ORIGINAL ARTICLE

Knowledge, Attitudes, and Practices of Senior Dental Clinicians of a Dental College in Manila on the Use of International Caries Detection and Assessment System (ICDAS)

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ABSTRACT

Objectives. This study aims to establish baseline data on the knowledge, attitudes, and practices (KAP) of senior dental clinicians, which may help determine areas of ICDAS that could be reinforced in teaching, training, and open opportunities for future studies in the Philippines.

Methods. A quantitative descriptive study design used a 4-part online questionnaire for senior dental clinicians from A.Y. 2020-2021 with 1-2 semesters of clinical experience. The survey tool, via Google Forms, gathered general information about the participants and KAP on ICDAS.

Results. Out of 29 participants, 19 (66%) had 1 semester, and 10 (34%) had 2 semesters of clinical experience. Overall mean score for knowledge was 76.1% and is considered "adequate". Five participants (17%) failed to reach the cut-off score of 70%. Based on the overall mean score, the participants were found to have a "positive" attitude. Two (7%) were categorized as "very negative". For the Practice component, all the clinicians showed "good practice."

Conclusion. The senior dental clinicians have demonstrated adequate knowledge, positive attitude, and good practice on ICDAS. A small percentage of the participants scored lower in their K (17%) and A (7%) scores. Even with good results, there is still a need to reinforce some of the basic ICDAS principles and more clinical exposure to reinforce the clinicians' skills in diagnosis and encouragement in using ICDAS.

Keywords: dental students, caries diagnosis, ICDAS

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INTRODUCTION

Dental caries is a disease of high prevalence and incidence that affects people all over the world regardless of age and socioeconomic status.[1] It is a cumulative disease that increasingly affects individuals across their life courses from early childhood to old age. It has a significant negative impact on their quality of life (QoL) and well-being, such that if left untreated, it causes severe pain and discomfort, resulting in eating and sleep disruptions, which can adversely affect their ability to perform their day-to-day tasks.[2] It also has negative effects on the nutrition and growth of individuals, which can have adverse contributions on their general health.[3] Based on the most recent survey, 73% of Filipinos suffer from dental caries, making it a major public health concern.[4] Despite the high prevalence, dental treatment remains unaffordable and inaccessible for many Filipinos

especially in the socioeconomically disadvantaged and marginalized populations.

The treatment of dental caries heavily depends on proper diagnosis. The two most common ways for marking dental caries are the G.V. Black and the World Health Organization Decayed-Missing-Filled Teeth (WHO-DMFT) systems. Black's method is based on the most common lesion sites and his understanding of its pathogenesis. This involves a non-conservative principle of cavity preparation that leans towards a surgical model approach of "extension for prevention" rather than "prevention of extension".[5] In comparison, the WHO-DMFT is used to assess and measure dental caries prevalence and incidence. It is simple, reproducible, and less time-consuming.[6] Both these methods record caries lesions only at the site and the cavitation level without considering the assessment of their severity and activity.[7] This practice results in the initiation of the restorative cycle, which has implications on the individual's QoL, day-to-day function, and finances as they will continuously seek treatment during the lifetime of the tooth and even beyond for its replacement and maintenance.[8]

As the understanding of the pathogenesis of dental caries has advanced, a conservative philosophy called Minimal Intervention Dentistry (MID) was established using the medical model approach of caries management.[9] MID encourages the detection of even non-cavitated caries lesions such that it will result in its inactivation (prevent, arrest, or reverse the progression of early caries lesions) for the preservation of tooth structure.[10] To properly treat dental caries under this approach, there is a need for an assessment system that can detect caries and assess its severity and activity.

The ICDAS-ICCMS™

The International Caries Detection and Assessment System (ICDAS) was developed in 2002 and later became a part of the larger International Caries Classification and Management System (ICCMS™).[11] The ICCMS™ works under four (4) key elements: (1) staging of caries severity, (2) lesion activity assessment, (3) management of risk factors, and (4) management of individual lesions through non-operative care (NOC) or tooth-preserving operative care (TPOC). The first two elements are determined with the use of ICDAS and have given a range of options to accommodate the needs of its users across four domains where the system is being used: (1) dental education, (2) dental practice, (3) research; and (4) in public health.

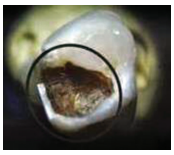
The ICDAS-ICCMS™ offers a common language of diagnosis for dental health practitioners at any point in time. It records the presence and location of lesions and guides practitioners by providing appropriate management that focuses on prevention, elimination, and a conservative treatment approach.[11] Overall, these give the patient an outcome-driven and personalized caries management plan.

ICDAS uses standardized and specific notations to describe caries lesions, even at an early stage, to describe the severity of the lesion, and assess its activity.[12] Grading can be classified into the Full, Modified, or Merged coding system to allow flexibility and options for collecting data (Table 1).

ICDAS in Philippine Dental Education

Since its establishment, ICDAS has already been widely used in many countries - in the African, Asia-Pacific, and Western regions (Americas and Europe).[13] However, more

Table 1. Full, Modified, and Merged ICDAS Coronal Caries Coding System

Full ICDAS Code						
Code 0	**Code 1**	**Code 2**	**Code 3**	**Code 4**	**Code 5**	**Code 6**
						
No evidence of caries seen before and after drying.	First visual change in enamel (white/brown spot lesions) seen after drying.	Distinct visual change in enamel which appears wider than the pits and fissures seen before and after drying.	Localized enamel breakdown but without dentin involvement seen before and after drying.	Dark shadow of discolored dentin visible through the enamel (underlying dark shadow from dentin)	Distinct lesion exposing the dentin that extends less than ½ of the tooth surface.	Extensive lesion exposing the dentin that extends more than ½ of the tooth surface.
Modified Code						
ICDAS 0 Sound	ICDAS A (1 & 2) Initial Lesions		Code 3	Code 4	Code 5	Code 6
Merged Code						
ICDAS 0 Sound	ICDAS A (1 & 2) Initial Lesions		ICDAS B (3 & 4) Moderate Lesions		ICDAS C (5 & 6) Extensive Lesions	

Source: ICCMS™ Guide for Practitioners and Educators Manual
**All photos were used upon permission from the ICCMS™*

studies on using ICDAS in dental education, clinical practice, research, and public health are needed in the Philippines.

The acceptability of using ICDAS in other domains largely depends on how practitioners have been trained in dental schools. A study showed that General Dental Practitioners (GDPs) believed that ICDAS had an essential role in caries prevention but reported four main barriers, one of which is the lack of undergraduate training.[14]

ICDAS was fully implemented in 2019 in the clinical training at the study site, a dental college in Manila. However, even before its full implementation, ICDAS was already taught theoretically in its pre-clinical Pediatric and Operative Dentistry courses since 2015.

The GV Black approach continues to be practiced and taught in other Philippine dental schools. Hence, to make the objectives of ICDAS-ICCMS™ more valuable and acceptable in education, practice, research, and public health, it is imperative to deliver training and improve its use in the dental undergraduate program. Furthermore, as dentistry moves from the surgical to the preventive and minimal intervention, there is a need to determine possible knowledge gaps, changes in behavioral patterns, and implications in practice. As the first dental school in the country to implement its use, this study sought to establish baseline data on the knowledge, attitudes, and practices (KAP) of its Senior Dental Clinicians on ICDAS use.

MATERIALS AND METHODS

The KAP Model

Knowledge, Attitudes, and Practices (KAP) studies tell us what 'people know about certain things, how they feel, and how they behave.'[15] This model can identify knowledge gaps, cultural effects in practice, behavioral patterns, understanding, and actions toward a certain topic.[16] This could be identified through quantitative (i.e., self-administered questionnaires, tests) and qualitative (i.e., open-ended questions, observations, and discussions) means. The KAP model is primarily based on the 'cognitive-affective-behavior' theory in social psychology where these variables are interconnected.[15] This model was used to answer the objectives of the study.

Study Design

A quantitative descriptive design was used to determine the KAP of the participants using a 4-part self-administered questionnaire (SAQ) adopted from the ICCMS™ website and administered online. The questionnaire included: Part I: general information questions; Part II A: 10 multiple choice questions (MCQs) on basic ICDAS concepts and procedures; Part II B: caries diagnosis using 20 pictures of tooth specimens; Parts III and IV: questions about attitudes and practices on ICDAS using a 5-point Likert scale. To ensure credibility, pictures from Part II B were lifted from the official ICCMS™ website after obtaining permission and each picture was given proper citation. The specimens covered all of the ICDAS Merged System codes (0, A, B, and C). Further, it was also guaranteed that the picture specimens have not been used in any previous calibration session or any other educational purpose in the dental college as this might have also introduced bias. The participants were given specific instructions in each given case item and each picture specimen included markings as to which particular surface is being assessed.

Since the study made use of questions and pictures based on the e-learning program of the ICDAS-ICCMS™, exposure to this was included as part of the Exclusion Criteria, as it might have introduced bias or conflict that could affect the results of the study.

Participant Selection and Recruitment

Upon the approval of the University of the Philippines Manila - Research Ethics Board (UPM-REB) with the code 2020-UND-816, a letter of invitation for recruitment was sent to the batch presidents to invite the senior clinicians to participate in the study. They came from two groups of senior dental clinicians - a group with one (1) semester of clinical exposure and the other with two (2) semesters. The junior clinicians were not selected as the representative population because they do not have any clinical experience, especially in charting using ICDAS, considering that patient contact was suspended since March of 2020 due to the COVID-19 pandemic. On the other hand, the resident clinicians were not chosen because some may have already graduated by the beginning of the implementation of the study and they may have varying degrees of clinical experiences making participant selection difficult.

Inclusion criterion

Participant is enrolled in during the 2nd Semester of AY 2020-2021.

Exclusion criterion

Participant has attended or participated in an accredited ICDAS training or calibration that involves actual performance of the assessment system (except lectures/webinars) outside the dental college including online calibration sessions such as the e-learning program of the ICDAS-ICCMS™.

Sampling Design

Total enumeration was used as the sampling design. This means that everyone in the target population has a chance of being included in the study given that they satisfy the selection criteria. This type of sampling was utilized since the number of the target population is relatively small (n = 37). The sampling frame that was used consisted of all senior clinicians from the dental college for the AY 2020-2021.

Data Collection and Waiver of Informed Consent

Data collection began in the 2nd week of October 2020 and ended in the 3rd week of November 2020. A total of 29

senior dental clinicians participated in the study. Since the survey was only done at one point in time and data were anonymized, no withdrawal criteria were set. Only when a participant exited the tab or decided not to submit the online survey would his/her response be forfeited.

Google forms was used as the platform for the survey. It was set such that the email addresses of the participants would not be recorded in their responses in order to ensure their anonymity. Since participation is voluntary, the first page of the form contained a waiver of informed consent. Upon submission, individual results were made available to the participants via the "View Score" button at the end of the form.

This study was designed in compliance with the Philippine Data Privacy Act of 2012 and the National Ethical Guidelines for Health and Health-Related Research (2017).

Data Processing and Statistical Analysis

The survey data were presented and summarized in the Google spreadsheet according to:

1. question and choices in each item, and
2. number of answers per choice in each item, and
3. total number of correct responses per item.

Since there were no identifiers, codes were assigned to each participant based on the order that the responses have been submitted.

Descriptive statistics were utilized for the quantitative analysis of the survey. Frequency and percentages were used for the general information variables. Total knowledge scores' mean and standard deviation were computed to determine Knowledge. To determine the Attitude and Practice, mean, standard deviation, and frequency distribution of the Likert scores were used to analyze the data. These were all presented in the form of tables and bar graphs.

Verbal interpretations of each participant's mean score were developed to identify the attitudes and practices of clinicians towards ICDAS. It is important that the distribution of the range for a 5-category Likert scale be equal. Thus, the computed verbal interpretation for the mean scores is as follows, where:

1.00–1.80: Strongly Disagree (SD) / Very Negative (VN) / Very Poor (VP)
1.81–2.60: Disagree (D) / Negative (N) / Poor (P)
2.61–3.40: Neutral (N) / Average (P)
3.41–4.20: Agree (A) / Positive (P) / Good (G)
4.21–5.00: Strongly Agree (SA) / Very Positive (VP) / Excellent (E)

Moreover, for items in Part III and IV which are negatively stated, the interpretation for Strongly Disagree/ Disagree will connote a Very Positive/Positive attitude and Good/Excellent practice.

Raw data management was first performed using Microsoft Excel, and all statistical analyses were done using SPSS 21.

All of the responses were stored in the researcher's Google account. Duplicate copies of the records were stored in a 16-GB flash drive and the principal investigator's Google Drive and made accessible to the co-investigators and the biostatistician. These data were only available during the conduct of the study and will be deleted three years after submission and dissemination.

RESULTS

Of the 29 selected participants, 19 (65.5%) had one semester of clinical exposure, while 10 (34.5%) had two semesters. For a half-day or 4-hour oral diagnosis (OD) duty, where clinicians are tasked to do history taking and clinical examination including full-mouth charting of patients using ICDAS, results show that 20 (69%) respondents are able to attend to two patients each, six (21%) respondents to one patient each, and the remaining three (10%) can do the charting of 3-4 patients each.

Knowledge Scores of Senior Dental Clinicians on ICDAS

Knowledge is adequate when a clinician scores 70% or higher in the survey (21 correct answers out of a 30-item questionnaire). This was based on the criteria set by the dental college for their online ICDAS calibration. The overall mean knowledge score of the 29 participants for Part II-A and II-B combined is 22.83 (out of 30) or 76.1% (s.d.=2.3, median=23). Twenty-four (83%) scored 70% and above, and 5 (17%) with one semester of clinical exposure scored below the cut-off score (Table 2).

Part II-A consisted of 10 questions about the basic ICDAS concepts and procedures. Almost all participants answered correctly on several questions except for four (1, 2, 8, and 9), which appeared to have the most confusion, as seen in Table 3.

The simpler merged ICDAS coding system is the method used at the dental college. For Part II-B, four out of the 20 teeth (Questions 2, 3, 11, 12) were found to have the most mistakes (Table 4). Q2 and Q11 demonstrated confusion between ICDAS 0 and A, while Q3 and Q12 were between ICDAS A and B. All other questions generated >50% correct responses (Figure 1).

Table 2. Knowledge Level of Senior Clinicians on ICDAS having 1 or 2 Semesters of Clinical Exposure

Knowledge level category	Frequency (n=29)		
	1 semester (n=19)	2 semesters (n=10)	Total
Not adequate (≤69% score)	5 (17%)	0 (0%)	5 (17%)
Adequate knowledge (≥70% score)			
70% - 79%	7 (24%)	5 (17%)	12 (41%)
80% - 89%	6 (21%)	4 (14%)	10 (35%)
90% and above	1 (3.5%)	1 (3.5%)	2 (7%)

Table 3. Frequency of Responses from Part II-A of the Survey about Basic ICDAS Concepts and Procedures

Question	Choices	No. of Responses (%)
1. Which of the following shows the correct order of steps that you should do prior to doing the ICDAS examination?	Ask patient to remove appliance (if present) - clean - visual exam while surface is wet - start visual inspection - dry the tooth - isolate	9 (31%)
	Clean - ask patient to remove appliance (if present) - dry the tooth - isolate - start visual examination - visual exam while surface is wet	0 (0%)
	Ask patient to remove appliance (if present) - clean - isolate - visual exam while surface is wet - dry the tooth - start visual inspection (Correct Answer)	**20 (69%)**
	Isolate - clean - ask patient to remove appliance (if present) - start visual inspection - dry the tooth - visual exam while surface is wet	0 (0%)
2. How long should you dry the tooth surface prior to its examination?	3 seconds	11 (38%)
	5 seconds (Correct Answer)	**18 (62%)**
	8 seconds	0 (0%)
	10 seconds	0 (0%)
3. Prolonged drying of the tooth surface should not be performed in order _____.	**To avoid dehydration of the tooth (Correct Answer)**	**24 (83%)**
	To make sure that the tooth is free from plaque	0 (0%)
	To make sure that all cracks on enamel will be visible	1 (3%)
	To avoid erroneous reading because of the refraction of light caused by a wet tooth surface	4 (14%)
4. Which among the following instruments is/are best to use for ICDAS examination?	A sharp-ended explorer	0 (0%)
	A blunt-ended explorer	3 (10%)
	A ball-ended probe	5 (17%)
	Choices 1 and 2	0 (0%)
	Choices 1 and 3	0 (0%)
	Choices 2 and 3 (Correct Answer)	**21 (72%)**
5. Which among the ICDAS merged codes is described as either 'a lesion that has localized enamel breakdown without dentin involvement' or 'a lesion that has a dark shadow of discolored dentin visible through the enamel'?	ICDAS 0	0 (0%)
	ICDAS A	0 (0%)
	ICDAS B (Correct Answer)	**29 (100%)**
	ICDAS C	0 (0%)
6. Which among the ICDAS merged codes is described as either 'a lesion exposing the dentin that extends less than 1/2 of the tooth surface' or 'a lesion exposing the dentin that extends more than 1/2 of the tooth surface'?	ICDAS 0	0 (0%)
	ICDAS A	0 (0%)
	ICDAS B	0 (0%)
	ICDAS C (Correct Answer)	**29 (100%)**
7. A sound, discolored tooth associated with developmental anomalies such as fluorosis and hypoplasias should be given an ICDAS code _____.	**ICDAS 0 (Correct Answer)**	**28 (97%)**
	ICDAS A	1 (3%)
	ICDAS B	0 (0%)
	ICDAS C	0 (0%)
8. Active lesions can be considered as such if they satisfy the following criteria, EXCEPT:	Lesion is a plaque-stagnation area, i.e., in the entrance of pits and fissures, near the gingival margin or, for proximal surfaces, below or above the contact point	1 (3%)
	Cavity feels soft and leathery on gentle probing of dentin	3 (10%)
	Surface of enamel is whitish/yellowish	6 (21%)
	None of the above (Correct Answer)	**19 (66%)**
9. Inactive lesions can be considered as such if they satisfy the following criteria, EXCEPT:	Surface of enamel is whitish, brownish, or black	2 (7%)
	The enamel may be shiny, feels hard and smooth when the tip of the ball-ended probe is moved gently across the surface	3 (10%)
	Surface is opaque with loss of luster, feels rough (Correct Answer)	**16 (55%)**
	None of the above	8 (28%)
10. The following are under the non-operative care (NOC) treatment approach, EXCEPT:	Oral hygiene reinforcement	0 (0%)
	Topical fluoride application	0 (0%)
	Sealants	2 (7%)
	None of the above (Correct Answer)	**27 (93%)**

Table 4. Question from Part II-B with the Most Number of Incorrect Answers

Question	Choices	No. of Responses (%)
Question 2 	**ICDAS 0 (Correct answer)**	**11 (38%)**
	ICDAS A	17 (59%)
	ICDAS B	1 (3%)
	ICDAS C	0 (0%)
Question 3 	ICDAS 0	0 (0%)
	ICDAS A (Correct answer)	**14 (48%)**
	ICDAS B	15 (52%)
	ICDAS C	0 (0%)
Question 11 	ICDAS 0	18 (62%)
	ICDAS A (Correct answer)	**9 (31%)**
	ICDAS B	2 (7%)
	ICDAS C	0 (0%)
Question 12 	ICDAS 0	0 (0%)
	ICDAS A	14 (48.3%)
	ICDAS B (Correct answer)	**14 (48.3%)**
	ICDAS C	1 (3.4%)

Photo courtesy of ICCMS™ (e-learning program)

Attitude Scores of Senior Dental Clinicians on ICDAS

Based on their individual attitude mean scores, results show that a combined majority of the participants (83%) have positive (48%) to very positive (35%) responses. However, there are 10% neutral, and 7% very negative towards ICDAS. It was noted that those who were negative about ICDAS were from the group with only one semester of clinical experience. The results reveal that the overall mean score for attitude is 3.84 (s.d.=0.84, median=3.88), which can be interpreted as a "positive attitude" towards using ICDAS.

Table 5 shows the mean scores of the respondents for each of the attitude statements and their corresponding verbal interpretations (SD, D, N, A, SA) given in the survey.

Practice Scores of Senior Dental Clinicians on ICDAS

Based on their individual practice mean scores, most of the respondents (86%) demonstrated good (69%) to excellent (17%) clinical practice of ICDAS. The four (14%) clinicians with average clinical practice have only one (1) semester of clinical experience, while no clinician registered poor to very poor clinical practice. This translates to an overall mean score of 3.75 (s.d.=0.37, median=3.71), interpreted as having "good" practice.

Table 6 shows the mean scores of the respondents for each of the practice statements and their corresponding verbal interpretations (SD, D, N, A, SA) given in the survey.

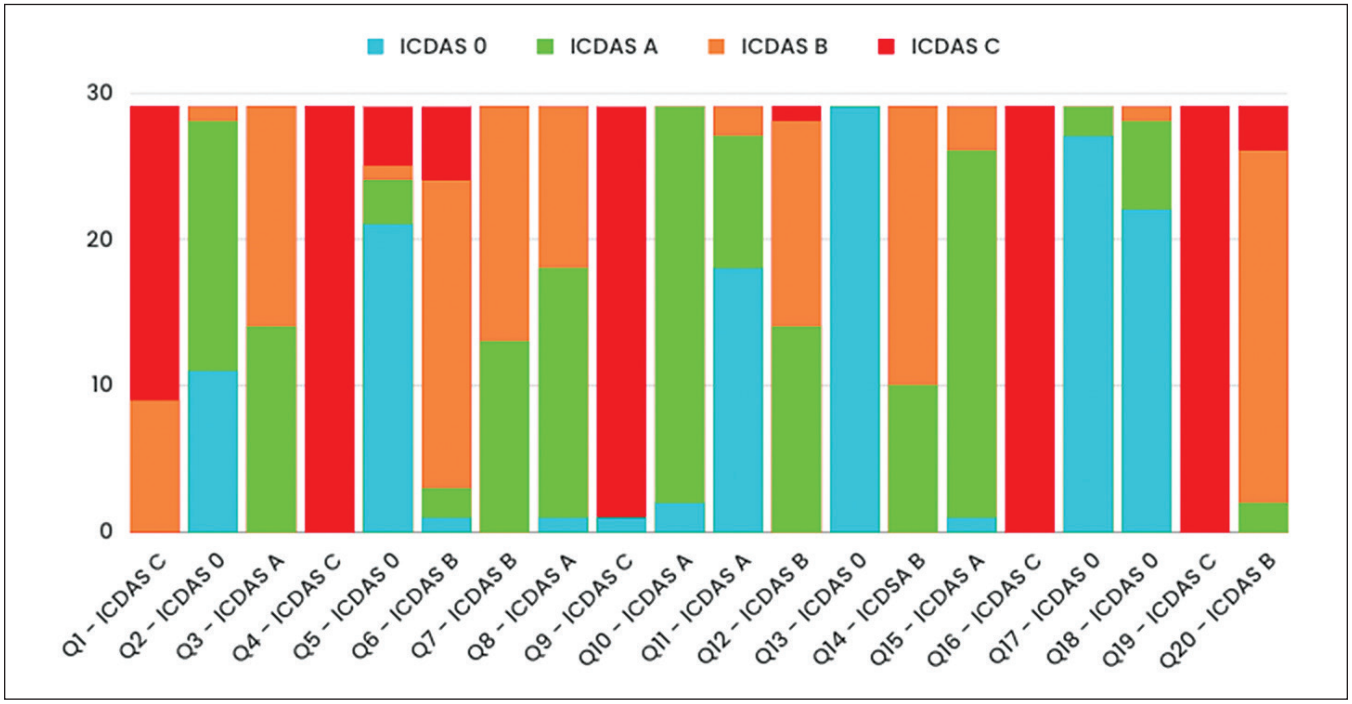


Figure 1. Frequency of responses per question (Q) from Part II-B of the survey on caries diagnosis using ICDAS Merged Coding System (ICDAS 0, A, B, and C). Q2, Q3, Q11, and Q12 showed <50% correct responses.

Most Confusing ICDAS Codes

The last part of the survey included a question regarding which ICDAS code/s the participants were most confused about in practice. They were allowed to select more than one code. Based on frequency, participants had the most confusion on ICDAS A (22 responses), B (14 responses), 0 (4 responses), and the least, ICDAS C (1 response).

DISCUSSION

Treatment decisions depend on a comprehensive and sound diagnosis. Compared to the Black and WHO-DMFT systems, ICDAS is an approach for caries detection and assessment geared towards prevention and MID. Following the direction of the medical model approach, the dental college fully implemented the ICDAS in its clinical training in 2019. However, there has yet to be an evaluation of the KAP of the senior dental clinicians since its use, thus the purpose of this study.

ICDAS Knowledge of Senior Dental Clinicians

The majority (83%) of the participants have adequate knowledge of ICDAS, having a mean score of 76.1%. It was noted that the participants (17%) who scored ≤69% are those who have only had one (1) semester of actual clinical patient exposure. Similar to the study done at the University of Dammam, Saudi Arabia[17], clinicians with more clinical experience demonstrated better knowledge of cariology and were more confident in detecting caries using ICDAS. However, it is important to note that these students have had a pre- and post-survey after introduction of ICDAS as compared to this current study that only tested the

Table 5. Mean Scores of the Participants and the Corresponding Verbal Interpretation for Part III - Attitude Statements

Statements	Mean score (s.d.)*	Verbal Interpretation*
1. I find ICDAS as an important tool for caries detection, diagnosis, and management.	4.48 (0.95)	Strongly agree
2. ICDAS is a useful tool in detecting early caries lesions.	4.48 (1.09)	Strongly agree
3. ICDAS classification should be carried out on all patients.	4.48 (0.95)	Strongly agree
4. ICDAS is an effective way of managing caries in a preventive manner.	4.34 (1.17)	Strongly agree
5. ICDAS helps me with the proper treatment to render the patient.	4.48 (0.95)	Strongly agree
6. I think ICDAS is too complicated.	2.97 (1.12)	Neutral
7. I think ICDAS is too time-consuming.	3.45 (1.06)	Agree
8. I think that ICDAS is too confusing.	3.14 (1.13)	Neutral

**Verbal Interpretation for Mean Scores: 1.00–1.80: Strongly disagree (SD), 1.81–2.60: Disagree (D), 2.61–3.40: Neutral (N), 3.41–4.20: Agree (A), 4.21–5.00: Strongly agree (SA)*

Table 6. Mean Scores of the Participants and their Corresponding Verbal Interpretation from Part IV - Practice Statements

Statements	Mean score (s.d.)*	Verbal Interpretation*
1. I follow all the ICDAS pre-examination procedures:		
a. Remove the appliance if present	4.76 (0.44)	Strongly agree
b. Clean the tooth	4.07 (0.88)	Agree
c. Isolate the tooth	3.48 (1.15)	Agree
d. Dry the tooth	4.45 (0.57)	Strongly agree
2. I use a ball-ended probe or blunt explorer when I examine the tooth surface	4.66 (0.61)	Strongly agree
3. I can easily recognize white or brown spot lesions from stains and developmental anomalies	3.31 (0.89)	Neutral
4. I can easily recognize lesions on smooth surface	3.93 (0.92)	Agree
5. I can easily recognize lesions on proximal surfaces	3.21 (0.82)	Neutral
6. I can easily recognize lesions on occlusal/incisal surfaces	4.24 (0.69)	Strongly agree
7. I use the ICDAS guide (e.g., my lecture notes, tables on OD form, posters on cubicles) as I do the charting	4.21 (0.90)	Strongly agree
8. I am often asked by my clinical instructors to modify my ICDAS diagnoses upon checking of my charting	3.14 (0.92)	Neutral
9. I am often asked by my clinical instructors to modify lesion activity (Active or Inactive)	2.41 (0.87)	Disagree
10. It takes me more than 30 minutes when charting a full mouth complete dentition using ICDAS	2.41 (1.05)	Disagree
11. I am often asked by clinical instructors to modify ICDAS management (NOC or TPOC) upon checking of my charting	3.83 (0.97)	Agree

**Verbal Interpretation for Mean Scores: 1.00 – 1.80: Strongly disagree (SD), 1.81 – 2.60: Disagree (D), 2.61 – 3.40: Neutral (N), 3.41 – 4.20: Agree (A), 4.21 – 5.00: Strongly agree (SA)*

participants' knowledge at one point in time. Moreover, it should be noted that although most of the items obtained a favorable score, some questions resulted in one-third or more incorrect answers.

Table 3 shows some slip-ups in the recommended order of procedural steps before ICDAS examination (Question 1). Some participants answered A and C, presenting a similar order for the first two steps except for the jumbled order of when to isolate. This could have caused confusion. There were also some mistakes in the recommended duration of drying time (Question 2), which may be due to a simple recall problem. Nevertheless, this is a vital step in differentiating sound and incipient caries lesions, and if done incorrectly, this may cause errors in diagnosis.[12] Lastly, participants were also confused in identifying the characteristics of active and inactive lesions. This is a crucial consideration in assigning the proper management (NOC or TPOC) to the lesion, as failure may result in overtreatment.[18] However, incorporating these in the training sessions requires more in-depth planning and deliberation as caries management depends both on the tooth and patient level.[12] Overall, there is a need to reinforce the concepts mentioned earlier to the clinicians.

As for the diagnosis, the respondents had the most mistakes in ICDAS 0, A, and B (Table 4). The results are similar to several studies[17,19,20] where dental students found the most confusion for ICDAS Codes 0, 1, 2, and 4 (ICDAS 0, A, and B). However, the study by Al-Khalifa made use of blocked tooth specimens to be identified using ICDAS while the other 2 studies made use of the e-learning program by the ICCMS™. Moreover, the aforementioned studies employed the Full ICDAS coding while in this present study, the merged coding system was used. In addition, it is essential to determine the possible reasons and limitations the participants may have encountered in this current study. In previous face-to-face calibration sessions conducted by the Restorative Section of the dental college, actual tooth specimens were used, and the participants were allowed to use ball-ended probes should there be doubts about any break in the enamel surface. As this study was a purely visual examination conducted online, a limitation for the respondents was their inability to confirm their diagnoses with a tactile exam, especially for initial and moderate lesions (ICDAS A and B). Also, as it was done remotely, the qualities of the pictures displayed on the screen may have differed from one participant to another depending on the devices they used. This is especially true for ICDAS 0 and A lesions, which present with initial visual changes in enamel, and even a slight difference in the display quality may significantly affect diagnosis.

The overall mean score for the knowledge part (76.1%) was affected mainly by the results of Part II-B (caries diagnosis), where most of the respondents scored lower as compared to Part II-A (definition of terms and basic procedural steps). This may mean that they are knowledgeable about the basic concepts and procedures of ICDAS but are still having some difficulties in diagnosing the carious lesion. In general, there is an agreement among various studies[17,19,20] including this study, that there is some confusion among the ICDAS codes 0, A, and B (or ICDAS 0, 1, 2, 3, and 4). Alves et al. proposed using the ICCMS™ e-learning program and other digital learning strategies as effective ways to accelerate the ability of pre-clinical dental students to detect carious lesions, making them "better prepared for clinical activities."[20] Khattak et al. likewise suggested reinforcing ICDAS training in undergraduate dental schools.[14] Additionally, as the students are on a learning curve, knowledge of ICDAS can be reinforced with more clinical exposure and practice.

ICDAS Attitude of Senior Dental Clinicians

The study showed that the combined majority (83%) of the senior dental clinicians have a "positive" to "very positive" attitude towards ICDAS. They find the use of ICDAS relevant in caries detection, diagnosis, prevention, and management (Table 5, 1-5). Al-Khalifa stated that the attitude of dental students towards caries detection and assessment impacts their treatment approach in dealing with carious lesions and their involvement in "offering preventive services in their future practice."[17]

Although the senior dental clinicians have a favorable attitude towards ICDAS, they also stated that it was time-consuming (Table 5, Question 7). They may have compared it to the DMFT charting system, which some said was easier to fill out. Meanwhile, they are neutral about ICDAS being complicated and confusing (Table 5, Questions 6 and 8). This could be because the dental college uses the Merged coding system, which is more simplified and easier to remember. Compared to the study done among general dental practitioners (GDPs) in West Yorkshire, the participants also found ICDAS time-consuming and its lack of simplicity as they made use of the Full coding system and because these would translate to lesser patients to be accommodated, hence "less income" which is not a factor in this current study[1,4] Despite these differences, with time and more experience, senior dental clinicians will hopefully be more adept at using ICDAS.

ICDAS Practice of Senior Dental Clinicians

Although the participants have only had one to two semesters of clinical patient exposure and experience using ICDAS, generally, they practice the recommended ICDAS-ICCMS™ pre-examination procedures (Table 6, Questions 1 and 2).

Regarding the recognition of carious lesions, the respondents stated that they could easily identify lesions on the facial, lingual, and incisal/occlusal surfaces of the teeth, mainly because these surfaces are exposed (Table 6, Questions 4 and 6). On the other hand, they may occasionally have hesitations in (1) distinguishing white or brown spot lesions (ICDAS A) from stains and developmental anomalies (ICDAS 0) (Table 6, Question 3) and (2) identifying proximal lesions (Table 6, Question 5). The former is

congruent with what was demonstrated in Part II-B (caries diagnosis) of this study. Developmental anomalies such as fluorosis, amelogenesis imperfecta, and the like have very similar visual presentations to initial carious lesions. This may explain why the clinicians express some hesitations in differentiating these two. Meanwhile, as to the hesitancies of the participants to identify proximal lesions, one study reported that even dental professionals have demonstrated some challenges in this aspect.[21]

The clinicians answered "neutral" when asked if the instructors often ask them to modify their diagnosis (Table 6, Question 8) and "agree" that they are often asked to modify their management choices, NOC, or TPOC (Table 6, items 11). This is consistent with their previous response (Table 6, Questions 3 and 5) that they may sometimes have difficulty differentiating and recognizing carious lesions, which may also affect the choice of management. Another possible reason is that the ICDAS merged system includes two different notations per code – A, B, and C. For example, ICDAS B lesions encompass both 3 and 4 in the full coding system; hence the approach can differ from each other. Code 3 may require either NOC or TPOC, but Code 4 is almost always considered an active lesion and may require TPOC. As beginner clinicians, this counterchecking by an instructor is considered part of their learning process.

The clinicians also stated that they are in agreement with the instructor when it comes to the lesion's activity status (Table 6, Question 9), which is not consistent with the results in the knowledge part (Table 6, Questions 8 and 9) where the participants have shown confusion as to the characteristics of an active and inactive lesion. This may imply that there is a disagreement between theoretical and practical applications in terms of identifying lesion activity status. Although a knowledge-practice gap may exist, having the students in agreement with their instructors is perhaps a better measure of the application of their knowledge.

In terms of efficiency, this study also found that the senior dental clinicians take 30 minutes or less to do a full mouth charting using ICDAS (Table 6, Question 10). They suggested that having an assistant would help improve their recording. Overall, it is notable that none of the senior dental clinicians has poor to very poor levels of practice (Table 6).

The clinicians were likewise asked which ICDAS code/s they were most uncertain about. Ranked in order of clarity for them were ICDAS C, 0, B, and A, which is consistent with the results in Part II-B (caries diagnosis) of the questionnaire and with the studies of Diniz et al., Al-Khalifa, and Alves et al.[17,19,20]

Average Number of Patients Charted in a Half-day OD Duty

One of the most important aspects of dental training is patient exposure. The attitude and practice of the participants towards ICDAS may have been largely influenced by the amount of clinical experience they have as presented earlier. Even with 1-2 semesters of patient exposure, their ability to diagnose dental caries as well as their behavior towards the use of ICDAS may have varied based on the average number of patients they can chart in a half-day OD duty. Results showed that a combined majority (90%) of senior dental clinicians can attend to 1-2 patients on average per half-day OD duty. However, the number of patients they can chart may be on a case-to-case basis depending on the patient's condition, such as the number of teeth present, number of carious lesions, and amount of dental biofilm present. Moreover, the results may have been affected by the way clinicians interview patients as charting in the dental college also includes history taking, review of systems, case presentation, and patient education, and not only dental charting.

The last part of the survey asked for their suggestions and comments on the implementation of ICDAS in the clinics of the dental college. Their responses were grouped into two themes, (1) the usability and relevance of ICDAS and (2) its training and implementation in the clinics of the dental college.

Usability and Relevance of ICDAS in the Clinics of the Dental College

The results showed that most senior dental clinicians agreed that ICDAS is valuable and helpful in diagnosing and managing caries. There was also a comment that ICDAS is preferable over the traditional Black system since it provides a "space for a more conservative and affordable treatment plan". However, some stated that ICDAS is too time-consuming, confusing, and difficult to apply relative to the DMFT charting system. They also mentioned that there should be more clinical practice for senior dental clinicians to "master" ICDAS.

Training and Implementation of ICDAS in the Clinics of the Dental College

A recurring comment was the need to improve the patient referral and appointment system in the clinics so that they may have more patient exposure. Some senior dental clinicians recommended having more calibration workshops or refresher courses/exercises on ICDAS every semester or annually. They also pointed out the importance of these workshops for enhancing the ICDAS knowledge and practice of all clinical instructors and clinicians, more so from instructors outside the Restorative Dentistry section. This is also one of the concerns expressed in the study by Khattak et al.[14] There were also suggestions that all clinical sections should have the same level of strictness or thoroughness when using ICDAS and having someone to assist them in writing the notations on the patient's chart may improve their efficiency during oral diagnosis.

Limitations of the Study

Due to the limitations brought about by the ongoing COVID-19 pandemic during the study period, all of the

components were conducted online, and the part for caries diagnosis was based solely on photographs. Hence, the participants did not have the advantage of a visual and tactile examination of the actual tooth specimens. Moreover, the quality of the images may have varied depending on the gadgets the participants used to view the carious lesions. Additionally, as a single data-gathering tool, more than the quantitative data from the practice part may be needed to ascertain their actual practice as it was not possible to make direct observations. Likewise, the practice part was self-reported. Thus, its truthfulness or recall may have affected the accuracy of the data gathered.

Further, given the small sample size, the data gathered can only be generalizable to the target population. However, as this provides baseline data, recommendations have been made for further studies regarding the topic.

CONCLUSION

The senior dental clinicians have shown adequate knowledge, positive attitude, and good practice of ICDAS. However, a small percentage of the participants scored lower in their KA scores. Despite having good results, there is still a need for reinforcement in some areas of their KAP, specifically in the procedural steps, the distinction among codes 0, A, and B, and the assessment and treatment of lesions. Further, based on the results, ICDAS is an effective teaching tool in the university. However, the senior dental clinicians need more clinical exposure, hands-on training, and periodic calibration to be more proficient.

Recommendations

For future research

1. To have the caries diagnosis and assessment exam done face-to-face using natural teeth specimens, unlike in this current study where it was done purely remote due to the limitations brought about by the COVID-19 pandemic.
2. To conduct qualitative data collection such as focus group discussions and observation to further explore and determine the clinicians' actual practice of ICDAS.
3. As this provides baseline data, it is recommended to look into the difference of the KAP between the junior and senior clinicians, as well as the comparison and correlation of the KAP between levels of clinical exposure time of the clinicians.

For the dental college

1. To look into available means to practice ICDAS such as the ICCMS™ e-learning program and other digital learning strategies.
2. To conduct additional training and emphasize in the pre-clinical and clinical courses the following areas:
    a. performance of ICDAS procedures (i.e., correct order of steps prior to doing ICDAS, length of drying the tooth),
    b. differentiation or distinction between ICDAS 0, A, and B as these are found to be the most confusing codes,
    c. characteristics of an active and inactive lesion, and
    d. assigning management options for the lesions whether NOC or TPOC.
3. To organize periodic calibration for all the faculty in the college.
4. To standardize the level of strictness and quality of counter-checking of the charts in all the clinical sections.

For the Philippine dental academe

As dentistry shifts towards preventive and MID, emphasis must be given to the first step of patient management - diagnosis. Hence, establishing a solid foundation of ICDAS in dental education may help advance its use in the other three domains - research, public health, and clinical practice. As the students graduate and venture into their own dental practice, the KAP on ICDAS formed while at the university will hopefully translate to a broader reach to the public by providing a more preventive approach to diagnosing and treating dental caries. The following recommendations may help achieve this goal:

1. For the dental college to actively promote the use of ICDAS in dental education in the country,
2. To share the dental college's experience on the use of ICDAS, teaching materials, and tools with other dental schools in the Philippines, and
3. Conduct collaborative research on the topic.

Overall, this is a step forward to address the ongoing global burden of dental caries by promoting preventive and conservative management at the teeth, patients, and community levels.

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All authors certified fulfillment of ICMJE authorship criteria

Author Disclosure

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REFERENCES

1. Petersen PE. Global policy for improvement of oral health in the 21st century--implications to oral health research of World Health Assembly 2007, World Health Organization. Community Dent Oral Epidemiol. 2009 Feb;37(1):1-8. doi: 10.1111/j.1600-0528.2008.00448.x. PMID: 19046331.
2. Heilmann A, Tsakos G, Watt RG. Oral Health Over the Life Course. In: Burton-Jeangros C, Cullati S, Sacker A, Blane D, eds. A Life Course Perspective on Health Trajectories and Transitions [Internet]. Cham (CH): Springer; 2015. Chapter 3. DOI: 10.1007/978-3-319-20484-0_3. PMID: 27683931.
3. Sheiham A. Dental caries affects body weight, growth and quality of life in pre-school children. Br Dent J. 2006 Nov;201(10):625-6. doi: 10.1038/sj.bdj.4814259. PMID: 17128231.
4. Department of Health – Disease Prevention and Control Bureau. National Survey on Oral Health (NSOH) in the Philippines, The Final Report. Manila, Metro Manila: ASPSI; 2019. 38-54.
5. Hamama HH, Yiu CK, Burrow MF. Caries management: a journey between Black's principals and minimally invasive concepts. Int J Dentistry Oral Sci. 2015;2(8):120–5.doi: 10.19070/2377-8075-1500026.
6. Campus G, Cocco F, Ottolenghi L, Cagetti MG. Comparison of ICDAS, CAST, Nyvad's Criteria, and WHO-DMFT for caries detection in a sample of Italian schoolchildren. Int J Environ Res Public Health. 2019 Oct;16(21):4120. doi: 10.3390/ijerph16214120. PMID: 31731559; PMCID: PMC6862073.
7. World Health Organization, Oral Health Surveys: Basic Methods [Internet]. 2019 [cited 2021 Feb]. Available from: https://www.who.int/publications/i/item/9789241548649
8. Yon MJY, Gao SS, Chen KJ, Duangthip D, Lo ECM, Chu CH. Medical model in caries management. Dent J (Basel). 2019 Apr;7(2):37. doi: 10.3390/dj7020037. PMID: 30939816; PMCID: PMC6631812.
9. Frencken JE, Peters MC, Manton DJ, Leal SC, Gordan VV, Eden E. Minimal intervention dentistry for managing dental caries - a review: report of a FDI task group. Int Dent J, 2012 Oct;62(5):223–43.doi:10.1111/idj.12007 PMID: 23106836; PMCID: PMC3490231.
10. Pretty IA. Caries detection and diagnosis: novel technologies. J Dent. 2006 Nov;34(10):727–39.doi:10.1016/j.jdent.2006.06.001. PMID: 16901606.
11. Gugnani N, Pandit IK, Srivastava N, Gupta M, Sharma M. International Caries Detection and Assessment System (ICDAS): A new concept. Int J Clin Pediatr Dent. 2011 May-Aug;4(2):93–100. doi: 10.5005/jp-journals-10005-1089. PMID: 27672245; PMCID: PMC5030492.
12. Pitts NB, Ismail AI, Martignon S, Ekstrand K, Douglas GVA, Longbottom C. ICCMS™ Guide for Practitioners and Educators [Internet]. 2014 [cited 2021 Feb]. Available from: https://www.iccms-web.com/uploads/asset/59284654c0a6f822230100.pdf
13. International Caries Classification and Management System (ICCMS)™, ICCMS™ Caries Management. 2018 [cited 2020 Sep]. Available from: https://www.iccms-web.com
14. Khattak MI, Csikar J, Vinall K, Douglas G. The views and experiences of general dental practitioners (GDP's) in West Yorkshire who used the International Caries Detection and Assessment System (ICDAS) in research. PLoS One. 2019 Oct;14(10):e0223376. doi: 10.1371/journal.pone.0223376. PMID: 31584966; PMCID: PMC6777823.
15. Kaliyaperumal K. Guideline for conducting a knowledge, attitude and practice (KAP) study. AECS Illumination. 2004 Jan-Mar;4(1):7-9.
16. World Health Organization & Stop TB Partnership. Advocacy, communication and social mobilization for TB control: a guide to developing knowledge, attitude and practice surveys. World Health Organization [Internet]. 2008 [cited 2020 Sep]. Available from: https://apps.who.int/iris/handle/10665/43790.
17. Al-Khalifa KS. Use of the International Caries Detection and Assessment System by dental students at the University of Dammam, Saudi Arabia. Saudi J Dent Res. 2016 Jan;7(1):38-44. doi:10.1016/j.sjdr.2015.03.001.
18. Afsaneh P, Fatemeh SS, Javad KM. Knowledge, Attitude and Self-Reported Practice of Senior Dental Students in Relation to Caries Risk Assessment [Internet]. 2014 [cited 2020 Sep]. Available from: https://www.semanticscholar.org/paper/Knowledge%2C-Attitude-and-Self-Reported-Practice-of-Afsaneh-Fatemeh/fa8d1cd88f595b445f07d11c63599f018aedb2b3
19. Diniz MB, Lima LM, Pinto LS, Eckert GJ, Ferreira Zandoná AG, Cordeiro R. Influence of the ICDAS E-Learning Program for Occlusal Caries Detection on Dental Students [Internet]. 2010 [cited 2020 Sep]. Available from: https://www.jdentaled.org/content/74/8/862/tab-article-info
20. Alves LS, de Oliveira RS, Nora ÂD, Cuozzo Lemos LF, Rodrigues JA, Zenkner JEA. Dental students' performance in detecting in vitro occlusal carious lesions using ICDAS with E-learning and digital learning strategies. J Dent Educ. 2018 Oct;82(10):1077-83. doi: 10.21815/JDE.018.100. PMID: 30275142.
21. Gomez J. Detection and diagnosis of the early caries lesion. BMC Oral Health. 2015;15 Suppl 1(Suppl 1):S3. doi: 10.1186/1472-6831-15-S1-S3. PMID: 26392124; PMCID: PMC4580848.