REDUCING THE REJECTION RATE OF INTRA-ORAL PERIAPICAL RADIOGRAPH AT TENGKERA DENTAL CLINIC

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Abstract

Intra-oral periapical (IOPA) radiograph is a crucial adjunct in diagnosing dental diseases. Obtaining diagnostically acceptable radiographs on the first attempt is vital, as rejected radiographs lead to time and resource wastage. At Tengkera Dental Clinic (TDC), the rejection rate of IOPA radiographs showed a concerning increase, rising from 6.4% (2021) to 7.0% (2022). This quality improvement study aimed to reduce the rejection rate to <5% within a year. The indicator used was the percentage of rejected IOPA radiographs. The standard was set at <5%, based on the Quality Objective of the Melaka Oral Health Division in 2022. This study was conducted in TDC from April 2023 to March 2024. Data were retrieved from the monthly report (BK13). A clinical audit and a survey were conducted among 25 operators to assess their knowledge, experience and skills in radiograph taking and processing. The verification study revealed a rejection rate of 5.9%. The main contributing factors identified include poor knowledge and skills among operators, inappropriate methods for taking and processing radiographs, and patient movement during radiation exposure. In Cycle 1, the strategies implemented were converting the current guideline into infographic posters, conducting hands-on training and clinical audits to improve operators' knowledge and skills. In Cycle 2, a demonstration video and an innovative tool were created to help patients stay still during radiograph acquisition. After two cycles, the rejection rate was reduced to 2.2%, with an Achievable Benefit Not Achieved of -2.8%. All criteria in the Model of Good Care were increased from 95 to 100%. Moreover, the cost was reduced by MYR104.40 (≈USD25.93 as of August 2026) (43%) within a year. Patients also reported increased satisfaction, decreased pain and reduced anxiety during radiograph acquisition. Remedial measures have been introduced to two other dental clinics (Ayer Molek Dental Clinic and Cheng Dental Clinic).

KEYWORDS: Periapical disease, radiography, dental, digital, quality improvement study

Problem

Intra-oral periapical (IOPA) radiographs are crucial diagnostic adjuncts, but their operator-dependent nature makes image quality prone to technical errors during acquisition (1-4). Obtaining high-quality IOPA images requires precise film positioning, beam alignment, and patient positioning (5). Rejected non-diagnostic radiographs require repeat exposure (6). To adhere to the As Low As Reasonably Practicable (ALARP) principle and ensure patient safety, repeated exposures must be minimised (7-9). Additionally, rejected radiographs increase treatment costs, patient waiting times, and operator workload (10,11).

Highlighting this issue, Tengkera Dental Clinic (TDC) recorded a concerning upward trend, rising from 6.4% in 2021 to 7.0% in 2022 (12). Out of 966 IOPA radiographs produced in 2022, 68 were rejected based on monthly logs in BK13 reports, exceeding the Melaka OHD quality objective of maintaining a rejection rate below 5%.

These rejections compromised clinical efficiency and resource utilisation at TDC, a primary government dental clinic in the Melaka Tengah district. In 2022, the facility served a total of 15,333 patients, providing services ranging from scaling and restorations to extractions, root canal treatment, and minor oral surgeries. It was staffed by 16 Dental Officers (DOs) and nine Dental Surgery Assistants (DSAs), who were responsible for taking and processing radiographs. Unlike facilities with a digital imaging system, TDC relies on a conventional dental radiographic system that involves exposing IOPA radiograph films to radiation and subsequently developing the film manually through chemical processing to produce visible images.

To address the gap, this quality improvement study aimed to reduce the rejection rate of IOPA radiographs at TDC to below 5% by implementing a few local interventions within a year.

Background

Radiographic imaging is an essential aid for oral diagnosis, treatment planning and carrying out specific dental procedures (1,2,13). Among the available imaging modalities, IOPA radiographs are one of the most commonly used because they provide detailed two-dimensional images of individual teeth and their surrounding structures (14). They come in multiple sizes, with 30 x 40 mm being the most commonly used, as it offers an optimal balance between coverage and patient comfort (6). Reducing unnecessary repeat exposures is important because the stochastic effects of ionising radiation are cumulative, and even small doses may pose a potential risk (8,16).

Despite its importance, the high rejection rate of IOPA radiographs poses a challenge to many dental practitioners worldwide. A review by Yeung et al. (17) reported an average IOPA radiograph rejection rate of 16.4% across multiple studies. In Saudi Arabia, 16.7% of IOPA radiographs were deemed unacceptable from an audit involving dental operators (13). This outcome is parallel with the findings of Salami et al. (18) from a postgraduate paediatric dental clinic in Dubai, which had 14.0% of radiographs categorised as unacceptable.

Several factors contribute to high IOPA rejection rates, which can be categorised as operator- or patient-related. The most frequent factors include incorrect film or X-ray tube positioning, angulation errors, processing errors and patient movement. Multiple studies revealed improper film and X-ray tube positioning as the most prevalent cause for IOPA radiograph rejection (17,19-22). The higher incidence of IOPA radiograph rejection has been linked to deep placement of the IOPA film within the oral cavity. In order to obtain a clear image of the root apices within the alveolar bone, the film often contacts the floor of the mouth or the palatal vault, causing patient discomfort and potentially triggering the gag reflex (17). Aside from positioning errors, studies by Patankar et al. (22) and Zewdeneh et al. (16) identified incorrect exposure settings and patient movement as common reasons for film rejection.

In order to obtain a diagnostically acceptable IOPA radiograph on the first attempt, film holders with guidance rings

should be used to hold the IOPA films in place and to align them precisely with the X-ray beam (13,17). Besides that, staff who undergo regular training and have excellent clinical experience generally contribute to lower IOPA radiograph rejection rates (17). Hence, periodic training and continuous professional education are recommended for all dental personnel to reduce the frequency of radiographic errors, notably when new techniques or equipment are introduced in a facility (13,17,22–24).

Implementing Quality Assurance (QA) initiatives is another effective strategy to reduce radiographic errors. These projects offer valuable insights into error prevention, contributing to cost reduction and minimising patient exposure to unnecessary radiation (16,18,25). The significance of integrating QA measures into clinical practice is parallel to the requirements of Ionizing Radiation (Medical Exposure) Regulations and the Ionizing Radiation Regulations 2017 (26,27).

Measurement

According to the Guidelines on Radiation Safety in Dentistry published by the Malaysian Dental Council in 2010 (7), corrective measures should be carried out if the radiograph rejection rate exceeds 10%. While the national guidelines established this threshold for corrective action, the criteria for analysing the rejection rate may vary depending on standards set by the state level or a specific dental facility.

Although the IOPA rejection rate at TDC was considerably lower than reported in the literature, it still exceeded the local benchmark of <5% set by the State OHD, thereby necessitating targeted interventions to achieve the required standard. A quality improvement study was conducted over the span of 12 months in TDC, from April 2023 to March 2024. Our inclusion criteria consisted of all IOPA radiographs with no exclusion criteria. An IOPA radiograph was considered acceptable if it provided diagnostic information by capturing the full length of the tooth with at least 3 mm of tissue surrounding the root tip (13). Conversely, a radiograph was classified as rejected if it exhibited image distortion (foreshortening or elongation), improper film exposure (poor contrast), failure to capture the area of interest (cone cut, image cut or contact overlap), image blurring or the presence of stains and fingerprints on films which hindered clear visualisation of the tooth (3,13, 28). The indicator for this study was the rejection rate of IOPA radiographs at TDC, obtained from the monthly BK13 report. The formula used to calculate the indicator is as follows:

$$\textit{Percentage of rejected IOPA radiographs} = \frac{\textit{Number of rejected IOPA radiographs}}{\textit{Total number of IOPA radiographs taken}} \times 100$$

A verification study conducted from May to June 2023 revealed that 10 out of 169 IOPA radiographs were rejected, resulting in a rejection rate of 5.9%. Following the verification study, the remedial measures and re-evaluation were implemented in two cycles: (i) Cycle 1: July – September 2023 and (ii) Cycle 2: October – December 2023.

Initial Assessment of the Problem

The initial process of care related to radiograph taking and processing was reviewed and outlined based on the Operating Procedure 4 (29). Six critical steps were identified:

i) Choosing the appropriate mode for the area/ tooth of interest;
ii) Positioning of patient;
iii) Choosing the appropriate X-ray film holder;
iv) Positioning of X-ray film;
v) Positioning of X-ray tube; and
vi) Processing X-ray film

The contributing factors to the high rejection rates of IOPA radiographs at TDC were outlined in the problem analysis chart in Figure 1. Among the five main factors identified, patient movement during radiation exposure, inappropriate methods for radiograph taking and processing, and lack of knowledge among operators were the

only three factors which could be remedied. Whereas unfavourable patient anatomy for proper placement of films and unfavourable materials available were the factors beyond our control and therefore not addressed in our study.

A few verification tools were used to identify the contributing factors causing increased rejection rates of IOPA radiographs. Firstly, a self-administered questionnaire was distributed among a total of 25 operators, comprising 16 DOs and nine DSAs. The questionnaire for DO consists of ten sections with 24 questions, whereas the questionnaire for DSA consists of ten sections with 23 questions. Both questionnaires were used to evaluate the operator's knowledge, training experience and difficulties faced during IOPA radiograph taking and processing. The results indicated that 32.0% (n=8) of the operators demonstrated poor knowledge in taking and processing IOPA radiographs, which corresponds to scoring less than 50% in the knowledge section of the questionnaire. Additionally, 56.0% (n=14) of them claimed that they lacked formal radiograph-taking training at work. While 20.0% (n=5) felt that the current guideline was overly wordy and difficult to be referenced during radiograph procedures, and eight per cent (n=2) of the operators were unaware of the Operating Procedures 4. Sixty-nine per cent (n=17) of the operators also felt that the rubber dam clamps obstructed the proper placement of the film in patients' mouths.

Our questionnaires revealed that unfavourable patient anatomy for proper placement of the film, such as a small mouth, presence of tori, and shallow palate, was rated as the top contributing factor at 92.0%. Patient movement during exposure was agreed by 84.0% (n=21) of our respondents. In addition to that, 28.0% (n=7) of the operators did not provide a clear explanation of the radiograph-taking procedure to patients beforehand, resulting in patient movement during radiography acquisition and subsequently causing rejection of radiographs. Operators also claimed gag reflex (96.0%), uncooperativeness (88.0%) and anxiety (28.0%) were causing the patient movement during the procedure. They also reported that the availability of only one film size at TDC contributed to the difficulty in taking IOPA radiographs.

Secondly, a clinical audit form (Appendix 1) was established based on the Operating Procedure 4, which included all the critical steps in our Model of Good Care (MOGC). It was conducted by two senior dental officers between May and June 2023 to evaluate the DO's and DSA's skills in taking and processing IOPA radiographs. The results from the audit showed that only the selection of the appropriate X-ray holder achieved 100% compliance, while the compliance for the remaining steps ranged from 45.0% to 95.0%. Twenty-six per cent (n=6) of the operators did not adhere to the Operating Procedure and were deemed to use inappropriate techniques during IOPA radiograph acquisition and processing. Both the questionnaires and clinical audit forms were validated by a dental restorative specialist from the Ayer Keroh Dental Clinic.

Strategy

Following the verification study, five strategies for change were implemented and re-evaluated after three months. There were two cycles of remedial actions implemented. Cycle 1, conducted from July to September 2023, included three strategies to improve operators' knowledge and skills. In Cycle 2, from October to December 2023, two strategies were added that focused on reducing patient movement during radiograph taking while reinforcing the strategies from Cycle 1. Although patient movement was the main contributor to the high percentage of rejected IOPA radiographs, operator factors were targeted in the first cycle as it is more predictable and manageable.

Cycle 1: July – September 2023

In Cycle 1, the guideline was converted into infographic posters for convenient reference during radiograph taking and processing (Appendix 2). This strategy addressed feedback from operators in the verification study, who found the current guideline to be too wordy and lengthy. The newly designed infographics provided clear, concise instructions with engaging visuals, allowing operators for a quick reference

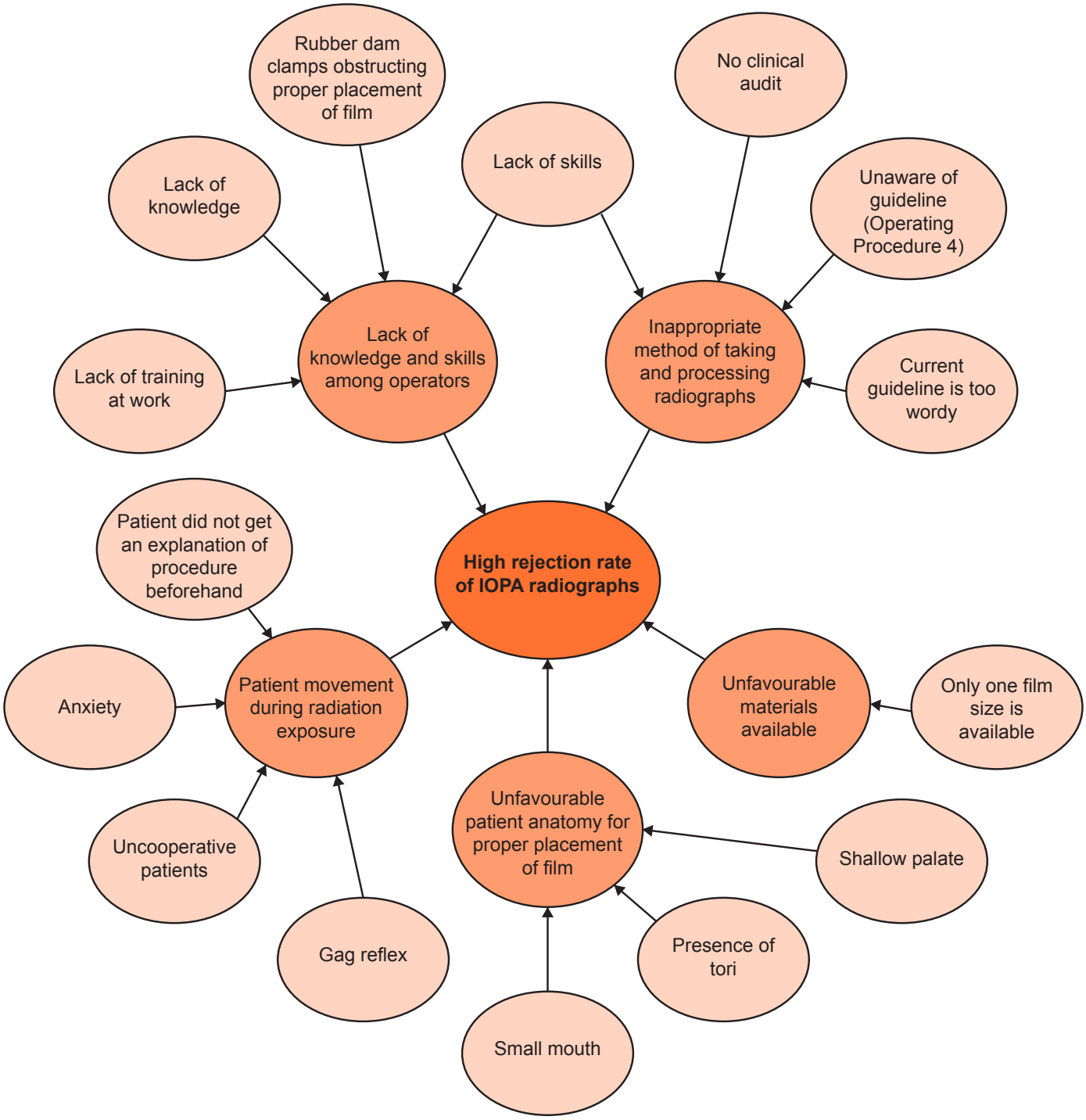


Figure 1: Problem analysis chart showing the factors contributing to the high rejection rate of IOPA radiographs

during procedures. The effectiveness was gauged based on operator feedback, which revealed a significant improvement in adherence to the recommended steps.

Secondly, a comprehensive hands-on workshop led by a restorative specialist was conducted to enhance operators' knowledge and skills in radiograph taking and processing. The workshop included a pre-assessment, theoretical lesson, practical session, and post-assessment. The pre- and post-workshop assessment was conducted using a self-administered questionnaire, made available to all operators via an online platform. The theoretical lesson comprised a lecture delivered by the specialist, covering key principles and protocols. During the practical session, operators practised

placing X-ray films and holders on each other, simulating real-life scenarios. The restorative specialist provided individualised advice and guidance throughout both lessons to ensure effective learning. At the end of the workshop, each operator was required to achieve a minimum score of 80% on the post-assessment.

Finally, a clinical audit in radiograph taking and processing was conducted by the DO in charge of TDC to closely assess and monitor all operators' skills. The DO observed each operator during the procedures, with their performance systematically cross-checked against an audit form outlining critical steps. Operators who failed to fully comply with the critical steps received tailored feedback aimed at preventing future errors. This hands-on monitoring and feedback approach helped to reinforce best practices and contributed to a notable reduction in the rejection rate.

Cycle 2: October – December 2023

Following the successful implementation of Cycle 1, Cycle 2 was introduced to address patient-related factors. By including strategies to reduce patient movement and anxiety, Cycle 2 aimed to further reduce the rejection rate of IOPA radiographs while maintaining the progress achieved in the first cycle.

Apart from implementing the strategies from Cycle 1, Cycle 2 introduced a two-minute demonstration video in Malay explaining the radiograph-taking procedure and safety measures. The video featured a detailed explanation of the IOPA radiograph safety and a simulation of the procedure. The video was shown to patients before the radiograph procedure to familiarise them with the process, reduce anxiety, and minimise movement.

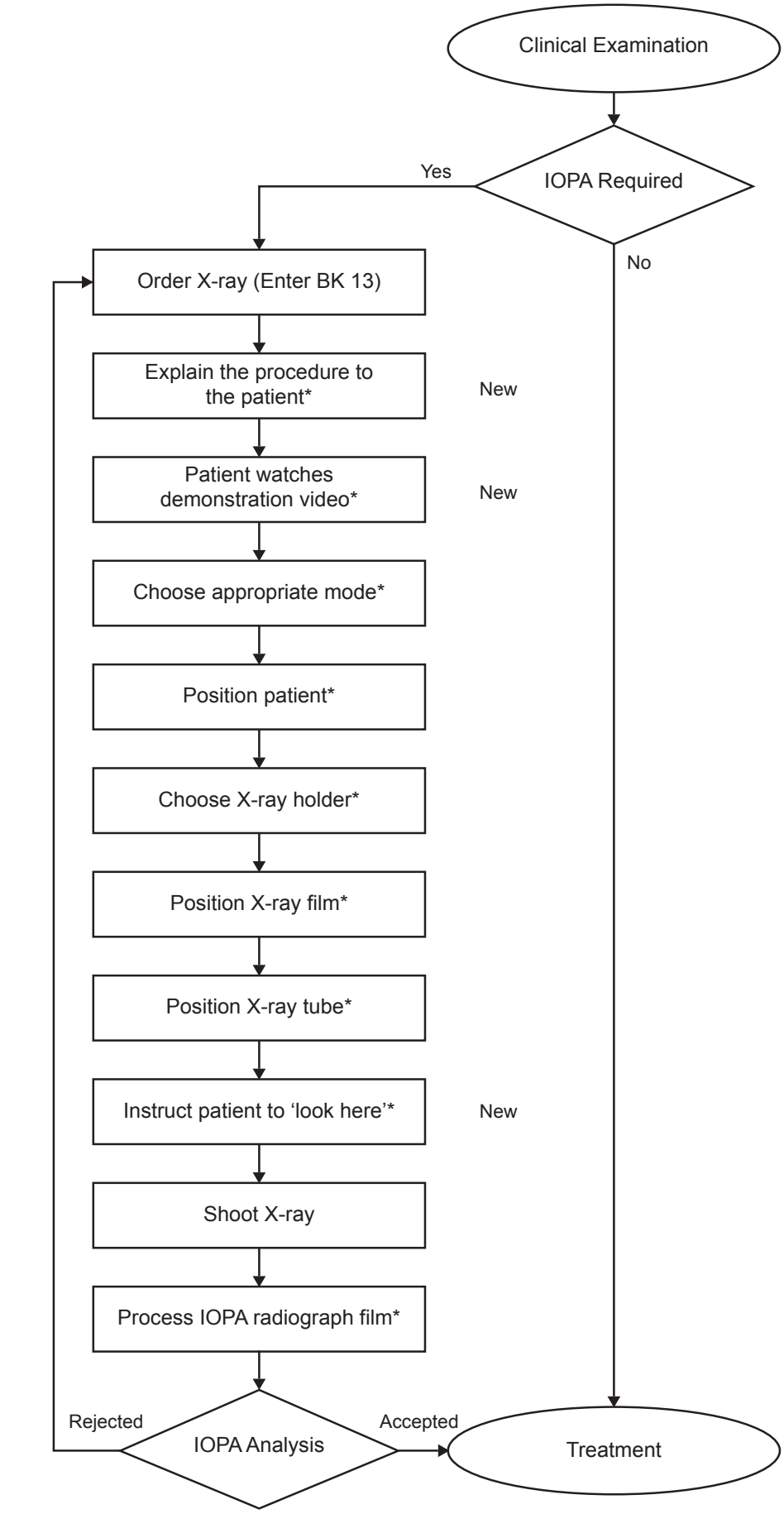
Additionally, a portable and affordable tool featuring a 'look here' sign was developed to assist patients in stabilising their heads during radiograph taking. The tool consists of a mobile phone holder and a customisable printed sign, which can display messages such as 'look here' or 'do not move'. It can be securely attached to the armrest of the radiograph chair, helping patients maintain a fixed head position by focusing on the sign during the procedure. With a cost of only MYR9.90 (USD2.43 as of September 2026), this tool is both practical and easily replicable for use in other dental facilities.

The process of care (Figure 2) was enhanced by adding three new critical steps: explaining the procedure to patients, ensuring patients watch the demonstration video and requesting patients to focus on the 'look here' sign before X-ray was radiated.

Results

The rejection rate was reduced from 5.9% to 3.9% in Cycle 1 and further to 2.2% in Cycle 2. Comparing the final rejection rate to the standard of <5%, the final Achievable Benefit Not Achieved (ABNA) was -2.8% (Figure 3). The percentage of operators with good knowledge in radiography, defined as scoring more than 50% in the knowledge section of the questionnaire, increased from 68.0% to 80.0%, achieving an average score of 90.5% in the post-workshop assessment. Clinical audits conducted before and after the implementation of remedial actions revealed that adherence to the original six critical steps ranged from 45.0% to 100% prior to the intervention. Following the remedial measures after Cycle 1, compliance improved significantly, reaching 95.0% to 100% across all steps, including full adherence to the three newly introduced critical steps. The detailed percentage improvement for each step is illustrated in Table 1. Beyond these outcomes, the project also yielded cost savings. The cost for purchasing IOPA radiograph film and developing chemicals was reduced by 43.0% (MYR104.40 ≈ USD25.85 as of August 2026) in 2023 (MYR144.40) compared to 2022 (MYR244.80), due to fewer retakes. A patient satisfaction survey was distributed to two separate groups of patients, with 21 patients in the pre-remedial phase and 21 in the post-remedial phase. The survey consisted of eight questions, which assessed the patients' pain experience, anxiety levels, and overall satisfaction with IOPA radiograph procedures at TDC. The feedback obtained indicated increased satisfaction, decreased pain and reduced anxiety among patients during radiograph taking.

In April 2024, our strategies were expanded to other dental clinics in Melaka. Endorsed by the Melaka Tengah District



*indicates critical steps

Figure 2: Revised process of care showing the process of radiograph taking and processing at TDC based on Operating Procedure 4

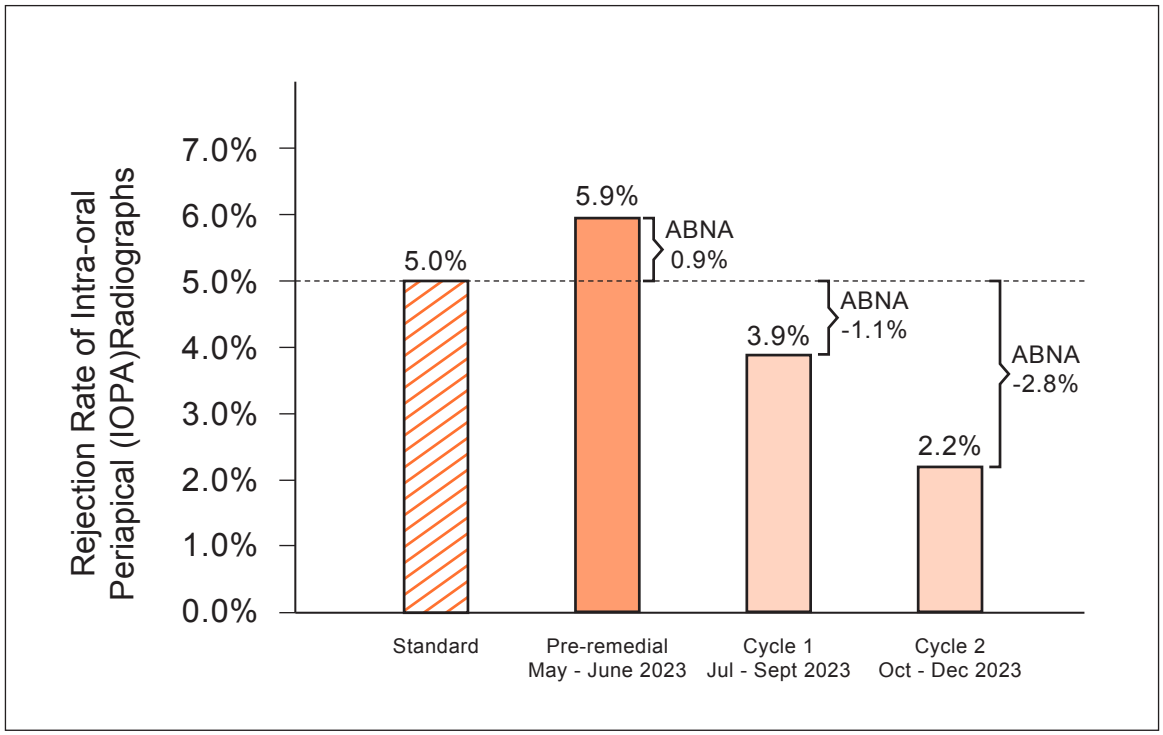


Figure 3: Percentage rejection rate of IOPA radiographs at TDC during pre-remedial and post-remedial phases

Table 1: Model of Good Care to reduce the rejection rate of IOPA radiographs at TDC

No.	Critical Step	Criteria	Standard (%)	Verification Study (%)	Cycle 1 (%)
New	Explaining the procedure to the patient	Explain the procedure to the patient verbally	100	0.0	100
New	Ensuring the patient watches the demonstration video	Ensure the patient watches the demonstration video before entering the X-ray room	100	0.0	100
1	Choosing the appropriate mode for the area/tooth of interest	Choose the correct exposure setting according to the type of area/tooth of interest and the patient's size	100	60.0	95.0
2	Positioning of the patient	Ensure the patient sits upright and does not move during the shooting of the X-ray	100	45.0	95.0
3	Choosing the appropriate X-ray film holder	Choose the appropriate X-ray film holder according to the area/ tooth of interest	100	100	100

4	Positioning of X-ray film	Position the X-ray film as close as possible to the area/ tooth of interest	100	95.0	100
5	Positioning of X-ray tube	Ensure the X-ray tube is parallel to the X-ray paralleling kit	100	95.0	100
New	Instructing the patient to 'look here' sign	Move the 'look here' sign to the patient's eye level and remind the patient to stay still throughout the procedure	100	0.0	100
6	Processing X-ray film	Inject the correct amount of DQE solution into the corner of the x-ray film packet	100	100	100
		Agitate the injected packet for more than 30 seconds	100	0.0	100
		Immerse the x-ray film in the hardening solution	100	100	100
		Wash the hardened film in running water for 15 seconds	100	0.0	90.0
		Drying film at the shade and good ventilation not more than 25°C	100	50.0	100

'New' indicates new critical steps added as part of the remedial actions taken

Dental Office, they were introduced at Ayer Molek Dental Clinic and Cheng Dental Clinic, both of which had the highest rejection rates within the first quarter of 2024, at 7.0% and 6.4% respectively. Following the implementation of remedial actions, the average rejection rates from May to July 2024 dropped to 5.2% at Ayer Molek Dental Clinic and 3.3% at Cheng Dental Clinic.

Lessons and Limitations

Despite the success, several challenges were identified. This includes limited availability of real patients for hands-on workshops, lack of time and supervision for regular clinical audits, and insufficient basic knowledge and training in quality assurance projects. Clinical audits were therefore not extended to Cycle 2 due to the unavailability of supervisors to oversee the process. Addressing these challenges is crucial for the sustained implementation of these strategies. Support from the OHD of Melaka and cooperation among all dental operators are imperative in minimising the rejection rate of IOPA radiographs in Melaka. Periodic discussions between management and dental staff are required to streamline the process of care, ensuring consistent improvement and adherence to the new guidelines.

Conclusion and the Next Steps

The remedial actions at TDC have been maintained throughout 2024. As of July 2024, the average rejection rate of IOPA radiographs at TDC was 2.2%. The success of these interventions at TDC has paved the way for their sustained implementation and expansion to all government dental clinics in Melaka. Following the introduction of remedial actions, the average rejection rate at Ayer Molek Dental Clinic dropped to 5.2%, whereas Cheng Dental Clinic was 3.3%. These results indicate that the strategies are effective and sustainable, supporting continued efforts to maintain rejection rates below the 5% standard.

Based on patient feedback, the demonstration video will be produced in multiple languages, including English, Chinese, and Tamil, to cater to a broader patient population. Discussions with the OHD of Melaka are underway to enhance the current dental radiography guidelines and establish a revised standard rejection rate. From a multidisciplinary perspective, these strategies have the potential to be scaled and adopted by the medical radiology department in Melaka.

In conclusion, the successful reduction of IOPA radiograph rejection rates at TDC from 5.9% to 2.2% highlights the effectiveness of our remedial measures. By expanding these strategies to other clinics and continuously refining our approach based on feedback and challenges, we can improve the quality of dental radiography across Melaka, benefiting both patients and dental practitioners.

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Conflict of Interest

The authors declare that there was no conflict of interest.

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References

1. Shah N, Bansal N, Logani A. Recent advances in imaging technologies in dentistry. World J Radiol [Internet]. 2014 [cited 2025 Feb 26];6(10):794. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC4209425/

2. Ali SA, Hussain M, Shahzad M, Irfan F. Quality analysis of periapical radiographs taken by dental assistants. Journal of the Liaquat University of Medical and Health Sciences [Internet]. 2018 Oct 1 [cited 2025 Feb 26];17(4):260–4. Available from: https://www.researchgate.net/publication/330699218_Quality_Analysis_of_Periapical_Radiographs_Taken_by_Dental_Assistants

3. Ediri Arachchi W, Chandrasena W, Tudugala R, Jayasinghe R. Reject Analysis of Intra-Oral Periapical (IOPA) Radiographs of Department of Radiology, Dental Teaching Hospital, Peradeniya, Sri Lanka. In: Proceedings of 8th International Research Conference, Kotelawela Defence University [Internet]. Sri Lanka: Kotelawela Defence University; 1996 [cited 2026 Sept 1]. Available from: https://www.researchgate.net/publication/281438774_Reject_Analysis_of_Intra-Oral_Periapical_IOPA_Radiographs_of_Department_of_Radiology_Dental_Teaching_Hospital_Peradeniya_Sri_Lanka_WM_Ediri_Arachchi_WMDTM_Chandrasena_R_Tudugala_and_RD_Jayasinghe

4. Nixon PP, Thorogood J, Holloway J, Smith NJD. An audit of film reject and repeat rates in a department of dental radiology. Br J Radiol [Internet]. 1995 [cited 2025 Feb 26];68(816):1304–7. Available from: https://pubmed.ncbi.nlm.nih.gov/8777590/

5. Williamson G. Intraoral Radiography: Principles, Techniques and Error Correction. 2014.

6. Chu WK, Ferguson S, Wunder B, Smith R, Vanhoutte JJ. A two-year reject/retake profile analysis in pediatric radiology. Health Phys [Internet]. 1982 [cited 2025 Feb 26];42(1):53–9. Available from: https://pubmed.ncbi.nlm.nih.gov/7056647/

7. Malaysian Dental Council. Guidelines on radiation safety in dentistry [Internet]. Putrajaya: The Malaysian Dental Council; 2010 Nov. Available from: https://www.academia.edu/34218953/Majlis_Pergigian_Malaysia_Guideline_on_Radiation_Safety_in_Dentistry_pdf

8. Lindell B, Dunster, H.J, Valentin J. International commission on radiological protection. History, policies, procedures. INIS – International Nuclear Information System [Internet]. 1999 Mar [cited 2026 Sept 1];8(1):1–8. Available from: https://inis.iaea.org/records/2dfy6-72432

9. Jabbari N, Zeinali A, Rahmatnezhad L. Patient dose from radiographic rejects/repeats in radiology centers of Urmia University of Medical Sciences, Iran. Health N Hav. 2012;04(02):94–100.

10. Zewdu M, Kadir E, Berhane M. Analysis and Economic Implication of X-Ray Film Reject in Diagnostic Radiology Department of Jimma University Specialized Hospital, Southwest Ethiopia. Ethiop J Health Sci [Internet]. 2017 Jul 1 [cited 2025 Feb 26];27(4):421. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC5615031/

11. Ofori E, Antwi W, Arthur L, Yeboah C, Dzefi-Tettey K. Analysis and economic implications of X-ray film repeat/reject in selected hospitals in Ghana. West Afr J Radiol [Internet]. 2013 [cited 2025 Feb 26];20(1):14. Available from: https://journals.lww.com/wajr/fulltext/2013/20010/analysis_and_economic_implications_of_x_ray_film.4.aspx

12. Ringkasan Daftar Bulanan Pengambilan X-Ray Klinik Pergigian Tengkera (M-BKPNM-BK13 pin.01)). Bahagian Kesihatan Pergigian Negeri Melaka.

13. Javed MQ, Kolarkodi SH, Riaz A, Nawabi S. Quality assurance audit of digital intraoral periapical radiographs at the undergraduate dental clinics. Journal of the College of Physicians and Surgeons Pakistan. 2020 Dec 1;30(12):1339–42.

14. Rakha M, R. GP, Sharma N, Devi RR, Rana AK, Kamble A. Radiographic Errors in Intraoral Periapical Radiographs. UNIVERSITY JOURNAL OF DENTAL SCIENCES [Internet]. 2024 Jun 22 [cited 2025 Feb 27];10(2). Available from: https://www.ujds.in/index.php/ujds/article/view/1207

15. Whaites E, Drage N. Essentials of dental radiography and radiology. S.L.: Elsevier Health Sciences; 2020

16. Zewdeneh D, Teferi S, Admassie D. X-ray reject analysis in Tikur ANBESSA and bethzatha hospitals. The Ethiopian Journal of Health Development [Internet]. 2016 [cited 2026 Aug 31];22(1). Available from: https://ejhd.org/index.php/ejhd/article/view/472

17. Yeung AWK, Wong NSM. Reject rates of radiographic images in dentomaxillofacial radiology: A literature review. Vol. 18, International Journal of Environmental Research and Public Health. MDPI AG; 2021.

18. Salami A, Halabi M, Hussein I, Kowash M. An Audit on the Quality of Intra-Oral Digital Radiographs Taken in a Postgraduate Paediatric Dentistry Setting. Oral Health Dent Manag. 2017;

19. Mourshed F. A study of intraoral radiographic errors made by dental students. Oral Surgery, Oral Medicine, Oral Pathology. 1971 Nov 1;32(5):824–8.

20. Patel JR, Greer DF. Evaluating student progress through error reduction in intraoral radiographic technique. Oral Surgery, Oral Medicine, Oral Pathology. 1986 Oct 1;62(4):471–4.

21. Hasan A, Ali SA, Khan JA, Batool Ali B. Technical Errors in Intra Oral Radiographs Obtained in Endodontic Department of A Teaching Dental Hospital. Journal of the Pakistan Dental Association [Internet]. 2019 May;28(02):50–4. Available from: http://www.jpda.com.pk/technical-errors-in-intra-oral-radiographs-obtained-in-endodontic-department-of-a-teaching-dental-hospital/

22. Patankar S, Karjodkar F, Sansare K, Vora S. Audit of the quality of intraoral periapical radiograph: An institutional study. Journal of Oral and Maxillofacial Radiology [Internet]. 2019 [cited 2025 Feb 27];7(2):21. Available from: https://journals.lww.com/jomr/fulltext/2019/07020/audit_of_the_quality_of_intraoral_periapical.1.aspx

23. Rushton VE, Hirschmann PN, Bearn DR. The effectiveness of undergraduate teaching of the identification of radiographic film faults. Dentomaxillofacial Radiology [Internet]. 2005 Nov 1 [cited 2025 Feb 27];34(6):337–42. Available from: https://dx.doi.org/10.1259/dmfr/19829457

24. Ezoddini Ardakani F, Dadsefat R. Investigating The Causes For Repeating Periapical Radiographies In Radiology Department Of School Of Dentistry And The Effect Of Education On Its Reduction. Iranian Journal of Medical Education [Internet]. 2010 [cited 2025 Feb 27];9(4):337–45. Available from: http://ijme.mui.ac.ir/article-1-1098-en.html

25. Toy A, Eaton KA. X-ray vision: how audit can help you reveal the quality of your radiography. Prim Dent J [Internet]. 2013 [cited 2025 Feb 26];2(1):32–9. Available from: https://pubmed.ncbi.nlm.nih.gov/23717888/

26. Benson E, Helen Hughes B, Rob Loader B, Dan Shaw I, Sue Edyvean I, Yvonne Sullivan P, et al. Guidance on using shielding on patients for diagnostic radiology applications 2 Guidance on using shielding on patients for diagnostic radiology applications [Internet]. Available from: www.bir.org.uk

27. The Ionising Radiations Regulations 2017 [Internet]. [cited 2025 Feb 26]. Available from: https://www.legislation.gov.uk/uksi/2017/1075/contents

28. Jayasinghe RD, Weerakoon BS, Perera R, Ediri Arachchi WM, Fonseka MCN, Wettasinghe KA. Quality of working length radiographs taken and used by dental students during endodontic treatment [Internet]. 2013. Available from: https://www.researchgate.net/publication/260782347_Quality_of_working_length_radiographs_taken_and_used_by_dental_students_during_endodontic_treatment

29. AK4 Pengambilan x-ray tanggungjawab tindakan [Internet]. [cited 2026 Mar 25]. Available from: http://203.217.177.13/eiso/bkpnm/admin/upload/doc_20200129142002_869558858.pdf

Appendix 1: Clinical audit form to evaluate DO and DSA's skills in dental radiography

LAMPIRAN A

BORANG PEMANTAUAN PENGAMBILAN X-RAY INTRA-ORAL UNTUK PEGAWAI PERGIGIAN (BERASASKAN AK 4 PENGAMBILAN X-RAY)

Nama Klinik: _____
Nama Auditor: _____
Tarikh Pemantauan: _____

KATEGORI	NO	VARIABEL	PESAKIT	1	2	...	20
			ID PESAKIT				
			SN XRAY				
Pengambilan Xray Intra Oral (Jenis Konvensional)	1	Pastikan bahagian mulut yang hendak di x-ray					
	2	Berikan penerangan tentang prosedur pengambilan x-ray kepada pesakit					
	3	Gunakan jenis filem x-ray yang sesuai					
	4	Rekod dalam Bk-13					
	5	Pasangkan suis lampu amaran radiasi					
	6	Pastikan mesin xray berfungsi					
	7	Pilih program x-ray yang sesuai mengikut bahagian mulut					
	8	Minta pesakit duduk di atas kerusi					
	9	Pasangkan apron pelindung sinaran x-ray pada pesakit					
	10	Letakkan filem x-ray di sebelah dalam bahagian mulut yang hendak di x-ray					
	11	Pastikan filem kekal pada bahagian yang hendak di x-ray					
	12	Tujukan tiub x-ray dengan betul pada bahagian mulut yang berkenaan					
	13	Gunakan x-ray parelling kit sekiranya ada dan mengikut keadaan					
	14	Minta pesakit jangan bergerak semasa pengambilan x-ray					
	15	Mulakan pancaran sinaran x-ray					
	16	Keluarkan filem dari mulut pesakit					
	17	Padamkan suis mesin x-ray dan lampu amaran radiasi					
	18	Minta pesakit menunggu di ruang menunggu/ bilik rawatan					

Kod skor diisi sebagai	
0	: Tidak Tepat
1	: Tepat
TB	: Tidak Berkaitan

PENGIRAAN SKOR				
KATEGORI	1	2	...	20
N (Jumlah skor)				
D (Jumlah variabel diperiksa)				
Peratus skor (N / D) x 100				
PURATA SKOR				

LAMPIRAN B

BORANG PEMANTAUAN PENGAMBILAN X-RAY INTRA-ORAL UNTUK PEMBANTU PEMBEDAHAN PERGIGIAN (BERASASKAN AK 4 PENGAMBILAN X-RAY)

Nama Klinik: _____
Nama Auditor: _____
Tarikh Pemantauan: _____

KATEGORI	NO	VARIABEL	PESAKIT	1	2	...	20
			ID PESAKIT				
			SN XRAY				
Pemprosesan Filem X-ray (Jenis Konvesional) dengan menggunakan X-ray Instant Hanshin	1	Sediakan larutan bancuhan fixer mengikut arahan pada kotak pembungkusan x-ray (100ml larutan air)					
	2	Keluarkan larutan DQE dengan syringe					
	3	Suntikan larutan DQEdengan perlahan ke penjuru pembalut x-ray mengikut sukatan yang detetapkan: Dental size: 3-3.5ml Junior size: 2-2.5ml Occlusal size 9-9.5ml					
	4	Gerakan larutan DQE dengan memicitkan perlahan-lahan pembalut plastik filem selama lebih dari 30 saat					
	5	Buka pembalut filem					
	6	Rendam filem ke dalam larutan 'hardening' yang telah disediakan					
	7	Cuci filem di bawah air lebih dari 15 minit dan tidak melebihi 30 minit					
	8	Pengeringan dibuat pada tempat yang terlindung dan mempunyai peredaran udara yang baik serta tidak melebihi 25°c					
	9	Filem X-ray diserahkan kepada PP untuk pengesahan status samada diterima atau tidak					
	10	Label filem x-ray (Nama pesakit/tarikh/SN/IC/kawasan terlibat) dan kepilkan					
	11	Bagi x-ray yang tidak memuaskan/tidak diterima, label 'Reject'					
	12	Catitkan hasil penemuan x-ray ke dalam kad rawatan dan maklumkan kepada pesakit					
	13	Kemaskini catatan pada BK-13					
	14	Ulang semula langkah pengambilan xray jika x-ray tidak diterima/reject					
	*	Jumlah masa yang digunakan untuk pengambilan x-ray					

Kod skor diisi sebagai	
0	: Tidak Tepat
1	: Tepat
TB	: Tidak Berkaitan

PENGIRAAN SKOR				
KATEGORI	1	2	...	14
N (Jumlah skor)				
D (Jumlah variabel diperiksa)				
Peratus skor (N / D) x 100				
PURATA SKOR				

Appendix 2: Infographic posters based on the Operating Procedure 4 guideline



