors in the settings of a tertiary care teaching hospital.

Methods

Study Population

Between January 1 2001 and March 31 2002, we surveyed the prescription orders from the intensive care units (ICUs) of a 961-bed teaching hospital and also prospectively analyzed any potentially serious prescribing errors made by doctors for in-patients. This hospital operates a typical ward pharmacy service. Briefly, such a service involves prescribers writing medication orders for inpatients by hand onto a formated drug chart. Junior doctors or nursing staff to ascertain the doses due at each medication round and to record their administration uses this

document. Ward pharmacists routinely examine drug charts to initiate the supply of any treatments not stocked on the ward and to check that medication orders are clear, legal, and clinically appropriate. We gave pharmacists examples of what constituted a potentially serious error, based on cases from a similar study.[8] Prescribers who made the reported mistakes were then contacted to request their participation in the study, at which point we explained that our aim was to explore the reasons why prescribing errors occurred and that participation was entirely voluntary.

Any member of medical staff involved in prescribing drugs for a hospital inpatient was eligible for inclusion. Since prescribing error is a sensitive subject, we reassured prescribers of confidentiality and reminded them of the hospital's non-disciplinary policy on errors made before the start of our study. All prescribers were aware that the study was taking place, as were clinical directors and all doctors, who we wrote to individually. We also did a presentation for junior medical staff, and put up posters about the study in the common room used by junior doctors. The local ethics committee approved the study and all prescribers interviewed gave written informed consent.

Study protocol

We adapted our data collection methods from those developed to investigate clinical incidents[9] by using a review of medical notes from January 1 2001 to March 31 2002. During the study period, the PDA was introduced into prescription system in January 1 2002. By using PDA, the prescriber can enter his orders and check available laboratory data at bedside. We used the interview and the medical notes to assess reasons for the prescribing error and the potential contribution of various factors in error production.[3,10-21] The results are presented according to Reason's four-stage model of human error.[1]

Statistical analysis

We entered all transcripts into Microsoft Excel 2000, a software package used to manage qualitative data. This system allows emerging themes to be coded and linked, and the numbers of errors in which common themes arise to be counted.

Results

Rates of prescribing errors

Table 1 depicts the events and the incidences of prescribing errors in the ICUs from January 1st 2001 to December 31st 2002. Before the use of PDA (i.e. December 31st 2001), the total prescribing errors is 1,505 among the overall 144,481 orders (1.04%). Those errors can be categorized into five main factors, including work

environment (670 events, 44% of total errors), team problem (190, 13%), individual factors (410, 27%), task problems (147, 10%) and patient factors (88, 6%). In detail, the factors included in work environment were uncomfortable physical environment (110, 7%), inadequate staffing (304, 20%) and heavy workload (256, 17%). The team problems included poor communication (58, 4%), inadequate supervision (42, 3%) and unclear responsibility (90, 6%). Of the individual problems, there were poor physical health (153, 10%), poor mental health (61, 4%) and inexperienced skills and knowledge (196, 13%). The task problems comprised lack of protocol (66, 4%) and of regulation (not routine) (81, 6%). And unhelpful patient, complex clinical disease, and language barriers contributed to 1%, 4% and 1% of the patient factors, respectively.

Factors affecting the differences of error rates

After the PDA era, the incidences of total prescribing errors decreased significantly compared to those before PDA use (0.58% of the 27,381 orders from January 1st 2002 to March 31st 2002 vs. 1.04% in 2001, $P<0.001$). Further analysis revealed that the decline in errors due to problems of work environment (31%), team (4%) and tasks (5%) were the main contributing factors. As to the relative ratios of prescribing errors, the problems of staffing (5% vs. 20%, $P<0.001$), communications (0% vs. 4%, $P<0.05$), responsibility (6% vs. 2%, $P<0.05$) and protocol (0% vs. 4%, $P<0.01$) decreased significantly. On the other hand, the factors concerning mental health (4% vs. 10%, $P<0.001$), skills and knowledge (22% vs. 13%, $P<0.001$) and unhelpful patients (3% vs. 1%, $P<0.05$) increased significantly.

If we presented these data as the real incidences, there were still significant decline in the factors concerning physical environment (0.3 ‰ vs. 0.7 ‰, $P<0.05$), staffing (0.3 ‰ vs. 2.1 ‰, $P<0.001$), communication (0.0 ‰ vs. 0.4 ‰, $P<0.05$), responsibility (0.1 ‰ vs. 0.6 ‰, $P<0.05$), protocols (0.0 ‰ vs. 0.4 ‰, $P<0.05$) and no routine pathways (0.3 ‰vs. 0.7 ‰, $P<0.05$). In other words, the evolution of the above six factors might be strongly associated with the use of PDA.

Discussion

Dr. Dean[9] ever suggested that the human error theory can be applied to the causes of prescribing errors. Although the physicians who give orders must be accountable for their actions, many other factors may still result in the errors. Prescribing errors could be reduced by training, adherence to existing systems of work, through the introduction of new working

practices, and through any process that can reduce the steps completing the prescription key-in such as the use of PDA.

As to human factors, junior doctors should be trained how to ascertain the correct dose of a drug and its frequency of administration, and how to identify the indications of adjusting. New doctors may rely on pharmacists to notice and explain their mistakes. This haphazard approach is hard to justify. A young prescriber should be able to tackle new prescribing conditions, however, they should also be trained to deal with those they are expected to meet routinely.

Gillie et al. ever proposed the basis for avoiding prescription and drug administration errors.[22] This report states that a drug chart should stay with the patient, that the doctor should write prescriptions clearly, that there should be minimal transcribing of medication orders, and that all medication orders should be checked by pharmacists. Other examples of good practice that might reduce prescribing errors include documenting the reason for prescribing a drug in a patient's notes, detailing allergies on the chart, and adhering to existing prescribing policies.

In addition to enforcement of these systems, the introduction of new procedures is needed. PDA has the advantages of real-time confirmation of the prescriptions and sufficient drug information. The skills of usage are very simple for each medical staff. In our study, the PDA use has been proved to be linked with the decline in errors due to physical environment, staffing, communication, responsibility, protocols and no routine pathways. In other words, the PDA may improve the environment factor during giving orders, pass by original multi-step key-in procedures (involving many staffs), establish good communication between staffs, set up well-defined responsibility, and accomplish a routine operation pathway or protocol.

Prescribing is not only the naming of a drug. The drug should always be accompanied by its dose, form, route of administration, and prescription-writing should be recognized as a high-risk activity. The team would also benefit from discussions about prescribing details, reviewing the drug chart on rounds, and regularly reviewing prescribing errors with their ward pharmacist.

Pharmacists play a key role in preventing prescribing error in the UK.[23] The condition should always be maintained and developed as a part of a strategy to reduce prescribing errors. Pharmacists provide a supply role and also monitor prescriptions to detect any errors that arise at the most time. However, the less time that a pharmacist has to spend on each prescription, the less time they can spend checking for errors.[24,25] There are

still the shortages of pharmacists in many countries. The errors may still occur if the pharmacists' workload is heavy. Our data suggested that the use of PDA might decrease almost half of the prescribing errors before the prescriptions were presented to the pharmacists. So the risk of pharmacists may reasonably decreased and their workload may also be relieved.

In Dr. Dean's study, human beings develop models of improvement through reflexive processes. Prescribing can be improved by increasing that reflexivity, by bringing the detail of prescribing into the open, and by reviewing errors in prescribing and by sharing them openly, so that prescribers learn and patients benefit.

All the prescribing errors that we identified might have been avoided by the implementation of small measures, which could have been enacted swiftly and at little financial cost. Although our study did not make cost-effective analysis, the prescribing errors dramatically occurred which might avoid unnecessary harm (both for patients and physicians) and medical costs.

In conclusion, the PDA can diminish at least half of the common factors affecting prescription errors and also decrease half of the incidences.

Table 1. Comparison of prescribing rates before and after personal digital assistance use

		Pre-PDA Era		Post-PDA Era		
		Events (ratio)	incidence$^{(10\text{-}3)}$	Events (ratio)	incidence$^{(10\text{-}3)}$	*P* value *
work environment	physical environment	110 (7%)	0.7	8 (5%)	0.3	<0.05
	staffing	304 (20%)	2.1	7 (5%)	0.3	<0.001
	heavy workload	256 (17%)	1.8	33 (21%)	1.2	NS
team	communication	58 (4%)	0.4	0 (0%)	0	<0.01
	supervision	42 (3%)	0.3	3 (2%)	0.1	NS
	responsibility	90 (6%)	0.6	3 (2%)	0.1	<0.01
individual	physical health	153 (10%)	1.1	33 (21%)	1.2	NS
	mental health	61 (4%)	0.4	16 (10%)	0.6	NS
	skills and knowledge	196 (13%)	1.4	37 (22%)	1.3	NS
task	protocols	66 (4%)	0.4	0 (0%)	0	<0.001
	not routine	81 (6%)	0.6	3 (2%)	0.1	<0.01
patients	unhelpful	15 (1%)	0.1	5 (3%)	0.2	NS
	complex clinical disease	59 (4%)	0.4	8 (5%)	0.3	NS
	language barrier	14 (1%)	0.1	3 (2%)	0.1	NS
Total events		1505 (100%)	10.4	159 (100%)	5.8	<0.001

*P value indicates the comparisons between incidence of errors in pre-PDA era and post-PDA era
PDA: personal digital assistance

References

1. Reason J. Human error. Cambridge: University of Cambridge, 1990.
2. Vincent C, Taylor-Adams SE, Chapman EJ, et al. How to investigate and analyse clinical incidents: Clinical Risk Unit and Association of Litigation and Risk Management
   Protocol. BMJ 2000; 320: 777-81
3. Leape LL, Bates DW, Cullen DJ, et al. Systems analysis of adverse drug events. JAMA 1995; 274: 35-43
4. Bates DW, Cullen DJ, Laird N, et al. Incidence of adverse drug events and potential adverse drug events: implications for prevention. JAMA 1995; 274: 29-34
5. Expert Group on Learning from Adverse Events in the NHS. An organisation with a memory. London: Department of Health, 2000
6. Institute of medicine. To err is human: building a safer health system--report of the Committee on Quality of Health Care in America. Washington: National Academy Press, 2000
7. Dean B, Barber N, Schachter M. What is a prescribing error? Qual Health Care 2000; 9: 232-37
8. Dean B, Schachter M, Vincent C, Barber N. Causes of prescribing errors in hospital inpatients: a prospective study. Lancet 2002;359:1373-8
9. Vincent C, Taylor-Adams SE, Stanhope N. Framework for analysing risk and safety in clinical practice. BMJ 1998; 316: 1154-57
10. Lesar TS, Lomaestro BM, Pohl H. Medication-prescribing errors in a teaching hospital. Arch Intern Med 1997; 157: 1569-76
11. Lesar TS, Briceland LL, Delcoure K, Parmalee JC, Masta-Gornic V, Pohl H. Medication prescribing errors in a teaching hospital. JAMA 1990; 263: 2329-34
12. Lesar TS, Briceland L, Stein DS. Factors related to errors in medication prescribing. JAMA 1997; 227: 31 2-17
13. McEwan D. An evidence-based approach for the development of a prescribing error policy. MSc thesis, University of London, 1999
14. Vitillo JA, Lesar TS. Preventing medication prescribing errors. DICP 1991; 25: 1388-94
15. Rowe C, Koren T, Koren G. Errors by paediatric residents in calculating drug doses. Arch Dis Child 1998; 79: 56-58
16. Lesar TS. Errors in the use of medication dosage equations. Arch Pediatr Adolesc 1998; 152: 340-44
17. Bleyer WA, Koup JR. Medication errors during intensive care. Am J Dis Childhood 1979; 133: 366-367
18. Perlstein PH, Callison C, White M, Barnes B, Edwards NK. Errors in drug computations during newborn intensive care. Am J Dis

Childhood 1979; 133: 376-79
19. Lesar TS. Common prescribing errors. Ann Intern Med 1992; 117:537-38
20. Battles JB, Kaplan HS, van der Schaaf TW, Shea CE. The attributes of medical event-reporting systems. Arch Pathol Lab Med 1998; 122: 233-38
21. Neale G. Reducing risks in medical practice. In: Vincent C, ed. Clinical risk management. London: BMJ Publications, 1995: 253-75
22. Department of Health and Social Services. Central Health Services Council report of the joint sub-committee on measures for controlling drugs on the wards (The Gillie Report) HM(70)36. London: DHSS, 1970
23. Cotter SM, Barber ND, McKee M. Survey of clinical pharmacy services in United Kingdom National Health Service hospitals. Am J Hosp Pharm 1994; 51: 2676-84
24. Barber ND, Blackett A, Batty R. Does a high workload decrease ward pharmacists' clinical monitoring? Int J Pharm Pract 1993; 2: 152-5
25. Barber ND, Batty R, Ridout DA. Predicting the rate of physician-accepted interventions by hospital pharmacists in the United Kingdom. Am J Health-Syst Pharm 1997; 54: 397-405

個人數位助理在減少醫囑錯誤方面的好處：來自醫學中心醫院的初步經驗

王宗倫　張珩

摘要

我們試著了解個人數位助理（PDA**）在開處方藥時是否有預防錯誤的好處。在** 2001 **年** 1 **月** 1 **日至** 2002 **年** 3 **月** 31 **日，我們從一個有** 961 **床的醫學中心的加護病房中，研究其所釋出醫囑，並也前瞻性分析了任何潛在的嚴重醫囑錯誤。在** 2002 **年** 1 **月** 1 **日，**PDA **被引進了醫囑系統。在** PDA **使用前，所有** 144,481 **件醫囑中，錯誤件數共** 1,505 **件（**1.04%**）。這些錯誤可被歸類為五大主要因素，包括了工作環境（**670 **項，佔所有的錯誤中的** 44%**）、合作問題（**190，13%**）、個人因素（**410，27%**）、作業問題（**147，10%**）以及病患因素（**88，6%**）。與** PDA **使用前作比較，在** PDA **時代之後，醫囑錯誤發生率有顯著的減少（**PDA **使用後與使用前比為** 0.58 % vs 1.04%，$P<0.001$**）。更進一步的分析，錯誤的減少，以工作環境（**31%**）、合作（**4%**）及作業（**5%**）的改善為主要原因。就實際發生率而言，有顯著下降的醫囑錯誤因素，包括生理環境（**0.3 ‰vs. 0.7 ‰，$P<0.05$**）、工作人員（**0.3 ‰vs. 2.1‰ $P<0.001$**）、溝通（**0.0 ‰vs. 0.4‰ $P<0.05$**）、責任歸屬（**0.1 ‰vs. 0.6‰ $P<0.05$**）、作業規範（**0.0 ‰vs. 0.4 ‰，$P<0.05$**）以及沒有例行程序（**0.3 ‰vs. 0.7‰ $P<0.05$**）。因此，我們的結論是** PDA **可以減少一半造成醫囑錯誤的常見因素，並且也降低了一半的醫囑錯誤發生率。***(Ann. Disaster Med 2002;1:20-28)*

關鍵詞：個人數位助理；醫囑錯誤；重症照護

財團法人新光吳火獅紀念醫院急診科
抽印本索取：王宗倫　台北市士林區文昌路 95 **號　新光吳火獅紀念醫院急診科**
電話：(02)28389425　**傳真：**(02)28353547　E-mail:M002183@ms.skh.org.tw