

The differences in health outcomes between Web-based and paper-based implementation of a clinical pathway for radical nephrectomy

P.L. CHANG, Y.C. LI* and S.H. LEE†

*Department of Urology, Chang Gung Memorial Hospital, Chang Gung University and *Graduate Institute of Medical Informatics, Taipei Medical University, Taipei, Taiwan, and †the Department of Epidemiology and Public Health, at University College London, London, UK*

Objective To evaluate the effects of a web-based clinical pathway (WCP) for radical nephrectomy on patient care, and to compare the effects with those of a paper-based clinical pathway (PCP).

Patients and methods Patients with renal cell carcinoma and who underwent radical nephrectomy were enrolled into the study. The results of using the WCP for radical nephrectomy from July 2000 to August 2001 were compared with those using the PCP between May 1999 and June 2000. The mean hospital stay, average admission charges, six quality indicators, and the advantages of the WCP were determined.

Results Using a WCP for radical nephrectomy reduced the hospital stay and admission charges by as much as the

PCP. A similar number of patients had variances from the WCP as with the PCP ($P=0.407$), but the number of undetected variances and the variance detection time in the WCP were significantly less ($P=0.0193$ and 0.0162). Implementing a WCP also improved the quality of care by as much as a PCP.

Conclusions Using a WCP for radical nephrectomy can improve health outcomes by reducing the hospital stay and admission charges, and by improving the quality of care by as much as a PCP. Furthermore, the WCP was more accurate and faster than the PCP in detecting variances.

Keywords Web-based, clinical pathway, health outcome, radical nephrectomy

Introduction

Web-based technologies have recently been adopted in the field of medical information; much web-based education for patients, nurses and physicians has been developed [1,2]. Web-based information can also be a tool of communication among patients, nurses and physicians [3]. The possibilities include a home-helper support system, assessment of students' testing and self-monitoring, primary care education, residents' education, and clinical skills. Many advantages of web-based technologies have been reported [1–5].

Many strategies have been used by organizations to improve the quality of medical care. Quality-orientated methods focus mainly on decreasing system failure and unnecessary variations in patient-care practices, and enhance collaboration among the healthcare team members. Clinical pathways have been reported as useful tools in clinical process management [6–8]. Several clinical pathways have been adopted by home-health care, peri-operative services and ambulatory care [9,10]. The development and implementation of clinical pathways in

caring for patients are still enthusiastically supported [11].

Radical nephrectomy is the conventional means of treating patients with RCC. A paper-based clinical pathway (PCP) for radical nephrectomy gave favourable results [12]. On transferring the PCP to a Web-based clinical pathway (WCP) for radical nephrectomy, a nurse must review the daily activities of the patient and make records on the pathway. Although most nurses are familiar with computer technology, the functional limitations of inexperienced nurses remain a problem. Thus designing a useable WCP for nurses is challenging; such a system for implementing a WCP should focus on increasing its functional accessibility.

In the present investigation we evaluated the effect of using the WCP for radical nephrectomy, on the approach to patients, admission charges and the quality of medical care. The results of using the WCP were compared with those of the PCP, and the advantages of the WCP described.

Patients and methods

Patients with RCC and who underwent radical nephrectomy between May 1999 and August 2001 were enrolled

into the study. Patients were divided into two groups, i.e. those treated using the PCP, from May 1999 to June 2000, and those treated using a WCP, from July 2000 to August 2001; the results from the two pathways were compared. The mean hospital stay, average admission charges and six quality indicators were evaluated.

The PCP for radical nephrectomy was developed and formalized by the clinical pathway development team in April 1997. In July 2000, a WCP for radical nephrectomy was developed and implemented to improve health outcomes (Fig. 1). Electronic medical records (EMR) of outpatients and inpatients were introduced in 1993 at our hospital. Physicians enter their orders directly into the EMR and nurses also use the EMR to obtain patients' data. An IBM-compatible personal computer was placed at the urological nursing station to gain access to the WCP. The WCP (written in hypertext markup language), includes data-entry forms that enable users to send information to the web server. The WCP form includes familiar data-entry objects, e.g. 'fill-in-the-blank' text fields and checkboxes (Fig. 2). The WCP includes daily special forms that schedule times of patient orientation, laboratory tests, treatment, medication, activity, nutrition, elimination, education, psychosocial support, a discharge plan between day 1 and day 9, and a variance-reporting form

after day 9. The variance-reporting form includes the code number and cause of variance (Fig. 3). Before implementation, urological nurses were educated in all the procedures involved in the WCP for radical nephrectomy.

All preoperative laboratory tests were undertaken on patients on the day of their admission. An assigned nurse educated the patient and family members about the condition and the likely outcome of treatment. The nurse reviewed the daily activities of the patient, which were recorded on the WCP. When the WCP varied from the actual management the assigned nurse was expected to resolve the variation or record it on the variance-reporting form. The ward nurses were separated into three groups according to duty time, i.e. group 1 (08.00–16.00), group 2 (16.00–24.00), and group 3 (24.00–08.00). Patients' activities were recorded on the WCP mainly by the nurses in group 2 and the records were checked by nurses in group 3. Variances were defined as deviations from the WCP, including those before admission and after discharge, by the patient, physician, hospital, or on discharge, which could alter the outcome. Variances before admission and after discharge included emergency admission, transfer to another institution, patient convenience and patient refusal. Patient-related variances included clinical complications, changing of the clinical regimen

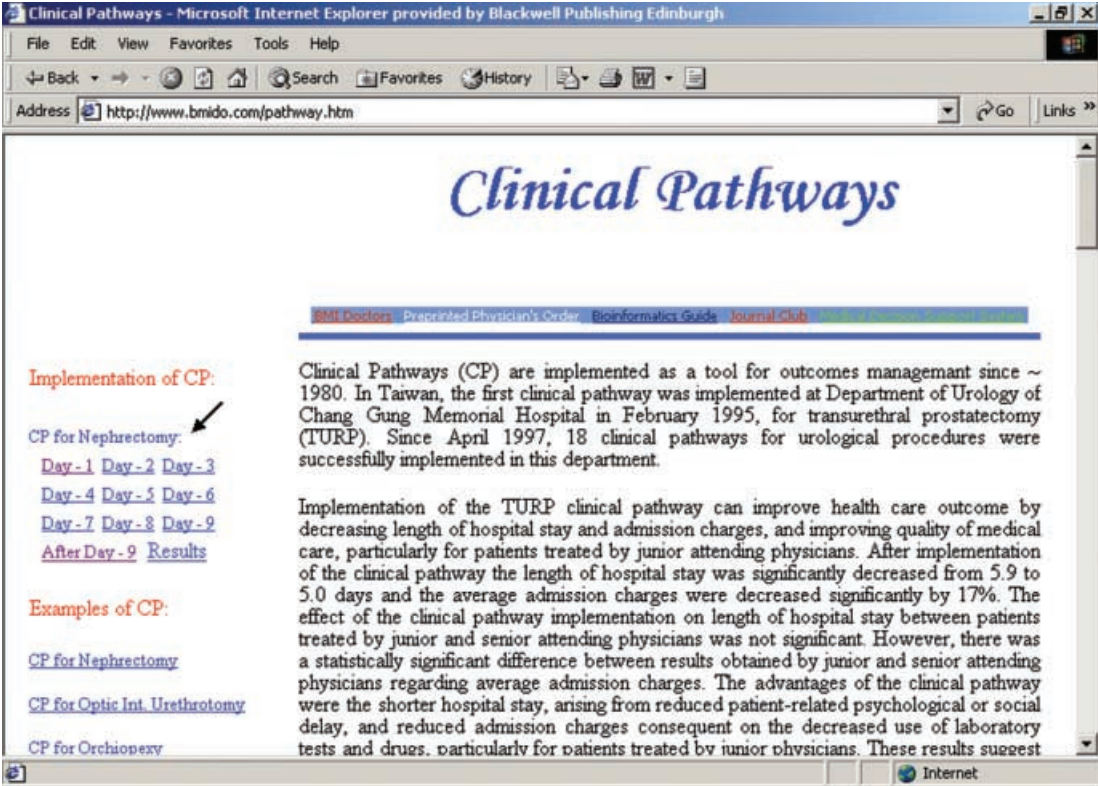


Fig. 1. The indicator for the WCP for nephrectomy (arrow).

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Clinical Pathway for Nephrectomy - Day 1

Hospital: CGMH Department: Urology

Chart No.:

Admission (Transferred) Date: -- mm/dd/yy

Pre-Operation Date: -- mm/dd/yy

Day 1 (Pre-operation day):

Consults -- ☐ OP permit ☐ Anesthesia permit ☐ Nursing preparation

Tests -- ☐ CBC/DC ☐ Chest PA ☐ EKG ☐ U/A ☐ BUN ☐ Cr ☐ GOT ☐ Sugar

☐ PT ☐ APTT

Treatments -- ☐ Weight ☐ Vital sign ☐ IV Fluid ☐ Prepare blood

Medications -- ☐ Send antibiotics to OR with P't CM

Nutrition -- ☐ NPO since midnight

Elimination -- ☐ Fleet enema

Education -- ☐ Orientation ☐ Pre/Post-op teaching

Psychosocial -- ☐ P't/family support

Discharge plan -- ☐ Admit assessment

Describe day 1 variations if necessary:

Signature:

Fig. 2. The WCP form for the nephrectomy pathway.

and psychosocial delay. Physician-related variances included physician-ordered delay, nurse delay and support service delay. Hospital-related variances included equipment workload and breakdown. Discharge variances included inadequate home support, unavailability of service and unresolved health concerns. Correctable, uncorrectable and undetected variances were also measured. The correctable variances were those that could be corrected immediately with no effect on health outcomes. Uncorrectable variances were those that could not be corrected or were obsolete. Undetected variances were defined as those discovered after a patient was discharged from the hospital. Variance detection time was defined as the period from the scheduling time to when the variance was identified, and was determined to compare the efficiency of the detection of variances between the groups.

Operations were normally arranged on the first day after admission; after surgery intravenous fluid was typically discontinued 1 day after the patients started a diet.

The Foley catheter for urinary drainage was normally removed 3 days after surgery and the drainage tube removed from the wound < 5 days after surgery. The daily record on the WCP was completed and sent to the web-server everyday, and could not be changed in any way. After the patients were discharged from the hospital the nurse completed the WCP, including the variance-reporting form. The variances were then discussed in regular meetings. The clinical pathway development team then analysed the treatment data. The results of the analysis and the variance data were stored on the web-server.

Six quality indicators were measured to evaluate the effect of the use of the WCP on the quality of care: (i) the percentage of patients to whom fluid was intravenously administered for > 1 day after starting a diet after surgery; (ii) the percentage of patients with a Foley catheter for > 3 days after surgery; (iii) the percentage of patients with a drainage tube indwelling for > 5 days; (iv) the percentage of patients with complications; (v) the percentage of in-

Fig. 3. The WCP variance-reporting form for the nephrectomy pathway.

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Clinical Pathway for Nephrectomy - After Day 9

Chart No.:

After Day 9: -- mm/dd/yy

Variations --

☐ 100 No Variance	☐ 120 Preadm./Postdisc. Variance
☐ 101 Adherence to clinical pathway	☐ 121 Emergency admission
☐ 102 Cancellations	☐ 122 Transfer to another institution
☐ 103 Preadmission testing	☐ 123 Patient convenience
☐ 104 Physician	☐ 124 Patient refusal
☐ 105 Institution	
☐ 130 Patient-Related Variance	☐ 140 Physician-Related Variance
☐ 131 Clinical complication	☐ 141 Physician-ordered delay
☐ 132 Unresponsive/change clinical regimen	☐ 142 Nurse delay
☐ 133 Psycho-social delay	☐ 143 Support service delay
☐ 150 Hospital-Related Variance	☐ 160 Discharge Variance
☐ 151 Scheduling delay due to equipment workload	☐ 161 Inadequate home support
☐ 152 Scheduling delay due to equipment breakdown	☐ 162 Other service non-availability
	☐ 163 Unresolved health concerns

Describe after day 9 variations if necessary:

Signature:

hospital mortality; and (vi) the percentage of patients readmitted within 2 weeks.

The differences between the average hospital stay, average admission charges and quality indicators of the two groups were determined. The independent Student's *t*-test was used to determine the statistical significance of the differences between the groups, and the chi-squared test to determine the differences among the variances, with $P < 0.05$ considered to indicate statistically significant differences.

Results

Sixty-one consecutive patients were treated for radical nephrectomy using the PCP from May 1999 to June 2000 (group 1) and 63 consecutive patients using the WCP from July 2000 to August 2001 (group 2). The numbers

of patients who underwent radical nephrectomy did not differ significantly between the groups (Table 1), and the mean hospital stay was similar (no significant difference). The proportions of men and women, mean patient age and admission charges were also not significantly different between the groups.

The total number of variances and patients with variances were similar; the most common variances were patient-related, followed by physician-, hospital- and then discharge-related, in both groups, with no significant differences. There were no variances before admission or after discharge in either group. The number of correctable and uncorrectable variances did not significantly differ between the groups but the number of undetected variances was significantly less in group 2 (three) than in group 1. The mean variance detection time in group 2 was significantly less than that in group 1 (Table 1).

Table 1 Demographic characteristics, length of hospital stay, admission charges, patients with variances and quality indicators for both groups

<i>Variable</i>	<i>Group 1</i>	<i>Group 2</i>	<i>P</i>
No. of patients	61	63	0.6780
M/F	39/22	38/25	
Mean (range) age, years	58 (25–82)	56 (19–80)	0.5385
Hospital stay, days	10.1	9.9	0.6914
Admission charges (NT\$)	77512	75178	0.7330
Variances			
Total no. of variances	54	42	0.2990
Number (%) of: patients with			
variances	20 (33)	15 (24)	0.4070
patient-related	25 (46)	22 (52)	0.5956
variances			
physician-related	17 (32)	10 (24)	0.1073
variances			
Hospital-related	11 (20)	9 (21)	0.5743
variances			
Discharge variances	1 (2)	1 (2)	0.9818
Correctable	26 (48)	25 (60)	0.7698
variances			
Uncorrectable	16 (30)	14 (33)	0.6059
variances			
Undetected variances	12 (22)	3 (7)	0.0193
Average variance	0.79	0.48	0.0162
detection time, days			
Quality indicators, n (%) of patients			
(i)	10 (16)	10 (16)	0.7637
(ii)	20 (33)	16 (25)	0.2172
(iii)	22 (36)	13 (21)	0.1069
(iv)	3 (5)	2 (3)	
(v)	0	0	
(vi)	0	0	

Values in bold are significant differences.

The six quality indicators of the WCP did not differ significantly from those in the PCP (Table 1). There were very few surgical complications after surgery, with three in group 1 and two in group 2 (too few for statistical comparison). There were no deaths in hospital and no rehospitalization within 2 weeks of discharge.

Discussion

The Web is accessible to a large population, with many providers of on-line health information available [13]. The turnaround time and cost of obtaining survey information through the Web can be considerably reduced and it may enhance completion rates [14]. Over the last few years, web-based surveys, clinical monitoring systems for elderly

patients, materials for medical education and distance education programmes have been reported to show good results [14–17]. However, the web-based implementation of clinical pathways has not been reported previously.

Clinical pathways outline laboratory tests, medication, therapy and nursing care plans that are essential to obtain a desired health outcome [18]. The clinical pathway has recently been reported to be useful as a tool for monitoring health outcomes and has emerged as a successful strategy for improving the quality and cost-effectiveness of medical care [19,20]. Many clinical pathways have been used at various medical centres [21,22]. A patient, their family and hospital can all benefit from the continuous use of clinical pathways [23,24]. At the authors' hospital, the first clinical pathway for TURP was implemented in February 1995. Since April 1997, 18 clinical pathways for urological operations were implemented in our department. Using clinical pathways can improve practice by reducing the length of hospital stay and admission charges, and by improving the quality of medical care [11]. In 2000, use of the PCP for radical nephrectomy improved the physician's practice [12] and thus we consequently developed and implemented a WCP for radical nephrectomy in July 2000 to allow a comparison with the PCP.

Regular nurses in the urological ward were trained before using the WCP for radical nephrectomy, and physicians and healthcare staff familiarised with the WCP. Nurses were continually trained throughout the year of the study to facilitate implementation.

In the PCP a special sheet and a variance-reporting form were included in the patient chart to track daily activities and record deviations from the pathway [18]. However, this chart was sometimes used by a doctor. The ward nurse assigned to a patient had to wait for the chart when he/she wanted to record the patient's activity on the pathway form. Using the WCP the special form and variance-reporting form were always available; the personal computer at the nurse station was only used to implement the WCP. The nurse could record and review daily activities on this form at any time and thus the WCP is clearly more convenient to the ward nurse than a PCP.

The demographic characteristics of patients managed using the WCP and PCP were similar; our previous report showed that the PCP for radical nephrectomy improved physician practice by reducing the hospital stay and admission charges to less than those before implementing the PCP [12]. Using the WCP, the hospital stay and the admission charges were less than with the PCP but not significantly. Therefore, the WCP reduces the hospital stay and admission charges by at least as much as the PCP.

Implementing clinical pathways is a complex and multifaceted task. The variances from clinical pathways

must be analysed to evaluate their effectiveness and identify areas requiring change [25]. Consequently, computerising patient outcomes and variances in the pathways is important in implementing a WCP. Any minor deviation was immediately corrected or recorded on the variance-reporting form for discussion at a later meeting. In the authors' experience, variances from the PCP declined significantly after implementation, and there was no difference when using the WCP, except in the number of undetected variances and the detection time, which were significantly less than with the PCP, suggesting that the WCP was more accurate and faster than the PCP.

The improvement in the quality of care when using a PCP was confirmed in previous reports [11,12,18,26]; in the present study three important quality indicators of patient care improved when using the WCP (although not significantly), and thus the WCP improved the quality of care by as much as the PCP.

A universal record which incorporates patient, nursing, administrative and physician input will be the desired aim for an integrated care pathway. Based on the WCP, a web-based decision-support system for creating, implementing and evaluating the clinical pathway could be developed in the future.

The advantages of the WCP for radical nephrectomy are: (i) a special sheet and variance-reporting sheet need not be prepared for any patient; (ii) nurses can record patients' daily activities at any time and do not need to wait for the paper chart; (iii) any variances are easily and quickly detected; (iv) a reduction in hospital stay, admission charges and quality equal to that of the PCP; (v) the nurse completes the clinical pathway and can transfer it to the clinical pathway development team with one keystroke; (vi) the data are captured directly in electronic format, facilitating and accelerating analysis. The two disadvantages of the WCP are that nurses must be keyboard and Internet literate, and that nurses cannot record the patients' activities at the point of care. The latter disadvantage could be overcome by installing the WCP on a palmtop or hand-held computer.

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Authors

P.L. Chang, MD, Chief,

Y.C. Li,

S.H. Lee,

Correspondence: Phei Lang Chang, Department of Urology, Chang Gung Memorial Hospital, No. 5, Fu-Shing Street, Kweishan, Taoyuan 333, Taiwan.

e-mail: henryc@tmu.edu.tw

Abbreviations: **PCP**, paper-based clinical pathway; **WCP**,

Web-based clinical pathway; **EMR**, electronic medical records.