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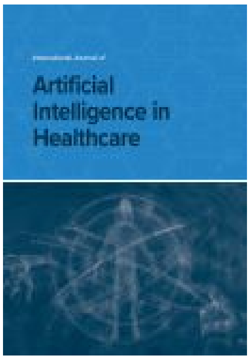

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An AI-based clinical decision support system for management of dental treatment

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Abstract: Dentists have diverse opinions about using AI-based clinical decision support system (CDSS) for abutment teeth selection used for attachment retained removable partial dentures (AR-RPD). Several studies have been done on factors affecting prognosis of abutment teeth. Dental decision support system (DDSS) helps in improving decision making process and provides substantial benefits in decreasing errors and assisting self-assurance in abutment selection. In this paper, we are proposing a DDSS based decision support system for managing dental issues. The system validation has been assessed by the knowledgeable prosthodontists. Cronbach's alpha and Pearson's correlation coefficient tests in SPSS were used to measure the system's reliability. Cronbach's alpha test displayed 0.918, which demonstrates internal consistency and agreement about the system's validity in creating the consistent and excellent quality management. Thus, the proposed DDSS will aid in determining the suitable abutment teeth used in AR-RPD to increase the patient's satisfaction.

Keywords: attachment retained removable partial dentures; AR-RPD; dental decision support system; DDSS; decision-making process.

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Biographical notes: Noha Algallai is a dedicated dentist. She is an affiliated faculty at University of Washington. She is a member of the American Dental Association (ADA) and the Washington State Dental Association (WSDA). She makes an effort to provide high care for her patients' health. She is passionate and has kind interactions with people, loves art, pays attention to detail, and strives to combine her creative and scientific skills to help her patients with their oral care.

Rami Muadab believes that a healthy body needs healthy teeth. By restoring missing teeth, he is not just restoring aesthetics and boosting self-esteem, but he is also restoring function. In order to chew food well you need healthy teeth. By restoring the teeth, he restores quality of life. He has an interest in treating complex and challenging cases that require interdisciplinary treatment, aesthetic cases, porcelain laminate veneers, full mouth rehabilitation, implant dentistry, crowns and bridges, and removable dentures.

Robert Flinton is a dentist specialising in prosthodontics and endodontics. He graduated from the State University of New York at Buffalo in 1966. He was the Chairman of Prosthodontics Post Graduate Program UMDNJ (currently retired). He published 28 articles in professional refereed journals. He is known for his skills in diagnosing and treating dental issues, as well as providing advice on proper dental prosthetics, such as crowns and bridges.

Hind A. El-Hammali is a prosthodontist and the lead prosthodontist at ClearChoice Harrisburg. She previously served as an Assistant Professor in the Department of Restorative Dentistry at Rutgers School of Dental Medicine. Her clinical expertise includes dental implants, full-mouth reconstruction, and digital dentistry. She is dedicated to advancing patient-centred care and mentoring the next generation of prosthodontists.

This paper is a revised and expanded version of a paper entitled 'Decision support system for selection of abutment tooth used for attachment in removable partial dentures' presented at Greater New York Dental Meeting, New York, 27 November 2022.

1 Introduction

Partial edentulism, resulting from losing one or more teeth, can impact a patient's overall health by causing inadequate nutrition and a consequent decrease in body mass index (BMI). It also adversely affects social and psychological well-being by reducing confidence and changing facial appearance while speaking, smiling, and eating. Various treatments address partial edentulism and help prevent complications associated with tooth loss, such as adjacent teeth tilting, rotating, and supra eruption (Stancić et al., 2014). Therefore, managing treatment for partially edentulous areas is a crucial aspect of prosthodontics in clinical practice (Abdurahiman et al., 2013). Significant decision-making in prosthodontic treatment is based on clinical outcomes and patient satisfaction (Cronin et al., 2009). In the case of tooth loss, the desire for replacement is understandable. Tooth loss is comparable to a chronic medical condition and requires long-term management (Griffin and Kinmonth, 2000).

Managing tooth replacement involves obtaining a thorough medical and dental history and intraoral and extraoral examinations. Several factors must be considered, including the patient's oral health, adherence to instructions, financial situation, and personal preferences (Jenkins, 1999). Treatment decisions should be guided by evidence-based dentistry and predictable outcomes (Anne et al., 2017)

The attachment retained removable partial denture (AR-RPD) for partially edentulous patients must provide both functional and aesthetic results. Many RPD designs offer adequate function but do not meet patients' aesthetic expectations. In contrast, the AR-RPD provides improved function along with the desired aesthetics. Additionally, it offers advantages in stability, retention, and hygiene (Gupta et al., 2016). Garg et al. (2005) conducted an extensive literature review assessing the impact of decision support systems (DSS) on patient outcomes through randomised and non-randomised trials. One hundred studies met the criteria. The CDSS enhanced practitioner performance in 62 out of 97 studies (64%) that assessed outcomes, including 4 of 10 (40%) diagnostic systems, 16 of 21 (76%) prompt systems, 23 of 37 (62%) disease management systems, and 19 of 29 (66%) prescribing systems. Sim et al. (2001) concluded that DSS improved practitioners' performance considerably. Selecting the abutment for an AR-RPD requires a highly complex intellectual process and a very rigorous training. This process depends on expert clinicians' experience, knowledge, and support. However, experts may not always be available and their quality of training may not be rigorous, which may lead to unsatisfactory outcomes. Based on the American Dental Association (ADA), 79% of dentists in the USA practice general dentistry, while only 21% specialise. Prosthodontists represent just 8.6% of all US dentists. Therefore, insufficient prosthodontists can support dental educators and general dentists decide abutment tooth selection in AR-RPDs. A CDSS, which combines evidence-based data with expert input can simplify this decision-making process. Currently, computer-based tools for managing such dental work are very limited, partly due to the restricted treatment modalities offered during dental training. CDSSs are designed to uphold and advance standards of quality care. Their use can reduce decision-making errors. Dentists, and recent trainees, can use CDSSs to evaluate clinical cases, provide accurate diagnoses and prognoses, and develop optimal treatment plans. The ADA defines treatment planning as a step-by-step guide for patient care as determined by the dentist's diagnosis and used by the dentist for the restoration and/or maintenance of optimal oral health (ADA, 2010). Multiple dental disciplines – such as endodontics, oral surgery, and periodontics can influence restorative decisions, adding complexity to the process. There are inadequate computer-based methods to manage dental work on this topic due to the limited treatment modalities for dental students during their undergraduate training. Therefore, errors occur in decision-making due to the lack of knowledge and experience, so the best solution is to use a CDSS, which assists in making decisions.

This study aims to design and develop a new computerised dental decision support system (DDSS) based on expert dental knowledge and evidence-based guidelines to assist in diagnosis and ensure accurate decision-making at the point of care (Shiffman et al, 1999). The focus is on selecting abutment teeth to support AR-RPDs. The system, named the EXSYS (2007) Corvid System, evaluates critical factors, including the condition of the abutment tooth, to guide attachment selection (Basker, 1986).

2 Methods and materials

2.1 Efficacy of computer-based tools in dental training

The recent developments in dental studies have led to an increase in the knowledge of dental scientists and practitioners, who cooperate in assembling the knowledge and helpfully regulating the information. It is challenging to remember this massive flow of new information when accessing it at the point of care (Jackson, 1999); this comes with the necessity for improvements in the recent computer-based technologies that might improve the effective use of this knowledge for the clinical management of patients. Dental specialists are urged to find methods to start a computer-based decision support methodology using patient-specific data for diagnosis and treatment planning in determining different case scenarios. Therefore, there is an extreme need to develop a supportive technical device to help in computer-based learning (CBL). The recent literature anticipated that CBL increases knowledge and offers the practitioners essential data that is necessary for deciding the point of care when handling patients.

Clinical decision support systems (CDSSs) are the most remarkable technique to improve CBL, so they are proficient in showing designed questionnaires, diagnoses, prognosis, treatment plans, commendations, substitutes, recorded data, and graphic helps on request. However, these systems do not replace conventional education, but they can reinforce its Approaches and create opportunities for current scientific scenarios in user-friendly, easy, and communicative methods (Trushkowsky, 2014). The education process can assist dental students in improving sufficient knowledge in the relevant areas of specialists and DSSs by using these tools. Schittek et al. (2001) defined the benefits of CBL and suggested benefits. The system helps self-learn students by using personal time to review the study material. Students learn from their mistakes without any adverse outcomes, because DDSS will generate automatic correct steps. Users can review the educational material without the computer getting tired. Due to the enormous benefits of using DDSSs as techniques for CBL in dental education, our planned DDSS is intended to simplify evidence-based decision-making methods for diagnosis, prognosis, and treatment planning (i.e., abutment selection used for attachment-retained removable partial denture) and develop an education course for dental students and inexperienced dentists. The end-user must provide the system with patient-related data to attain valuable treatment recommendations for this system.

2.2 CDSS basic features

Computers in CDSSs assist clinicians with diagnosis, treatment planning, and practical recommendations to resolve the issues. CDSS assists in the improvement of health care. The selection of abutment teeth is one of the most challenging techniques in dentistry. The CDSS was established using Exsys Corvid Core software to assist dental students and newly graduated dentists select a suitable abutment for AR-RPD (Mago et al., 2012). The CDSS has three essential components:

- *User interface*: This provides the user with online access to the system, allows interaction with the CDSS, and allows the user to obtain recommendations.
- *Knowledge bases* are acquired from external resources such as databases, books, and journal articles.
- *Inference engine*: Analyses the rules from the knowledge base and generates recommendations to aid decision-making in solving the problem (Zitzmann et al., 2007).

The inference engine uses various rule-based approaches to run the DSS, namely, Backward and forward chaining. Backward chaining is a goal-driven method that starts from the goal and works backward. Forward chaining is a fact-data-driven methodology. The main building blocks in the system are variables, logic blocks, and command blocks (Zitzmann et al., 2007). The system uses if/then statements to set the knowledge base rules. Both ends of the If/Then statement are stored in the system as variables. The logic block connects all the variables to produce an actual If/Then statement, which is executed by the command block as rules.

One of the specific rule used is:

- *If*: Does the patient meet the inclusion criteria (controlled diabetes, adequate manual dexterity)? Yes
- *and*: What is the patient's chief complaint? Missing teeth
- *and*: Is the missing teeth condition complete or partial edentulism? Partial edentulism
- *and*: Are there any signs of fracture in the abutment teeth? Yes
- *and*: Does the abutment have a horizontal or vertical fracture? Horizontal
- *and*: Does the horizontal fracture compromise the abutment root? No
- *then*, the procedures needed are: *Crown lengthening*, *root canal treatment*, *post and core, and crown*.

2.3 The rules and knowledge base

For the procedures, based on prosthodontic specialists' opinions, the knowledge dbase was compiled, and over 50 rules were proposed. These rules represent the criteria for selecting abutments to be used in AR-RPDs. A total of 71 variables were included in this DDSS application. The variable section of the system contains all related factors and criteria for abutment selection, types of attachments used, and additional information that will assist the dentist in avoiding errors in the decision-making process.

There are two types of variables used in our study:

- *Static list variables*: These are multiple-choice lists. 23 static variables were included in this study (Figure 1).
- *Confidence variables* are variables whose value is a numeric (Figure 2).

2.4 Inference engine:

This component analyses the rules from the knowledge database and makes a recommendation to decide. DDSS works in an approach where multiple-choice questions are accessible to the end-users. There are two inference methods: backward chaining and forward chaining. Backward chaining represents a goal-driven way that starts from the goal and works backward. Forward chaining is a data-driven inference. The user starts by putting the data into the system. The system helps in constructing an adequate treatment plan. It is stated in logic on the front page of the system that describes briefly essential points of its phases as a flow diagram to assist the user in recognising the system's mechanism.

Figure 1 Static variable list

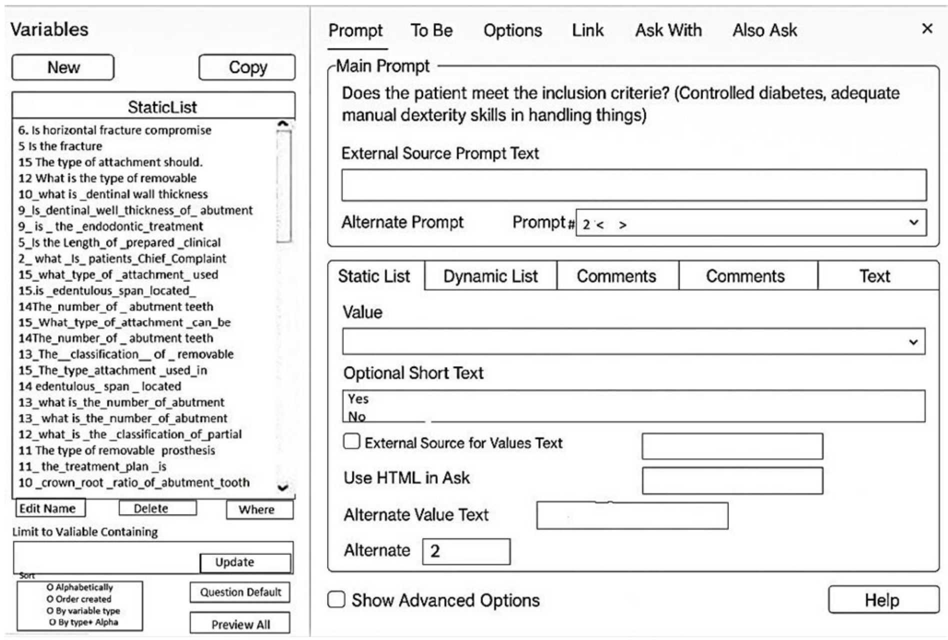
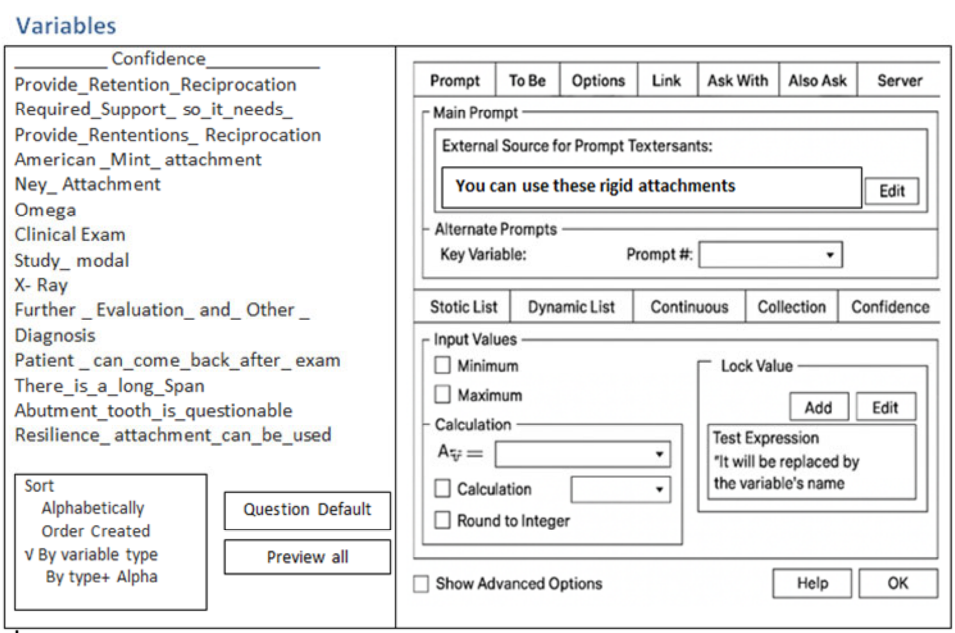


Figure 2 Confidence variables list (see online version for colours)



The DDSS utilises two primary inference methods: backward chaining and forward chaining. Backward chaining is when the intellectual process begins with a definite objective or hypothesis and works backward to define the essential conditions supporting this conclusion. The method is particularly effective when the desired outcome is known, and the system needs to identify which data or rules can justify it. It systematically traces the knowledge base in reverse, evaluating which rules can be applied to achieve the target outcome. This technique is often used in diagnostic processes where a specific condition is suspected, and the system searches for evidence to support or refute the diagnosis (Tavakol and Dennick, 2011), otherwise, forward chaining, the data-driven inference approach is used. In this approach, the process begins with the available input data entered by the user at the start. The system then applies logical rules in a forward sequence to draw conclusions and reach a solution. This method is well-suited for situations where clinical data are abundant, and the goal is to determine the most plausible diagnosis or treatment recommendation based on that data. Forward chaining is typically used in therapeutic planning or decision support scenarios where various data points influence the recommended clinical pathway.

In the context of the proposed DDSS, both inference techniques are integrated to ensure comprehensive decision support that adapts to different clinical scenarios. The system ensures the development of an individualised and very effective treatment plan, by systematically evaluating user input against established clinical guidelines and decision rules. Additionally, the structure and logic of the system are visually represented on the main interface through a flow diagram. This diagram enumerates the key steps of the decision-making process, helping users understand system operation and performance. The system increases user confidence and supports informed clinical judgment by clearly showing the intellectual process.

2.5 System design

DDSS assists in creating an optimum treatment plan. The system diagram contains an illustrated description of the procedure to help the user recognise how the system works.

a *Primary evaluation phase*: The patient's essential medical data were collected relative to referral for a medical consult to get appropriate management in case of condition. This data represents the patient's eligibility for AR-RPD (Figure 3).

b *Secondary evaluation phase*: This phase defines abutment tooth criteria for an AR-RPD by assessing relevant factors to ensure a suitable treatment plan.

2.6 System validation:

The completed and improved system has to undergo authentication for proper acceptance. Successful validation confirms correct system operation. All associated influences and guidelines are presented in the system. The system validation was done by questionnaires aimed to be responded to by experts in prosthodontics, who can recommend new thoughts and suggestions to improve system validation. The answers from experts were gathered from Rutgers University- Dental School, New York University College of Dentistry, and some dental clinics in New Jersey and New York. The answers are categorised on a scale of 5 points from 'highly agree' to 'highly disagree'.

The questionnaire items were as follows:

Q1 This system is user friendly in all facts.

Q2 The Title of the area of interest matches the questions in the system.

Q3 This system has a logical and consistent flow of questions.

Q4 This system is an excellent tool to help the general practitioner make the right decision in the selection of abutments for AR-RPD.

Q5 The system improves patient care and outcomes in dental care.

Q6 The system has valuable information about the selection of abutment teeth to be used for an RPD attachment.

Q7 This system assists in solving difficulties of varying complexity and reaching proper decisions.

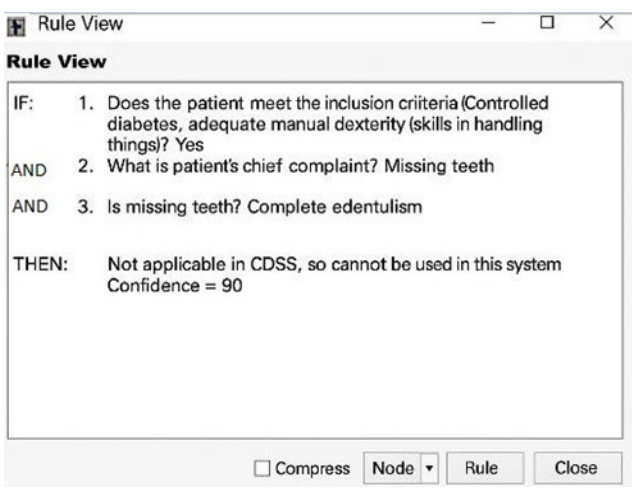
Q8 Would the system be helpful in a private practice setting in addition to a dental school setting?

Q9 This system is recommended as a teaching tool in dental schools and clinics.

Q10 Overall agreement with this system.

The questionnaires were sent to 50 expert prosthodontists. 31 out of 50 responded to the questions based on the rules and scientific scenarios. The specialists completed the questionnaire regarding their agreement with the system's guidelines and provided valuable feedback on developing the system using the Likert scale. IBM® SPSS Statistics software was used to analyse the questionnaire. The questionnaire results were analysed using Cronbach's alpha was used to measure internal consistency ('reliability') (Bhatnagar et al., 2014). In addition, the Pearson product-moment correlation test was also used to assess the validity of the questionnaires.

Figure 3 Primary evaluation



3 DDSS-based results

The questionnaires were distributed to 50 prosthodontists. 31 of 50 responded to the questions according to the rules and scientific bases. The specialists completed the questionnaire regarding their agreement with the system's guidelines and provided valuable feedback on developing the system.

The system's reliability was evaluated using Cronbach's alpha and Pearson correlation coefficient tests, which were applied to responses from a group of experienced prosthodontists. The primary objective of this section is to demonstrate the consistency and validity of the CDSS in providing appropriate abutment selection recommendations and its potential impact on clinical decision-making. The questionnaire responses were analysed using SPSS Statistics software.

Table 1 This system is user friendly in all fact

		Frequency	*Percent*	*Valid percent*	*Cumulative percent*
Valid	Highly agree	13	41.9	41.9	41.9
	Agree	16	51.6	51.6	93.5
	Neither agrees nor disagrees	2	6.5	6.5	100.0
	Total	31	100.0	100.0	

41.9% of experts highly agreed, 51.6% agreed, and about 6.5% of experts neither agreed nor disagreed.

Table 2 The Title of the area of interest matches the questions in the system

		Frequency	*Percent*	*Valid percent*	*Cumulative percent*
Valid	Highly agree	17	54.8	56.7	56.7
	Agree	13	41.9	43.3	100.0
	Total	30	96.8	100.0	
Missing system		1	3.2		
Total		31	100.0		

56.7% of experts highly agreed, and 43.3% agreed about matching the title of the area of interest and the questions in the system.

Table 3 This system has a logical and consistent flow of questions

		Frequency	*Percent*	*Valid percent*	*Cumulative percent*
Valid	Highly agree	15	48.4	50.0	50.0
	Agree	13	41.9	43.3	93.3
	Neither agrees nor disagrees	1	3.2	3.3	96.7
	disagree	1	3.2	3.3	100.0
	Total	30	96.8	100.0	
Missing system		1	3.2		
Total		31	100.0		

50.0% highly agreed, and 43.3% agreed that the system has a logical and consistent flow of questions. However, only 3.3% neither agreed nor disagreed and 3.3% disagreed with this question.

Table 4 This system is an excellent tool to help the general practitioner make the right decision in the selection of abutments for AR-RPD

		Frequency	*Percent*	*Valid percent*	*Cumulative percent*
Valid	Highly agree	17	54.8	54.8	54.8
	Agree	10	32.3	32.3	87.1
	Neither agrees nor disagrees	4	12.9	12.9	100.0
	Total	31	100.0	100.0	

54.8% highly agreed, 32.3% agreed that the system is an excellent tool to help the general practitioner decide on the abutment for AR-RPD, and 12.9% neither agreed nor disagreed about this question.

Table 5 The system improves patient care and outcomes in dental care

		Frequency	*Percent*	*Valid percent*	*Cumulative percent*
Valid	Highly agree	14	45.2	45.2	45.2
	Agree	13	41.9	41.9	87.1
	Neither agrees nor disagrees	4	12.9	12.9	100.0
	Total	31	100.0	100.0	

45.2% highly agreed, 41.9% agreed that the system improves patient care and outcomes in dental care, 12.9% neither agreed nor disagreed.

Table 6 The system has valuable information about the selection of abutment teeth to be used for an RPD attachment

		Frequency	*Percent*	*Valid percent*	*Cumulative percent*
Valid	Highly agree	19	61.3	61.3	61.3
	Agree	11	35.5	35.5	96.8
	Disagree	1	3.2	3.2	100.0
	Total	31	100.0	100.0	

61.3% highly agreed, 35.5% agreed, and 3.2% disagreed that the system has valuable information about selecting abutment teeth for AR-RPD.

Table 7 This system assists in solving difficulties of varying complexity and reaching proper decisions

		Frequency	*Percent*	*Valid percent*	*Cumulative percent*
Valid	Highly agree	11	35.5	35.5	35.5
	Agree	14	45.2	45.2	80.6
	Neither agrees nor disagrees	6	19.4	19.4	100.0
	Total	31	100.0	100.0	

35.5% highly agreed, 45.2% agreed, and about 19.4% neither agreed nor disagreed that the system assists in solving difficulties of varying complexity and reaching proper decisions.

Table 8 Would the system be helpful in a private practice setting in addition to a dental school setting

		Frequency	*Percent*	*Valid percent*	*Cumulative percent*
Valid	Highly agree	10	32.3	33.3	33.3
	Agree	15	48.4	50.0	83.3
	Neither agrees nor disagrees	2	6.5	6.7	90.0
	Disagree	3	9.7	10.0	100.0
	Total	30	96.8	100.0	
Missing system		1	3.2		
Total		31	100.0		

33.3% highly agreed, 50.0% agreed that the system would be helpful in a private setting and the school. However, 6.7% neither agreed nor disagreed, and 10.0% disagreed with this question

Table 9 This system is recommended as a teaching tool in dental schools and clinics

		Frequency	*Percent*	*Valid percent*	*Cumulative percent*
Valid	Highly agree	18	58.1	58.1	58.1
	Agree	12	38.7	38.7	96.8
	Neither agrees nor disagrees	1	3.2	3.2	100.0
	Total	31	100.0	100.0	

58.1% highly agreed, 38.7% agreed, and about 3.2% neither agreed nor disagreed that the system is recommended as a teaching tool in dental schools and clinics.

Table 10 Overall agreement with this system

		Frequency	*Percent*	*Valid percent*	*Cumulative percent*
Valid	Highly agree	12	38.7	40.0	40.0
	Agree	18	58.1	60.0	100.0
	Total	30	96.8	100.0	
Missing system		1	3.2		
Total		31	100.0		

40.0% highly agreed, 60.0% agreed, 3.2% represent unanswered respond.

The Cronbach's alpha of this study is 0.918, which indicates high internal consistency (Table 11) (Bhatnagar et al., 2014). Such a high alpha is considered excellent, suggesting coherent and predictable respondent answers. Therefore, the questionnaire reliably captures relevant data.

The results show that the specialists are in complete agreement regarding the necessity of developing the system for abutment selection in AR-RPD (Table 12).

Table 11 Cronbach's alpha coefficient reliability statistics

Cronbach's alpha	*N of items*
0.918	10

Table 12 Cronbach's alpha coefficient for each question item

Item-total statistics				
Question item	*Scale mean if item deleted*	*Scale variance if item deleted*	*Corrected item-total correlation*	*Cronbach's alpha if item deleted*
Q1	5.50	23.222	0.523	0.918
Q2	5.68	22.819	0.710	0.910
Q3	5.46	20.702	0.774	0.904
Q4	5.46	20.851	0.749	0.906
Q5	5.39	21.062	0.732	0.907
Q6	5.61	20.988	0.783	0.904
Q7	5.21	20.471	0.789	0.903
Q8	5.71	23.989	0.463	0.920
Q9	5.14	19.683	0.704	0.912
Q10	5.46	22.332	0.821	0.905

Pearson's r correlation test is also used to test the validity of the questionnaire. The validity test product moment Pearson correlations connects each item's questionnaire score with the total score essence; it measures the strength and direction of the linear relationship between the score of each questionnaire item and the total score (excluding the item in question), thereby assessing how well each item reflects the construct being measured (Valparaiso University, 2014).

The Pearson correlation coefficient, indicated as r, ranges from –1 to +1.

A coefficient of approximately +1 indicates a positive correlation, meaning that as the score on an individual item increases, the total score also tends to increase. In the context of questionnaire validation, a high positive correlation suggests that the item is consistent with the overall theme or concept being measured by the instrument.

A reference was made to a critical values table for Pearson correlation coefficients at standard significance levels of 0.05 and 0.01 (Schober et al., 2018). The degrees of freedom (df), which are required to use the critical values table, are calculated using the formula:

$$\mathrm{df} = \mathrm{N} - 2,$$

whereas N denotes the sample size. In this study, the sample comprised 31 participants, thus:

$$\mathrm{df} = 31 - 2 = 29$$

According to the critical values table, the threshold for statistical significance at the 0.01 for df = 29 is 0.456.

The Pearson coefficient value greater than 0.456 was determined statistically significant at the 99% confidence level. This criterion ensures a high degree of confidence in the validity of the items.

Table 13 Pearson correlation table

		Correlations										
		Q1	*Q2*	*Q3*	*Q4*	*Q5*	*Q6*	*Q7*	*Q8*	*Q9*	*Q10*	*Total*
Q1	Pearson correlation	1	0.530**	0.511**	0.182	0.426*	0.566**	0.390*	0.286	0.518**	0.216	0.602**
	Sig. (2-tailed)		0.003	0.004	0.328	0.017	0.001	0.030	0.118	0.003	0.252	0.001
	N	31	30	30	31	31	31	31	31	30	30	28
Q2	Pearson correlation	0.530**	1	0.586**	0.491**	0.380*	0.696**	0.473**	0.405*	0.657**	0.604**	0.756**
	Sig. (2-tailed)	0.003		0.001	0.006	0.038	0.000	0.008	0.026	0.000	0.001	0.000
	N	30	30	30	30	30	30	30	30	29	29	28
Q3	Pearson correlation	0.511**	0.586**	1	0.539**	0.570**	0.741**	0.574**	0.184	0.636**	0.544**	0.828**
	Sig. (2-tailed)	0.004	0.001		0.002	0.001	0.000	0.001	0.329	0.000	0.002	0.000
	N	30	30	30	30	30	30	30	30	29	29	28
Q4	Pearson correlation	0.182	0.491**	0.539**	1	0.647**	0.608**	0.624**	0.316	0.551**	0.641**	0.809**
	Sig. (2-tailed)	0.328	0.006	0.002		0.000	0.000	0.000	0.084	0.002	0.000	0.000
	N	31	30	30	31	31	31	31	31	30	30	28
Q5	Pearson correlation	0.426*	0.380*	0.570**	0.647**	1	0.529**	0.607**	0.294	0.778**	0.606**	0.794**
	Sig. (2-tailed)	0.017	0.038	0.001	0.000		0.002	0.000	0.108	0.000	0.000	0.000
	N	31	30	30	31	31	31	31	31	30	30	28
Q6	Pearson correlation	0.566**	0.696**	0.741**	0.608**	0.529**	1	0.622**	0.407*	0.569**	0.440*	0.832**
	Sig. (2-tailed)	0.001	0.000	0.000	0.000	0.002		0.000	0.023	0.001	0.015	0.000
	N	31	30	30	31	31	31	31	31	30	30	28
Q7	Pearson correlation	0.390*	0.473**	0.574**	0.624**	0.607**	0.622**	1	0.340	0.701**	0.594**	0.841**
	Sig. (2-tailed)	0.030	0.008	0.001	0.000	0.000	0.000		0.061	0.000	0.001	0.000
	N	31	30	30	31	31	31	31	31	30	30	28
Q8	Pearson correlation	0.286	0.405*	0.184	0.316	0.294	0.407*	0.340	1	0.268	0.442*	0.536**
	Sig. (2-tailed)	0.118	0.026	0.329	0.084	0.108	0.023	0.061		0.152	0.014	0.003
	N	31	30	30	31	31	31	31	31	30	30	28
Q9	Pearson correlation	0.518**	0.657**	0.636**	0.551**	0.778**	0.569**	0.701**	0.268	1	0.708**	0.851**
	Sig. (2-tailed)	0.003	0.000	0.000	0.002	0.000	0.001	0.000	0.152		0.000	0.000
	N	30	29	29	30	30	30	30	30	30	29	28
Q 10	Pearson correlation	0.216	0.604**	0.544**	0.641**	0.606**	0.440*	0.594**	0.442*	0.708**	1	0.790**
	Sig. (2-tailed)	0.252	0.001	0.002	0.000	0.000	0.015	0.001	0.014	0.000		0.000
	N	30	29	29	30	30	30	30	30	29	30	28
Total	Pearson Correlation	0.602**	0.756**	0.828**	0.809**	0.794**	0.832**	0.841**	0.536**	0.851**	0.790**	1
	Sig. (2-tailed)	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.000	
	N	28	28	28	28	28	28	28	28	28	28	28

Notes: **Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).

Upon analysis, it was found that all questionnaire items yielded Pearson correlation coefficients exceeding the critical threshold of 0.456, which indicates that each item has a positive correlation with the total score, confirming that the items are valid representations of the measured construct. The detailed results of the validity analysis, including the Pearson correlation values for each item (Table 13).

4 Discussion

Treatment planning in prosthodontics requires a comprehensive evaluation of each tooth from the perspectives of endodontics, periodontics, and prosthodontics (Ash et al., 2003). Since many dental diseases affecting teeth and surrounding tissues are bacterial, the grading and assessment of influencing factors can often be inconsistent, subsequently impacting the prognosis of individual teeth before intervention (Trivedi et al., 2002).

The DDSS used in this study integrates evidence-based literature and expert clinical judgment to provide informed decision-making. It promotes practitioners' diagnostic accuracy and provides structured support, particularly for less experienced clinicians such as dental students and early-career dentists. While the system does not consider every possible clinical scenario, it involves a broad and relevant range of commonly encountered factors. Its recommendations are grounded in current research and expert consensus, making it a practical and educational tool for selecting abutment teeth for AR-RPD cases (Payne, 2000). The key strength of this CDSS is its prospect of reducing subjectivity in clinical decision-making, especially in instances of complex abutment selection. The system promotes consistency and clarity in treatment planning by interpreting expert knowledge and scientific evidence into a designed digital format, particularly valuable in academic settings, where students benefit from decision-making processes that reflect professional opinion. The system promotes consistency and clearness in treatment planning by interpreting expert knowledge and scientific evidence into a designed digital format, which is particularly valuable in academic settings, where students benefit from decision-making processes that reflect professional opinion. Also, the system provides better communication between practitioners and patients by giving clear treatment plan decisions and increasing patient trust.

Another advantage is the system's dual applicability in academic and private clinical settings. In institutions where prosthodontic training is limited due to a shortage of specialists, as in many dental schools in the United States, the CDSS is a valuable supplementary educational resource. Its integration into dental curricula may bridge the gap between theoretical learning and practical application. Despite its strengths, the system also has several limitations. One major challenge is clinician implementation. Dental professionals may be hesitant to implement new systems due to unfamiliarity, skepticism, or concerns about practicality. Dental professionals may resist incorporating decision support tools into their workflow due to a perceived lack of practicality and unfamiliarity with digital systems. Social and economic factors related to interpreting system-generated recommendations can further delay the implementation of prevalent recommendations.

Moreover, while the system includes a comprehensive behaviourof rules, it cannot fully substitute the decision of experienced clinicians, mainly in atypical cases. The CDSS is principally designed to help, not replace, clinical decisions. Further research is needed to evaluate clinical effectiveness in dental offices. Also, a follow-up study could explore user feedback after repeated system use in treatment planning scenarios, helping to improve its interface and functionality. A randomised controlled trial would provide stronger data on the system's impact on clinical outcomes and decision accuracy among novice and experienced users.

This study adds to the existing body of prosthodontic knowledge by introducing a structured, evidence-based CDSS specifically designed for abutment tooth selection in AR-RPD treatment planning – an area with limited standardised guidance. This system interprets expert opinions and literature-based criteria into a digital decision-making system. The study demonstrates that this system can support consistent, high-quality decisions and serve as an educational resource for dental students and inexperienced clinicians. As one of the first efforts to formalise abutment selection through a computerised framework, this work fills a critical gap and sets the foundation for further improvements in prosthodontic DSSs.

5 Conclusions

This study presents the validation of a CDSS designed to help select abutment teeth for AR-RPD. The system integrates 58 rules from expert dental opinions and evidence-based guidelines to support consistent and informed clinical decision-making.

Validation of the DDSS was done through expert evaluation using a designed questionnaire, and the results strongly support the system's reliability and validity. A Cronbach's alpha coefficient of 0.918 indicates excellent internal consistency, while Pearson correlation values exceeded the critical threshold (0.456 at the 0.01 significance level), affirming the validity of the questionnaire items. The feedback from 31 experienced prosthodontists revealed high levels of agreement regarding the system's user-friendliness, logical flow, and value as a clinical decision aid. According to the results, the system can be confidently applied in clinical settings, which suggests a reliable, evidence-based framework for guiding practitioners through decision-making processes in AR-RPD treatment plans. Its application in dental offices and educational institutions can promote diagnostic accuracy, support less experienced clinicians, and standardise treatment approaches.

In summary, the proposed DDSS achieves its purpose as an AI based tool in clinical practice and dental education to help make decisions in the management of dental treatments.

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