Pathways in Multidisciplinary Oral Health Care as a Tool to Improve Clinical Performance

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Purpose: To investigate the optimization of multidisciplinary and interdisciplinary oral health care through the introduction of pathways. ***Materials and Methods:*** A prospective randomized clinical trial was carried out in a tertiary referral academic institution. Ninety-one patients admitted for multidisciplinary oral health care from January 1, 2001, to March 31, 2003, were randomized to the test group (n = 50) or to the control group (n = 41). Pathways were implemented by means of the Medical Patient Management program, a computerized planning and coordination system specifically developed for a population with multidisciplinary oral rehabilitation needs. The efficiency of pathways in interdisciplinary oral health care was assessed. ***Results:*** Statistically significant differences between test and control groups were found for variables regarding the process of care, such as "number of planned versus actual disciplines," "length of planned versus actual treatment," and "average length of a treatment session." For variables regarding patient satisfaction, significant differences between test and control groups were found for questions regarding patient involvement with the treatment and patient satisfaction with the outcome of multidisciplinary treatment. Regarding practitioner satisfaction, the results of the questionnaire indicate that implementation of pathways into everyday clinical practice is desired but remains difficult. ***Conclusion:*** The findings of this study show that the implementation of pathways in multidisciplinary oral health care improved some aspects of the process of care and increased patient satisfaction. The predictive capability of the Medical Patient Management program in managing oral health care has been demonstrated. *Int J Prosthodont;19:227–235.*

Because of the complexity of human oral health care and the multitude of highly innovative techniques, emphasis is increasingly being placed on health care conducted by groups of clinicians belonging to different disciplines. In recent years, this movement toward multidisciplinary patient-focused oral health care has created new clinical teams. Ideally, all teams should work together to obtain the best result. Increased specialization may lead to better knowledge of and experience with the discipline and consequently to better health care, but it also carries certain risks, such as inappropriate organization, inefficient patient care, and growing costs.

To optimize patient management, universities and hospitals are establishing multidisciplinary and interdisciplinary departments and programs. While multidisciplinary care refers to teams working in parallel or sequentially from their specific disciplinary base to address a common problem, interdisciplinary care teams work jointly but still from a discipline-specific base to address the problem. Literature on the topic suggests that interdisciplinary research and patient care are much more challenging than multidisciplinary research and patient care.[1]

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In an attempt to improve clinical effectiveness by introducing a multidisciplinary and interdisciplinary approach in patient care, clinical pathways have been implemented in the past. Initially, the pathways were used for the management of nursing care,[2] but they have been extended to patient-focused care in basically every discipline of health care. A *clinical pathway* (synonyms: critical pathways,[3] integrated care pathways,[4] care maps,[2] collaborative care pathways[5]) is defined as the sequence for standardized, interdisciplinary processes or clinical events that must occur for a particular case type to move the patient toward the desired outcome within a defined period of time.[6] Clinical pathways break down the process of care into different activities and assign the different tasks to individual team members. The goal of the concept is to ensure high-quality and efficient patient-focused care. The pathway allows each discipline involved in the patient's care to determine the critical elements of care (milestones) with their expected time course, cost, and outcome and to define the coordination of their application. Clinical pathways offer a structured means of developing and implementing local protocols of care using evidence-based clinical guidelines.

A clinical pathway may consist of a single multidisciplinary record that is part of the patient's clinical record, and aims at an interdisciplinary use. A clinical pathway should *(1)* be patient-centered, *(2)* implement evidence-based management guidelines, *(3)* reflect consensus-based multidisciplinary practice, *(4)* provide detailed documentation of the clinical process, and *(5)* facilitate the audit of process and outcome. Pathways should be specific to a particular setting and to a specific diagnosis and are therefore usually unique to the institution in which they are developed. A clinical coordinator facilitates the introduction of the pathways, educates staff, reviews the patient's progress, and explains the plan of care to the patient when appropriate. The coordinator may also be involved in analyzing the causes of variation from the pathways and in revising the pathways so that they represent the best current practice.

Clinical pathways and derivative tools may provide a number of benefits: *(1)* they reduce errors and ineffective practice[7]; *(2)* they identify patients who fail to progress as expected, allowing early and appropriate intervention[8]; *(3)* they may anticipate problems and be proactive; and *(4)* they allow better communication and coordination between disciplines, preventing duplication of clinical care and minimizing delays in investigation and treatment.[5,9] Further, clinical pathways also provide a means of updating knowledge, increase the educational opportunities for new staff and junior clinicians,[10] and enhance practitioner and patient satisfaction.

Key factors influencing the success of pathway implementation are: *(1)* the central role of the clinical coordinator, *(2)* access and availability of the multidisciplinary record, *(3)* pathway reminders—the form and the timing of reminders are crucial to influence the clinical decision prospectively, *(4)* simplicity and user-friendly formats, and *(5)* credibility (evidence based). Similar findings have been reported in surveys performed elsewhere.[11,12]

Unfortunately, the effectiveness of clinical pathways in improving clinical efficiency is still unclear in several disciplines of medicine. Saint et al[13] investigated whether clinical pathway implementation has been successful in reducing patient length of stay and resource utilization. Although some pathways did reduce length of stay, resource utilization, or both, most pathways reduced neither. Because substantial resources must be expended on pathway development, implementation, and maintenance, the authors concluded that future efforts should be placed on further evaluating the effectiveness of critical pathways and understanding the reasons behind their success or failure. In a literature review, Campbell et al[14] evaluated publications on integrated care pathways. Of the estimated 4,000 references to integrated care pathways and related topics published worldwide, most described the experience and recorded perceived benefits or concerns associated with their use or practical barriers to implementation. They identified no randomized controlled trials. Many of the reports in nursing and health management journals are either descriptions of experience in developing and using integrated care pathways or simple, uncontrolled before-and-after studies. These reports do not provide reliable evidence, and publication bias is highly likely.

The current study aimed at investigating in a prospective randomized trial the effect on clinical performance of the introduction of pathways in the treatment of patients in need of multidisciplinary oral care. A computerized planning system, the Medical Patient Management (MPM) program, was used to plan and coordinate the sequence of activities according to the specific, multidisciplinary need of a patient, and it was then assessed whether the introduction of a planning system led to improved clinical efficiency. We also aimed to investigate the attitudes of the patients, the practitioners, and the undergraduate students toward the introduction of clinical pathways.

Materials and Methods

Survey Instrument

A Microsoft Access–based software package for multidisciplinary oral care planning, the MPM program,

Table 1 Some Examples of the Algorithm in the MPM Program

Domain	Bloc	Tasks
Orthodontics	Fixed appliance therapy	Bonding Monthly follow-up
Orthodontics	Rapid palatal expansion without surgical assistance	Impression with bands Placement of the fixator Weekly follow-up Fixation
Maxillofacial surgery	Bilateral sagittal split osteotomy	Check third molars Surgical planning Hospital admission Surgery Hospital dismissal First follow-up after surgery Weekly follow-up for 2 weeks Follow-up 2 months after surgery

was developed and used at the School of Dentistry of the Catholic University of Leuven, Belgium. The MPM program organizes the clinical rehabilitation team around the multidisciplinary patient in the elective oromaxillofacial specialty. The patient is regarded as a member of the team. The MPM tool describes the sequence of multidisciplinary clinical events that must occur for a particular case type to move the patient toward the desired outcomes within a defined period of time. Therefore, the oromaxillofacial speciality is subdivided into domains or disciplines (such as periodontics, orthodontics, maxillofacial surgery, prosthetic dentistry, etc), blocs (within a domain), and tasks (within a bloc). Domains, blocs, and tasks have a time relationship within and between each other. A task can be scheduled before, after, or together with another task. Cross-time relationships of tasks from one bloc with a task belonging to another bloc, or even to a different domain, are possible. Standardized treatment plans are integrated into the system, but adaptation by subtracting or adding tasks, blocs, and domains is possible. Once the selected domains and blocs are introduced, the system organizes the correct sequence of activities. For example, introducing the bloc "bilateral sagittal split osteotomy of the mandible" automatically introduced "removal of third molars" 9 months before the start of the treatment. Examples of the algorithm used in the MPM program are shown in Table 1 and Fig 1. The correspondence information of each member of the team involved in treatment of the patient was brought into the system, thus facilitating messaging when necessary.

The MPM program was used to set the clinical pathway for all patients of the test group. Each pathway described the tasks to be carried out, along with the timing and the sequence of these tasks and the discipline involved in completing each task. The use of clinical pathways was thought to support patient care management but not to influence the quality of treatment as such. Accordingly, no informed consent procedure was

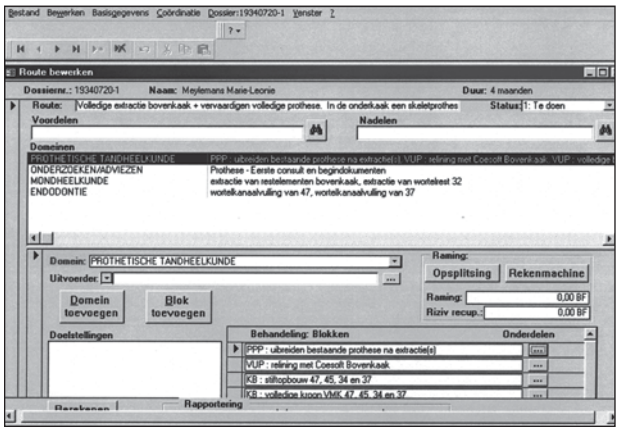

Fig 1 MPM screenshot.

undertaken. The pathway was added to the patient's medical file as a single multidisciplinary record and the patients received care according to the pathways.

Study Design

Between January 2001 and March 2003, 91 consecutive patients in need of multidisciplinary oral health care with at least 3 disciplines were selected for the study. The disciplines (domains) involved were endodontics, implant dentistry, temporomandibular joint dysfunction, pedodontics, oral and maxillofacial surgery, radiology, orthodontics, periodontics, prosthetic dentistry, and restorative dentistry. Patients were randomly allocated either to the test group (n = 50) or to the control group (n = 41). For all patients, the consensus view of the care and treatment proposal was agreed upon in a meeting with experienced staff belonging to the 5 departments of the School of Dentistry (Conservative, Prosthetic, Orthodontic, Oral Surgery, and Periodontic departments). For the patients in the test group, this information was entered into the MPM database by the first author and the individualized clinical pathway was

set up. For patients in the control group, the treatment course was set according to the common procedure by use of the information in the medical files. Treatment course consisted of the different disciplines needed to complete the proposed treatment, together with the sequence of the treatment sessions and the minimum amount of time needed to accomplish the treatment. This record was not part of the patient's medical file but was stored separately by the clinical coordinator. It was used at the end of treatment to enable comparison of planned activities with the actual data of the control group. Patients in test and control groups received care by the same treatment staff.

Patients belonging to the test group were informed by mail at the beginning of their treatment, and the aim of the MPM program was outlined. They received a printout of the multidisciplinary record, with which they could follow the course of their treatment and the minimum period of time (in days) needed to finish the treatment. They were asked to participate actively in the study by recording the time spent in the dental chair as well as the time spent in the waiting room on the "Contact Time" form. They were also asked to record cancelled appointments, either by the patient or by the practitioner, on the form. Patients selected for the control group received only the "Contact Time" form and were asked to record the above-mentioned parameters during their treatment. To reduce missing data, the scheme was added into all patients' medical files at the inner front page. Members of the different departments were asked to fill in the form accurately at the end of each treatment session.

In December of 2000, all members of the School of Dentistry, including undergraduate students, were informed orally as well as in writing about the implementation of the study. To remind practitioners about the selected patients, a colored MPM sticker was put on the front page of the 91 patients' medical files.

Survey questionnaires were distributed among patients, practitioners, and undergraduate students immediately following completion of the treatment. Completion of the treatment was defined as the date of the follow-up session 1 to 2 weeks after completion of treatment, the date of the last appointment if treatment was not completed, or March 31, 2003, the ending date of the MPM study.

The first section of the questionnaire for the patients elicited information about sociodemographic factors (age, education, profession, place of living). In the second section, the involvement and satisfaction with the treatment was evaluated by means of questions consisting of "Yes" or "No" responses and ratings on a visual analogue scale (VAS). The patients were asked to send the completed questionnaire back with the "Contact Time" form.

The questionnaire for practitioners and undergraduate students aimed at evaluating the need for improvement of interdisciplinary patient care and the effectiveness of the implementation of the pathways in the School of Dentistry, as well as its efficiency in multidisciplinary patient care. Also investigated was the need for introduction of a "central intake unit," where all patients attending the School of Dentistry for the first time would be concentrated.

Questionnaires were returned anonymously, meaning that nonresponders could not be traced individually. Reminders were distributed to all patients 4 to 8 weeks after initial distribution.

Data Recording

Different variables were recorded for both test and control groups to evaluate the process of care, patient satisfaction, practitioner satisfaction, the adequacy of the study methodology, and the educational characteristics of clinical pathways. The criteria of judgment and the different variables are defined in Tables 2 and 3.

Statistical Methods

In the first part of the analysis, all 91 patients (full data set) were included and the following variables were analyzed for test and control groups: *(1)* number of patients who completed treatment versus number of patients included in the group, *(2)* number of patients who ceased their treatment versus number of patients included in the group, and *(3)* number of questionnaires received from patients versus number of patients included in the group. For all variables, a z-statistic with the Yates continuity correction was used for testing the equality of proportions. In the case of small expected values, the Fisher exact test was used.

In the second part of the analysis, patients who ceased treatment were excluded, reducing the sample sizes to 47 patients in the test group and 33 patients in the control group. The following variables were analyzed for each patient: *(1)* number of planned versus actual sessions, *(2)* number of planned versus actual disciplines, *(3)* length of planned versus actual treatment, *(4)* average length of treatment per session, *(5)* average time spent in the waiting room, *(6)* average number of planned sessions, and *(7)* average number of actual sessions. For the first 5 variables, the nonparametric Wilcoxon rank sum test was used for detecting differences between the 2 groups. To obtain a more objective measure of discrepancy for the variables "number of planned versus actual sessions," "number of planned versus actual disciplines," and "length of planned versus actual treatment," the absolute value of the planned minus the actual variables

Table 2 Criteria of Judgment

Criteria	Parameters
Process of care	No. of patients who completed treatment No. of patients who ceased treatment No. of disciplines (planned/actual) Length of the treatment (planned/actual) Average length of a treatment session No. of sessions (planned/actual)
Patient satisfaction	Response rate to the patient questionnaire Information on the treatment course Personal involvement with the treatment Outcome of the treatment Communication between practitioners
Practitioner satisfaction	Effectiveness of implementation of the pathways Efficiency of pathways in patient care Involvement of the practitioner in the setup of the pathway Flexibility of the pathway Effect of implementing pathways on communication between practitioners
Adequacy of study methodology	Average time spent in the waiting room No. of planned sessions No. of actual sessions
Educational characteristics of clinical pathways	VAS score to offered record

Table 3 Definition of Terms

Term	Definition
No. of patients who completed treatment	No. of patients who followed the entire course of the proposed treatment. No further treatment was needed except for follow-up sessions.
No. of patients who ceased treatment	No. of patients who started the multidisciplinary treatment but ceased treatment for various reasons.
No. of planned sessions	No. of sessions needed to offer patient care according to the MPM multidisciplinary record and to guide the patient toward the desired treatment outcome.
No. of actual sessions	No. of sessions with the patient present. From the first technical act until the follow-up session 1 to 2 weeks posttreatment, or until the last session if treatment was ceased, or until March 31, 2003 if the treatment was not yet finished when the study was ended.
No. of planned disciplines	No. of disciplines needed to offer patient care according to the MPM multidisciplinary record and to guide the patient toward the desired treatment outcome.
No. of actual disciplines	No. of disciplines the patient was in contact with during the treatment period.
Length of the planned treatment	Period of time (d) between the planned starting date of the treatment and the planned ending date of the treatment.
Length of the actual treatment	Period of time (d) between the start of treatment and the end of treatment (date of the follow-up session/date of the last session/March 31, 2003).
Average length of a treatment session	The duration (min) of the whole treatment divided by the number of sessions.
Average time spent in the waiting room	The total time (min) spent in the waiting room divided by the number of sessions.

was used. For the last 2 variables, a *t* test assuming unequal variances was used when normality was detected and a Wilcoxon test was used when not.

For the VAS scores of the patient questionnaire, the relative values (ie, the reported score divided by the total line length) were used to test for difference between the 2 groups using a permutation test. Missing values were present but excluded from the calculations.

The significance level for each test in both parts was set at $\alpha = 5\%$. Power analysis was performed for the variables "number of patients who ceased their treatment versus number of patients included in the group" and "number of planned versus actual sessions." The analysis was based on the bootstrap method because of the relatively small sample size. All analyses were performed with the statistical package S-PLUS 6.1 (Insightful, Professional Edition, Release 1).

Results

The results of the recorded variables for the full data set are shown in Table 4. The response rate of the patient questionnaire was significantly higher in the test group compared to the control group ($P = .025$).

The results for the variables "number of planned versus actual sessions," "length of planned versus actual treatment," and "average length of a treatment session" are shown in Figs 2 to 4. The results for the variable

Table 4 Results of the Full Data Set for Test and Control Groups

Variable	Observed proportions (absolute numbers)	
	Test group	Control group
No. of patients who completed treatment versus number of patients included in the group	0.78 (39/50)	0.6585 (27/41)
No. of patients who ceased treatment versus no. of patients included in the group	0.06 (3/50)	0.1951 (8/41)
No. of questionnaires received versus no. of patients included in the group	0.84* (42/50)	0.6098* (25/41)

*Values were statistically significant different between test and control groups ($P = .025$).

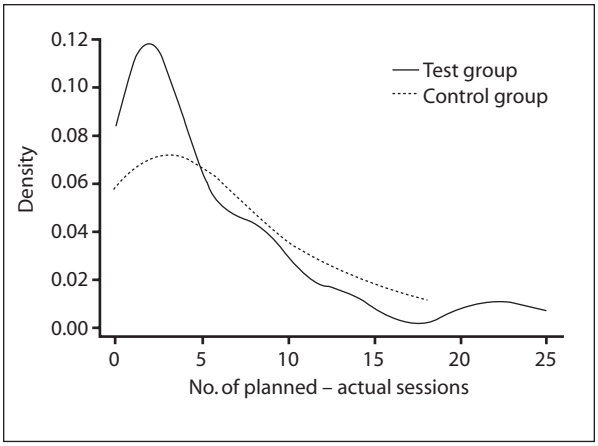

Fig 2 Frequency of patients with an absolute difference between the number of planned versus actual sessions in test and control groups. No statistically significant difference was found between the median absolute value for test (3.0) and control (4.0) groups. Density is equivalent to frequency and represents, for values on the x-axis with corresponding high/low densities, a high/low frequency (probability) of patients having these values.

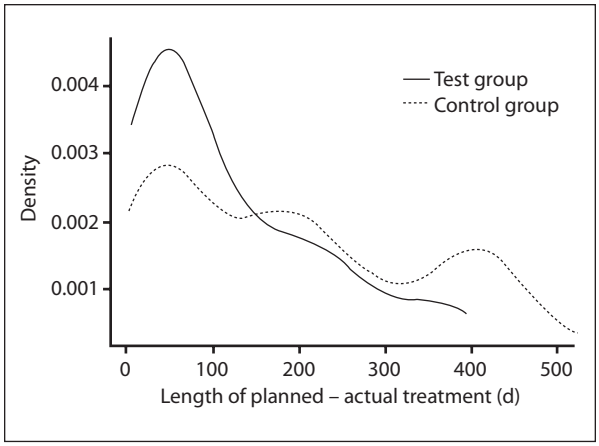

Fig 3 Frequency of patients with an absolute difference between the length of planned versus actual treatment in test and control groups. A statistically significant difference was seen between the median absolute value for test (69.0) and control (180.0) groups ($P = .0456$). Density is equivalent to frequency and represents, for values on the x-axis with corresponding high/low densities, a high/low frequency (probability) of patients having these values.

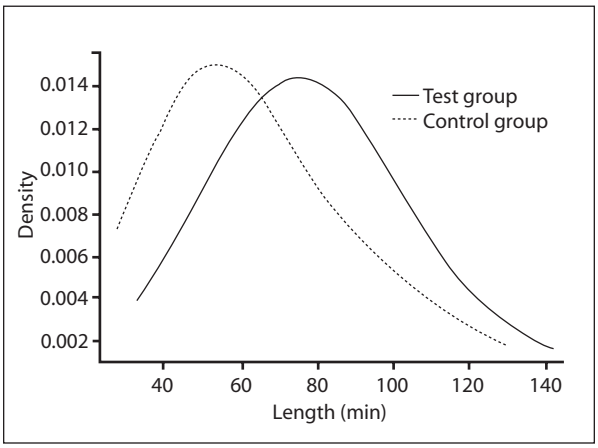

Fig 4 Frequency of patients for the variable "average length of a treatment session" in test and control groups. A statistically significant difference was seen between the median average length of a treatment session for test (77.58) and control (59.33) groups ($P = .0053$). Density is equivalent to frequency and represents, for values on the x-axis with corresponding high/low densities, a high/low frequency (probability) of patients having these values.

"number of planned versus actual disciplines" are shown in Table 5. Significant differences between the 2 groups were found for the variables "number of planned versus actual disciplines," "length of planned versus actual treatment," and "average length of a treatment session."

The VAS ratings of the patients' questionnaires are shown in Table 6. Significantly different scores between test and control groups were found for the questions, "I didn't have the opportunity to give feedback during the treatment period" and "I am satisfied with the result of my treatment."

Regarding the questionnaires of the undergraduate students, the response rate was 100%. Only 38.3% of the respondents noticed the multidisciplinary record in the patient's medical file and 23.4% of them studied the record. More than two thirds (72.7%) of the undergraduate students who had studied the multidisciplinary record claimed that it gave them a better insight into the treatment planning of a patient.

Table 5 Results for the Variable "No. of Planned Versus Actual Disciplines" for Test and Control Groups

	Absolute value of planned minus actual no. of disciplines		
Group	0	1	2
Test	32*	12**	3***
Control	8†	24††	1†††

Corresponding values for test group*,**,*** and control group†,††,††† are statistically significant different (P = .0001).

Table 6 Results (VAS Scores*) of the Patient Questionnaire

	Test group		Control group	
Question	Minimum	Maximum	Minimum	Maximum
I received the information I needed	0.4333	1.0000	0.0936	1.0000
I received the information I needed in time	0.1333	1.0000	0.0625	1.0000
I received too much information	0.0000	0.4187	0.0000	0.8625
I felt involved during the treatment period	0.4467	1.0000	0.0750	1.0000
I didn't have the opportunity to give feedback during the treatment period	0.0000*	0.5563*	0.0000†	0.9187†
It cost me a great effort to attend the appointments	0.0000	0.9733	0.0000	0.6125
I am satisfied with the result of my treatment	0.6267**	1.0000**	0.0313††	1.0000††
The communication between the different departments of the School of Dentistry is well established	0.0667	1.0000	0.0500	1.0000

For the VAS scores, the relative values (reported rating divided by the total line length) are presented. No = 0 and Yes = 1. Significant differences between test and control† groups (P = .0105). Significant differences between test** and control†† groups (P = .0265).

Regarding the questionnaires of the practitioners, the response rate was 59.3%. Although all respondents were in favor of the implementation of a multidisciplinary planning program in the School of Dentistry—as expressed by the unanimous affirmative answer to the question, "Do you think a weekly planning meeting with the presence of an experienced member of each department would be useful to plan a multidisciplinary treatment?"—only half of them used the multidisciplinary record enclosed in the patients' medical files. Of the respondents, 93.8% agreed with the proposed treatment planning.

Discussion

The development of a pathway with input from an experienced member of each department of the School of Dentistry and the implementation of the MPM program in multidisciplinary patient care seemed to be effective in identifying the multifaceted needs of an individual and in improving clinical performance. Clinical performance is a broad concept and was evaluated in our study by identification of 3 groups of parameters, namely the process of care, patient satisfaction, and practitioner satisfaction. The results of the present study showed significant differences between the test group and the control group for several variables regarding the process of care and patient satisfaction.

The proportion of patients who started but for various reasons did not complete the multidisciplinary treatment was smaller in the test group compared to that in the control group. A statistically significant difference was nearly reached (P = .0596). Power analysis of the test revealed a moderate power value of 0.459, indicating that a significant result might be expected if the study were performed with a bigger sample size.

For the variable "number of planned versus actual disciplines" (Table 4), the absolute value was 0 for a larger number of patients belonging to the test group compared to the number of patients in the control group, indicating that the number of planned equaled the number of actual disciplines. In case of a wrongly predicted number of disciplines (one or more disciplines), the majority of the patients belonged to the control group. These differences between test and control groups reached statistical significance, indicating that the introduction of pathways improved this aspect of the process of care.

For the variable "length of planned versus actual treatment," the results are shown in Fig 3. A small absolute value for this variable was observed for a larger proportion of patients in the test group than in the control group, indicating that the MPM planning and coordination program was efficient in predicting the length of the multidisciplinary treatment.

The average length of a treatment session was significantly higher for patients in the test group compared to those of the control group (Fig 4). This may indicate that treatment sessions for patients in the test group were longer because of the combination of multiple multidisciplinary technical acts in a single treatment session. This finding is in agreement with data published by Delpierre et al[15] and points toward superior control of the process of care for the patients belonging to the test group. However, viewing this result as in accordance with the results for the variable "number of planned versus actual sessions" was not possible. Although it seemed that more patients in the test group had a small absolute value for this variable compared to the number of patients in the control group (the peak observed in Fig 2), the spread of the data was such that we could not claim a difference. Because of the low power value (0.064), a much larger sample size is required to reveal a significant difference for this variable.

The results of the questionnaires were both qualitative and quantitative. Both research strategies were used to produce a general picture of the attitudes of patients, practitioners, and undergraduate students toward the introduction of pathways.

Regarding the patients' satisfaction, the patient questionnaire response rate was significantly greater for the test group, indicating greater patient compliance with the treatment than in the control group (Table 4). Significant differences between test and control groups were found for the questions regarding involvement with the treatment and satisfaction with the multidisciplinary treatment (Table 6).

The results of the practitioners' questionnaires reveal a common demand for the use of a multidisciplinary planning and coordination system in the School of Dentistry. The implementation of pathways may have organizational repercussions, such as the need for a "central intake unit." At this primary care facility, the goal-planning process is set during the patient's first visit by experienced members of the different departments. The role of a clinical coordinator is of utmost importance to streamline the treatment course and to coordinate the "dispatching" of the patient to the different departments. Although all respondents were in favor of the organizational changes necessary to implement pathways, only half of them used the MPM multidisciplinary record. This result indicates that the integration of clinical pathways into everyday clinical decision making in dentistry is not evident. Possible reasons might be that *(1)* some clinicians still regard dentistry to be a special "art," thus hindering the acceptance of standardization in the treatment process; and *(2)* practitioners are not aware of the existence of specific clinical pathways. The fact that more than one third of the respondents reported a lack of awareness of individualized clinical pathways underscores the need for a more systematic and transparent method of pathway implementation.

On the one hand, the results of the undergraduate students' questionnaires confirm the above-mentioned difficulties when implementing pathways; on the other hand, they also emphasize the educational characteristics of clinical pathways. They provide a means of updating knowledge in multidisciplinary patient care and enhance the educational opportunities for junior staff and undergraduate students.

Analysis of the variables "average time spent in the waiting room," "average number of planned sessions," and "average number of actual sessions" for both test and control groups was added to gauge whether the randomization procedure of the present clinical trial was well performed. The fact that no statistically significant differences were found between the 2 groups for these variables emphasizes the randomized patient allocation.

Weaknesses of the study were the single-center setup and varying staff attendance during the treatment-planning meetings of the patients. The study was conducted in a single center, and care was given to all patients by the same treatment staff. It is possible that the treating behavior of the practitioners was influenced by the multidisciplinary MPM record enclosed in the file of the test patients and differed from the care given to the patients belonging to the control group. This bias could limit the differences found between the 2 groups. As a result of varying attendance of the practitioners of the different departments of the School of Dentistry during the treatment-planning meetings, it could be argued that the established clinical pathways were not always representative of the treatment-planning process of the multidisciplinary team as a whole within the center, and this could then jeopardize the results. A strength of the study was that it measured patient outcomes. However, concentrating on the evaluation of the patient's outcome as a measure of the success of the implemented clinical pathways might be insufficient, given the difficulties of interpreting data on the small numbers and the uneven participation of the patients.

While clinical pathways focus on improved treatment quality, increased team efficiency, and improved patient satisfaction, the question remains whether better planning and coordination of multidisciplinary dental treatment may lead to cost reduction. In the present study we did not focus on the economic aspects evolving from the introduction of clinical pathways in the School of Dentistry. But as no significant differences were found between the planned versus the actual number of sessions, we might suppose that the present study with the MPM program did not lead to cost reduction as such.

Conclusions

Limitations notwithstanding, the results of the present study demonstrate the synergy generated from collaborative working and reveal that implementation of pathways in multidisciplinary oral health care improved some aspects of the process of care and increased patient satisfaction. The full potential of the MPM program system within the School of Dentistry is still to be recognized. However, it provides a mechanism for the continuous evaluation of treatment course and outcome of patients with multidisciplinary oral rehabilitation needs and supports the drive toward interdisciplinary clinical effectiveness in patient care.

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Literature Abstract

Mathematical derivation of the minimally acceptable all-porcelain margin angle

Very few researchers have investigated the minimally acceptable porcelain margin angle required to withstand the seating stresses of a crown restoration with porcelain margin. The physical properties that are crucial in porcelain margin fracture were determined to be the tensile strength of the porcelain, the axial reduction, the diameter of the tooth, the margin angle, and the seating force. A mathematical model was used to calculate this porcelain margin angle. The authors went on to conclude that: *(1)* tensile stress was found to be the most crucial factor for calculating the minimally acceptable porcelain margin angle; *(2)* seating force of the restoration was directly proportional to the minimally acceptable margin angle; *(3)* thickness of the porcelain margin was inversely proportional to the minimally acceptable margin angle; and *(4)* assuming a seating force of 100 N and a porcelain margin thickness of 1.5 mm, a minimal porcelain margin angle of 33 degrees was calculated. An in vitro study of this mathematical calculation would be interesting.

Dalvit DL, Jackson RA, Hawkins MC, Parker MH. *J Prosthet Dent* 2005;93:467–472. **Reference:** 12. **Reprints:** Dr Deborah L. Dalvit, 1987 Winsome Lane, Adams, TN 37010. Fax: 270-956-0375. E-mail: Deborah.Dalvit2@se.amedd.army.mil—*Ansgar C. Cheng, Singapore*