The impact of the Dental Practicality Index on treatment planning

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Key points

- A systematic approach to enhanced dental treatment planning.
- Assists in identifying the complexities of dental treatment.
- Provides a framework to aid patient discussion.

Abstract

Aim To compare the treatment planning decisions made by undergraduate and postgraduate dental students before and after training on the use of the Dental Practicality Index (DPI).

Methodology One hundred and eight undergraduate and postgraduate dental students were randomly assigned to test (DPI) or control groups. The baseline knowledge was assessed in the first session; both groups were shown 15 clinical scenarios and asked to assign one of four treatment plan options (no treatment, simple treatment, complex treatment or extract). The most appropriate treatment plan had been agreed by a consensus panel of experienced dentists. The test group was then trained on the use of the DPI. In the second session, both groups were shown the same clinical scenarios again in a different order and asked to assign one of the four treatment plan options. Both groups completed the confidence questionnaire.

Results Training with the DPI improved the test (DPI) group mean scores from 9.1 in the first session to 10.3 out of 15 in the second session, which was a statistically significant difference ($p = 0.005$) when compared to the control group mean scores of 8.9 in the first session to 9.2 out of 15 in the second session. The mean confidence score of the students was 6.5 out of 10. There was no correlation between self-reported confidence scores of the students and the treatment planning result scores.

Conclusions The DPI aids in the systematic assessment and appropriate treatment planning of dental restorative problems by dental students.

Introduction

Dental treatment planning can be challenging and requires the clinician to consider many inter-related factors to devise a coherent treatment strategy. The tooth's endodontic and periodontal status, as well as the structural integrity (the restorability), must be assessed. These factors must also be contextualised in relation to the patient's medical and dental conditions, as well as the patient's expectations and the clinician's clinical skills (the context).[1]

The General Dental Council learning outcomes highlight treatment planning as an essential clinical skill for a registered dental practitioner.[2] However, there has been minimal literature published on the teaching of treatment planning and there is no consistent teaching format in dental curricula.[3] Treatment planning has been shown to be one of the most important skills for a graduate dental student to develop to prepare them for clinical practice.[4] However, it has been found that undergraduate dental students felt less confident in formulating a comprehensive treatment plan and knowing when to refer a case when compared to the confidence they felt in performing other clinical tasks.[5] These findings were similar to a study of 186 newly qualified dentists and their educational supervisors, with 56% of the educational supervisors reporting that the trainees were 'poorly' or 'very poorly' prepared for diagnosis and treatment planning in general practice.[6]

This has led to the introduction of various treatment planning indices which aid clinical decision-making. However, in practice, many clinicians have found that these guides are sometimes too complex or time-consuming to complete, resulting in a poor uptake in their use.[7] Other indices limit the guidance to just one aspect of dental treatment and therefore do not offer the clinician a holistic approach to treatment planning. The Tooth Restorability Index (TRI) assesses the restorability of a tooth by quantifying the volume and position of the remaining dentine into a numerical score.[8] The index assesses the suitability of a single cuspal coverage restoration and does not take into consideration the periodontal or endodontic status of the tooth in question or any other aspect of the patient's oral and overall health.

The American Association of Endodontists' Endodontic Case Difficulty Assessment takes into account the difficulty of 17 aspects relating to endodontic treatment.[9] It considers patient factors, such as the medical history, mouth opening and gag reflex, as well as treatment considerations such as tooth position, morphology, radiographic findings and periodontal disease. However, the comprehensive and complex nature of the assessment was found to be a disadvantage;

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it has been found that the guide was used by less than 10% of American general dental practitioners (GDPs) due to the time taken to complete the form.[7] To improve the uptake of case assessment forms, a simplified index was developed: the Dutch Endodontic Treatment Index (DETI). This form took 1–2 minutes to complete by 90% of the clinicians and discriminated between uncomplicated and complicated endodontic cases.[10] Although simple to complete, it only focuses on the complexity of endodontic treatment and does not consider the periodontal status, overall restorability of the tooth or patient factors.

The Restorative Dentistry Index of Treatment Need (RDITN) was developed to produce an index which would allow dental restorative treatment need to be identified and ranked by complexity.[11,12] The RDITN is separated into four complexity components: periodontal, endodontic, fixed and removable prosthodontic treatment assessment. Each complexity component is assessed as low (1), moderate (2) or high (3) and then a 'modifying factor' can be applied. The modifying factors are specific to each component and attempt to assess the biomedical and psychological aspects of providing dental treatment. The RDITN aims to convert clinical findings into numerical data which can indicate the complexity of treatment need and be used to allocate funding to provide these services. These indices measure the severity of the need, but do not indicate the complexity of providing the treatment for individual patients or monitor the progress or success of treatment; it also does not apply to the treatment of children.[13] The reproducibility of the root canal treatment assessment component of the RDITN was evaluated and, although it was found to be easy to use, the grading system was incomplete and there were reproducibility issues, such as the potential for variable interpretation of root canal access, angulation and negotiability.[14]

The Dental Practicality Index (DPI) (Table 1) weighs the structural integrity, periodontal status and endodontic status of the tooth, and crucially puts these in context with the local and general factors, such as the state of (or absence of) nearby teeth and the social, dental and medical history.[15] The DPI aims to encourage clinicians to plan treatment systematically and holistically, and crucially to improve confidence in assessing which treatments are within the clinician's competency and when to refer to secondary or tertiary (specialist) care for appropriate advice and/or management. The endodontic treatment need, periodontal treatment need, tooth structural integrity and context are individually evaluated and scored as '0' if no intervention is required, '1' if simple treatment is required, '2' if the treatment is more complex and '6' if it would not be practical to treat. Additional scores are given for 'context', which are modifying factors which may complicate or have an impact on the treatment plan; for example, radiotherapy of the head and neck region, caries rate, intravenous bisphosphonate medication or active periodontal disease. The cumulative score from each of these categories is added to give the overall DPI score – a DPI ≥6 indicates that restoring the tooth may not be advisable and alternative treatment should be discussed.

The effectiveness of the DPI to predict the outcome of root canal re-treatment has been evaluated.[16] The study found that, for a molar tooth with a DPI score below 3 (Table 1), there was a favourable outcome of 96%, compared to a 74% favourable outcome for a molar tooth with a DPI score above 3. This represents a tenfold greater chance of a favourable outcome if the DPI is below 3, indicating that the systematic evaluation of a tooth using the DPI can give a good prediction of the outcome for root canal re-treatment, which therefore helps clinicians formulate treatments plans; that is, whether it is practical to consider treating a tooth versus no treatment or extraction.

Table 1 Dental Practicality Index, adapted with permission from A. Dawood *et al.*, 'The Dental Practicality Index – assessing the restorability of teeth', *British Dental Journal*, 2017, Springer Nature[15]

Weighting	Tooth structure integrity	Periodontal treatment need	Endodontic treatment need	Context
0 No treatment required	Unrestored Existing restoration ok	Probing <3.5 mm (BPE 0–2) Periodontal disease treated	Vital pulp Existing RCT ok	**Local:** Adjacent teeth are healthy
				General: History of IV bisphosphonates, head and neck radiotherapy
1 Simple treatment required	Simple direct or indirect restoration Suitable for GDP	Probing 3.5–5.5 mm (BPE 3) RSD suitable for hygienist or GDP	Simple RCT Canal(s) visible, straight	**Local:** Will this tooth be a bridge abutment?
				General: Planned radiotherapy of head and neck region, immunocompromised patient
2 Complex treatment required	Minimal sound tooth Subgingival margins Post-core	Probing >5.5 mm (BPE 4) Short root Crown lengthening Grade 2 mobility Grade 2–3 furcation involvement	Complex root canal system Sclerosed canal(s) Acute curvatures Fractured instrument removal Perforations	**Local:** Prosthodontic treatment planned of multiple teeth
				General: High caries rate Poor oral hygiene Parafunctional habits Extensive tooth surface loss Active periodontal disease
6 Impractical to treat	Inadequate structure for ferrule	Untreatable periodontal disease	Untreatable root canal system	**Local:** Keeping the tooth would compromise a simple plan; for example, one remaining over-erupted tooth affecting denture construction
				General: Potentially life-threatening medical conditions where the objective of dental treatment is pain relief only

Key:
BPE = Basic Periodontal Examination, RCT = root canal treatment, IV = intravenous, RSD = root surface debridement

The aim of this study was to compare the treatment planning decisions made by the undergraduate and postgraduate dental students, before and after training on the use of the DPI.

Materials and methods

Dental students

Ethical approval was obtained from King's College London (KCL) Ethics Committee (Remas: RESCM-18/19-6993) and University of Central Lancashire (UCLan) Ethics Committee (STEMH 1008). Undergraduate and postgraduate students were asked to volunteer to participate in the multi-centre study. Each student was given a written information leaflet and consent form, detailing the purpose of the study and that their involvement was voluntary. The participants were advised that they could withdraw from the study at any point, and were given details on how their confidentiality and anonymity would be maintained as well as how the data from the study would be stored and handled in accordance with the General Data Protection Regulation 2016.

The dental students represented a range of experience levels. The undergraduate students were in their third or fourth year of training at KCL or UCLan and the postgraduate students were dental core trainees or studying for a diploma in endodontics at KCL.

The dental students were randomly assigned to one of two groups: the test group and the control group. In the first session, both groups were shown the same 15 clinical scenarios and asked to assign a treatment plan; this gave a baseline test score for each student, allowing statistical analysis to take into account the variation in baseline knowledge of each student. The test group was then trained on the use of the DPI, while the control group left the room. In the second session on the same day, both groups were then shown the same clinical scenarios as in the first session but in a different order and asked to assign a treatment plan. For completeness and fairness to the participating volunteers, the control group was trained on the use of the DPI following completion of the second session (Table 2). Both groups completed the confidence questionnaire, using a ten-point Likert scale.

Case scenarios

Clinical scenarios of 15 teeth with periapical radiographs and clinical photographs were included in the study (Figures 1 and 2). The

Table 2 Sequence of testing for the test group and the control group

Session	Test group	Control group
First session	Confidence questionnaire 15 clinical scenarios	Confidence questionnaire 15 clinical scenarios
	↓	↓
Second session	Training on DPI	Leave the room
	↓	↓
	15 clinical scenarios (different order)	15 clinical scenarios (different order)
	↓	↓
	Leave the room	Training on DPI

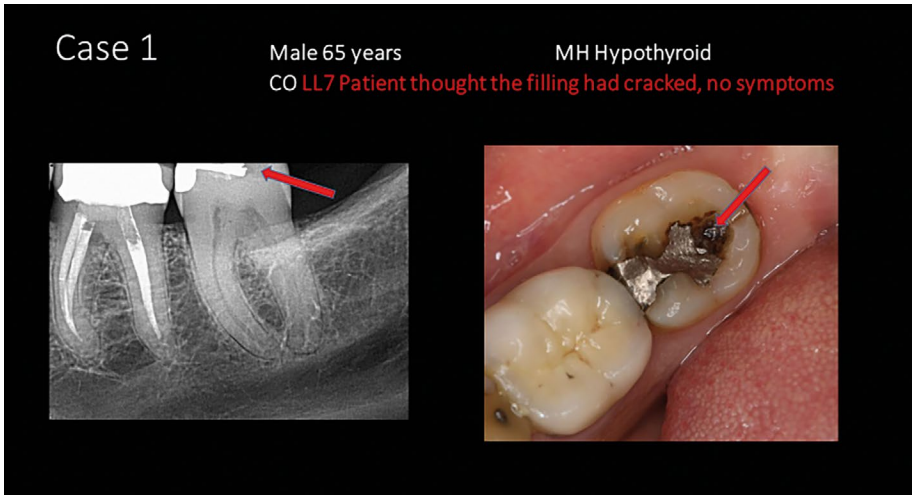

Fig. 1 One of the clinical case scenarios used for treatment planning

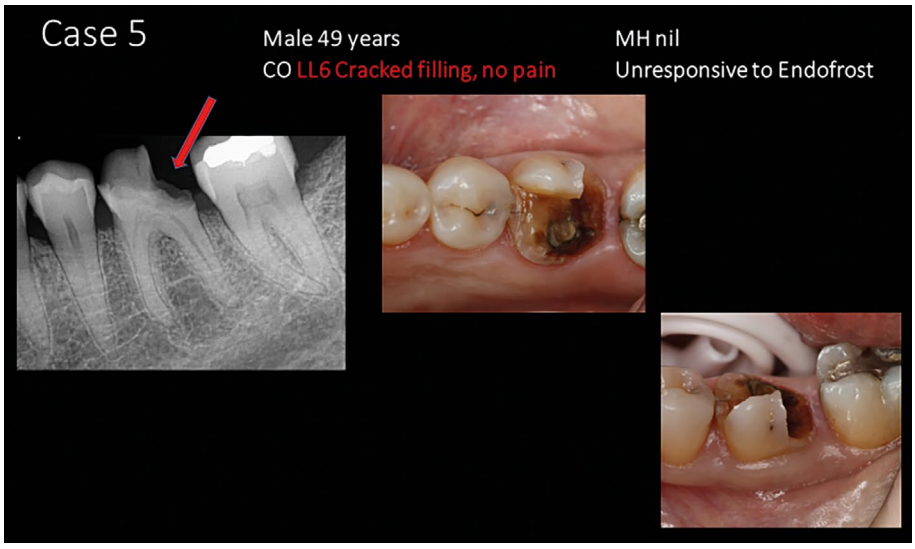

Fig. 2 One of the clinical case scenarios used for treatment planning (case 5 in session one = case 3 in session two), adapted with permission from N. Patel *et al.*, 'Unconscious racial bias may affect dentists' clinical decisions on tooth restorability: a randomized clinical trial', *JDR Clinical & Translational Research* (Volume 4, Issue 1), pp 19–28, copyright © 2019 by International & American Associations for Dental Research, reprinted by permission of SAGE Publications, Inc[28]

cases were chosen to represent a range of clinical scenarios that would typically be encountered in primary care. Each of the 15 cases had been assigned a treatment plan (Table 3) by a consensus panel of three experienced dental educators who were all involved in designing and implementing dental curricula and teaching undergraduate and postgraduate dental students, as well as working in specialist referral practice.

Table 3 Treatment options assigned to clinical scenarios

DPI score	Treatment plan	Explanation
0	No treatment	No treatment or review
1	Simple treatment	Straightforward treatment/GDP level
2	Complex treatment	Recognise the complexities of treatment Additional training may be required to complete the case successfully or referred to secondary or tertiary care
6	Extract	Impractical to treat (leave or extract)

Table 4 Showing mean scores in the first and second treatment planning sessions (KCL = King's College London, UCLan = University of Central Lancashire)

Students	Mean score			
	First session		Second session	
	Test group	Control group	Test group	Control group
KCL undergraduate students	7.4	7.1	8.6	7.4
UCLan undergraduate students	9.2	9.4	10.2	9.6
KCL postgraduate students	10.5	9.8	11.6	10.2
All students	9.1	8.9	10.3	9.2

Table 5 Comparing the dental student answers in first treatment planning session to the consensus group answers

108 test and control groups – answers for first treatment planning session							
Case scenario	Expected answer	No answer	No treatment	Simple	Complex	Extract	% agreement
1	Simple	1	4	103	0	0	95%
2	Extract	1	1	15	8	83	77%
3	Complex	1	0	26	74	7	69%
4	Simple	1	1	64	27	15	59%
5*	Complex	0	2	77	6	23	5%
6	Extract	0	0	7	36	65	60%
7	Complex	1	4	45	57	1	53%
8	Extract	0	2	14	45	47	44%
9	No treatment	1	96	9	1	1	89%
10	Complex	0	50	11	42	5	39%
11	Simple	0	7	98	3	0	91%
12	Extract	1	0	58	7	42	39%
13	Extract	1	12	61	2	32	30%
14	Complex	0	0	24	72	12	67%
15	Simple	1	9	98	0	0	91%

Key:
* = case 5 in session one = case 3 in session two

The dental students were shown the 15 clinical scenarios on a PowerPoint presentation (Microsoft Office 365, Microsoft Corporation, Redmond, WA, USA) and asked to assign one of the four treatment plan options – no treatment (score 0), simple treatment (score 1), complex treatment (score 2) or extract (score 6) – for each clinical scenario. The clinical scenarios were assessed in quiet seminar rooms. The data were entered on to an Excel database (Microsoft Office 365, Microsoft Corporation, USA) and statistically analysed (Excel Analysis, Microsoft Corporation, USA). Frequencies were used to examine the responses of the dental students compared to the consensus panel and to describe the demographics of the dental students.

Results

Demographics

In total, 108 undergraduate and postgraduate dental students participated in the study, with 47 males and 61 females. The test group consisted of 24 males and 30 females, with an age range of 20–46 years. The control group consisted of 23 males and 31 females, with an age range of 21–51 years. The mean age of both the test and control group was 27 years.

The mean self-reported confidence level of the dental students in the test group was 6.5 and in the control group was 6.6, out of a maximum confidence score of 10 on the Likert scale. There was no correlation between the students' self-reported confidence levels and the score they achieved in the first treatment planning session.

The mean score for the first treatment planning session was 9.1 and 8.9 for the test and control group, respectively. Following training with the DPI, the test group mean score increased by 1.2 to 10.3 in the second treatment planning session and the control group score marginally increased by 0.3 to 9.2 in the second treatment planning session (Table 4). An unpaired two-tailed t-test was conducted to compare the mean difference in scores of the test group and the control group, finding a statistically significant difference with $p = 0.005$.

The majority of dental students agreed with the consensus panel in 10 out of the 15 clinical scenarios in the first treatment planning session. The percentage of agreement ranged from 5% to 95%. In 11 out of the 15 clinical

scenarios, the most frequently given answer by the dental students agreed with the consensus panel answer (Table 5).

The majority of dental students agreed with the consensus panel in ten out of the 15 clinical scenarios in the second treatment planning session following training on the DPI. The percentage of agreement ranged from 31% to 91%. In 14 out of the 15 clinical scenarios, the most frequently given answer by the dental students agreed with the consensus panel answer (Table 6).

Discussion

The aim of the study was to investigate how training dental students on the use of the DPI influenced their treatment planning decisions for a variety of restorative dental problems. The study of 108 undergraduate and postgraduate dental students found a statistically significant difference in treatment planning answers following training on the DPI ($p = 0.005$), achieving a greater level of agreement with the consensus panel. The study methodology utilised a test-retest method and an experimental control method to evaluate the effect of the training on the students' treatment planning decisions.

It would seem logical to assume that any training would improve the skills of all students; however, this will only be the case if the training is effective. To know if the training is having the desired impact requires evaluation and testing of the training techniques employed. The Kirkpatrick Model is a four-step evaluation for analysing educational programmes, taking into account the reaction to training, learning evaluation, behavioural change and organisational performance.[17] This study demonstrated learning evaluation by showing that the training was effective at influencing the way the dental students evaluated dental restorative treatment planning. Further research could be done to evaluate behaviour change and assess how the students utilised these techniques in future clinical practice.

The methodology minimised sampling bias, and improved external validity by conducting the study at two centres (KCL and UCLan) and including both undergraduate and postgraduate dental students. The variation in baseline knowledge of the undergraduate and postgraduate dental students was taken into account by conducting a baseline test and measuring the change in scores for each student following training on the DPI or no additional training. The internal validity was improved by managing confounding variables; that is, by randomly assigning the students to the groups, having a control group and conducting the study on the same day which maintained 100% participation throughout the study. Undertaking the first and second treatment planning sessions on two different days to allow more time for the test group to become familiar with utilising the DPI was discussed; however, it would have been very difficult to ensure that the test group did not discuss the DPI with anyone in the control group between the first and second sessions, so to reduce this risk, the first and second sessions of the study were conducted on the same day in both centres.

The use of a consensus panel to formulate an opinion on a given topic has sometimes been called the method of last resort, as it is not clear if the answer derived by the panel is actually 'correct'. However, a consensus panel can be useful when unanimity of opinion on a topic does not exist due to insufficient scientific evidence or when the evidence available gives differing results. In constructing the consensus panel, it is important to maximise the benefits of having an informed panel consider the problem, while minimising the problems associated with collective decision-making.[18] The quality of a consensus panel can be improved by ensuring diversity, with each panel member having variation in clinical training, speciality and experience with differing socioeconomic, racial and ethnic groups.[19] In this study, the panel members were chosen for their diverse experience in undergraduate and postgraduate teaching and treating patients in multiple specialist restorative practices. Each panel member independently reviewed the clinical scenarios and assigned a treatment plan based on the DPI; where differences existed, these cases were discussed collectively to achieve consensus – there was a high level of inter-rater reliability between the panel members.

The study found high levels of agreement between the dental student treatment plan answers and the consensus panel treatment plan answers. In 11 out of the 15 clinical scenarios in the first treatment planning session, the most frequently given answer by the dental students agreed with the consensus panel answer, and following training with the DPI, the most frequently given answer by the dental students agreed with the consensus

Table 6 Comparing the test group dental student answers in second session to the consensus group answers

54 test group answers for second treatment planning session							
Case scenario	**Expected answer**	**No answer**	**No treatment**	**Simple**	**Complex**	**Extract**	**% agreement**
1	Simple	0	0	45	9	0	83%
2	Extract	0	0	17	18	19	35%
3*	Complex	0	0	16	20	18	37%
4	Complex	0	0	4	46	4	85%
5	Complex	0	22	4	17	11	31%
6	Complex	0	2	12	40	0	74%
7	Extract	0	7	15	11	21	39%
8	Simple	0	3	49	2	0	90%
9	Extract	0	0	2	13	39	72%
10	Extract	0	1	0	4	49	91%
11	Complex	0	0	6	47	1	87%
12	No treatment	0	46	2	5	1	85%
13	Simple	0	1	26	23	4	48%
14	Simple	0	3	49	2	0	91%
15	Extract	0	0	4	8	42	78%

Key:
* = case 3 in session two = case 5 in session one

panel answers in 14 out of the 15 clinical scenarios in the second treatment planning session. Training on the DPI assisted the dental students to assess the clinical scenarios with a systematic approach, which helped to identify if additional challenges were present. However, even with training, some variation in treatment planning decisions were still present. Variation in clinicians' treatment planning decisions has been attributed to the ambiguity of clinical data, variations in its interpretation, uncertainty of the presence of disease and uncertainty about the effects of treatment.[20]

The clinical scenario shown in Figure 2 had the largest degree of disagreement between the dental students' answer in session one and the consensus panel answer, with 71% of dental students choosing the option 'simple treatment (GDP level)'. The consensus panel assigned this case 'complex treatment' and thought that this case would require additional training for the treatment to be completed, as the case requires root canal treatment; with no canals visible in the mesial root and calcified pulp chamber, a post-core would be required due to loss of coronal tooth structure and the distal margin is 1 mm above the alveolar crest, necessitating crown lengthening to achieve a good margin on sound tooth for the cuspal coverage restoration. The confidence expressed by the dental students in their ability to treat this case may reflect their lack of experience and ability to assess the complexities of the case, and may indicate unconscious incompetence.[4] However, following training with the DPI, the test group students' level of agreement with the consensus panel answer increased (Table 6). Training on the DPI increased the dental students' agreement with the consensus panel to 37%, indicating that the DPI assisted the students in identifying the complexities of treating this case.

The study found no correlation between the self-reported student confidence and the treatment planning result scores, which concurs with a previous systematic review of the literature on self-reported levels of competence in medical doctors.[21] The systematic review concluded that, although the quality of the evidence was poor, the evidence does suggest that clinicians have a limited ability to accurately self-report their level of competency. The complexity of assessing how confidence relates to competence has been evaluated, and it has been found that it lacks objectivity and is biased by the beliefs and values individuals hold about themselves. When a clinician is faced with clinical uncertainty and unknowns, they need to assess if they can perform the procedure and know when to stop if they are unsuccessful. An over-confident clinician may undertake procedures without fully appreciating and evaluating the risks, and may not have the competency to adequately carry out the procedure, whereas an under-confident but competent clinician may struggle to work independently. Ideally, a clinician should be able to temper confidence with a knowledge of their personal limitations and weaknesses, and have the ability to self-evaluate their own competence.[22]

Decision-making is influenced by the dentist's training and competency, patient preferences, and environment and resource factors, such as equipment availability. McCaul *et al.*[23] found that diagnosis and treatment decisions for endodontic conditions varied depending on the dental speciality training of the dentist. It has also been noted that there is considerable bias in making clinical decisions due to the limitations in human memory and judgement.[24] In a review of 11 decision-making studies, ten were focused on the variation of dentists' treatment planning, with many studies showing a wide variation among dentists. However, establishing that variation in treatment planning occurs is only one aspect in decision-making; research should now be focused on aiding improvements in establishing diagnoses, criteria for treatment, cost-benefit analysis and integration of patient preferences.[25] It has been found that reflecting on and discussing complicated treatment planning cases can also be a useful way of highlighting issues in treatment planning which may not have been initially apparent and may aid the clinician to provide practical and predictable treatment.[26]

Studies into decision-making have attempted to address this variation by providing a common model on which to base dental practice and standardise treatment, but there is a lack of research-based evidence to formulate coherent guidelines. Some have questioned if variation is always undesirable and that strict adherence to guidelines could reduce the innovation necessary for continued development of the knowledge base. It may also have the potential unintended effect of an increased risk of litigation if a clinician does not follow the guidelines.[23] However, it has been found that decision aids can have a positive effect on clinician-patient communication, with a decrease in decisional conflict relating to the patient feeling uninformed. Following a consultation using a decision aid, patients felt they had an increased knowledge of their condition and were equally or more satisfied with their treatment decision.[27]

The DPI provides a structured format to assess the inter-related factors which should be taken into consideration during the dental treatment planning process, including when to seek advice and consider referral to a more experienced clinician. It also encourages reflection and providing holistic patient-centred care by assisting the clinician in the decision-making process, rather than providing rigid guidelines on what treatment should be provided. The index helps to methodically assess the patient and highlights potential complications with treatment, which can then be discussed with the patient before commencing treatment, to manage the patient's expectations and provide the best treatment for the patient's own unique circumstances.

Conclusion

This study demonstrated that training with the DPI aids in the systematic assessment and appropriate treatment planning of dental restorative problems by dental students. Further large-scale studies will be required to enhance the validity of the results and assess the long-term impact of the training.

Conflict of interest

The authors declare no conflicts of interest.

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