Abstracts of Theses Approved for the PhD/ MSc at the School of Dental Sciences, Universiti Sains Malaysia, Kubang Kerian, Kelantan, Malaysia

THE ACCEPTANCE OF THE ELECTRONIC PAYMENT SYSTEM FOR HEALTHCARE SERVICES AT HOSPITAL UNIVERSITI SAINS MALAYSIA

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Introduction: The success of integrating an electronic payment system (EPS) in public healthcare services is dependent on user acceptance, but little is known about this among Malaysians.

Objectives: This study assessed the prevalence and characteristics of EPS users, and the factors influencing acceptance of its use at public hospitals.

Methods: A cross-sectional survey was conducted on adults who perform a payment transaction at Hospital USM. Participants were selected using systematic random sampling and asked to complete self-administered questionnaires. Information on sociodemographic background and acceptance of EPS which was assessed using validated and reliable perceived usefulness (PU) and perceived ease of use (PEU) instruments and rated using a 5-point Likert scale, were collected.

Results: Of the 203 participants, 82.6% were current EPS users. PU and PEU were significantly correlated ($P < 0.001$). PU and PEU were associated with the participant's age, education level, monthly income, smartphone ownership and knowledge of and experience with EPS. Acceptance of EPS among current users was associated with frequent and daily use, modes and number of systems used and preferred. Participants who perceived EPS as a daily necessity had higher acceptance scores, planned to use it for healthcare services and supported the integration initiatives.

Conclusion: The participants in the study generally accepted the use of EPS as a payment method for healthcare services in public hospitals. However, there are individual variations related to the background and usage experience. While similar acceptance is expected among the city population, similar research is recommended to understand EPS acceptance among rural and less affluent populations.

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ANTI CANCER EFFECT OF PADDY HUSK EXTRACTS IN HUMAN SALIVARY GLAND EPIDERMOID CANCER CELLS IN VITRO MODEL

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Introduction: Global agriculture produces millions of tons of waste yearly. Paddy husk is an inedible agriculture waste obtained during the process of rice milling. Studies reported that it has chemopreventive potential due to the presence of related phytochemicals.

Objectives: The aim of this study is to elucidate the presence of anti-cancer related phytochemicals from paddy husk extract and evaluate its inhibitory and anti-proliferative effects against human submaxillary salivary gland epidermoid carcinoma cells (HTB-41).

Methods: Two types of solvent for paddy husk extract have been used; water and aqueous methanol. The phytochemical constituents of paddy husk extracts were identified using GC-MS. The inhibitory activity and cytotoxicity analysis was calculated using Trypan blue exclusion assay (TBEA). Apoptosis and cell cycle analysis were evaluated by flow cytometer and cell morphology post treatment was analysed ultrastructurally, while Western blot was performed for proteomic analysis.

Results: Our results showed presence of vitamin E and other phytochemicals in paddy husk extracts. Both water and aqueous methanol extracts demonstrated inhibitory activity on HTB- 41 cells where IC_{50} dose of water extract (400 µg/mL) managed to reduce cell viability to 53.0% and IC_{50} dose of aqueous methanol extract (200 µg/mL) managed to reduce cell viability to 51.12 % without exhibiting any significant cytotoxic effects. Apoptosis analysis revealed that water and aqueous methanol extracts induce apoptosis effect on HTB- 41 as supported with microscopic findings of cell shrinkage, membrane blebbing and apoptotic bodies, meanwhile, Hoechst 33342 staining showed nuclear shrinkage and fragmentation. Flow cytometry analysis demonstrated that paddy husk extracts promote a significant amount of apoptotic cellular population from 76.00% (untreated) to 47.86% (paddy husk water extract) and 43.13% (paddy husk aqueous methanol) and arresting the cells at S-phase from 19.90% (control) to 36.90 % (paddy husk aqueous methanol extract) and 27.86 % (paddy husk water extract). The Western blot analysis reveals that apoptosis was induced through caspase 3-mediated intrinsic pathway.

Pro-apoptotic and tumour suppressor proteins; Bax, p27kip1 expressed higher ($P < 0.05$), while anti-apoptotic protein, Bcl-2 downregulated after treatment ($P < 0.01$). This leads to increase of caspase 9 expression which in turn activate caspase 3 and caspase 7 leading to cell apoptosis.

Conclusion: In conclusion, the presence of phytochemicals in paddy husk especially in aqueous methanol extract successfully showed better inhibitory and anti-proliferative effects on the human submaxillary salivary gland epidermoid carcinoma cells (HTB-41), while it acted in a tumour-selective manner by not inducing any significant changes on human gingival fibroblast cell (HGF-1).

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HYBRID MODELLING USING DECISION TREE AND ORDERED REGRESSION: AN APPLICATION TO HEALTH SCIENCES RESEARCH

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Introduction: With the increasing complexity of healthcare data, there is a need for more advanced and integrative predictive modelling techniques. This thesis presents a novel hybrid methodology integrating Decision Trees and Ordinal Regression using the R-syntax.

Objectives: The study objectives include the development of the hybrid method, measuring its efficacy and efficiency, validating its performance through predictive classification analysis and optimising parameter estimates for optimised statistical inferences.

Methods: The hybrid methodology uses decision trees, facilitated by visualisation tools, to identify influential factors that shape the model's predictions. The bootstrap resampling method boosts the data set's resilience and facilitates the development of an ordinal regression model. The introduction of the hybrid accuracy index enhances interpretability.

Results: The hybrid methodology is employed in two health sciences scenarios. In Case I, it predicts the frequency of tooth brushing among students and in Case II, it predicts diabetic status using oral health indicators. This study introduces a hybrid method that generates numerical results along with graphical visualisation, enhancing the accuracy and efficiency of the parameter estimates.

Conclusion: The findings of this study contribute to the development of an innovative approach to transforming predictive modelling in healthcare, contributing to future research methodologies for more precise decision-making.

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PREVALENCE AND RISK FACTORS OF WORK-RELATED MUSCULOSKELETAL DISORDERS, AND EFFECTIVENESS OF DENTAL ERGONOMICS MODULE (DENTERGO) AMONG DENTAL THERAPISTS IN NORTHERN MALAYSIA

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Introduction: Dentistry is a high-risk profession for work-related musculoskeletal disorders (WMSDs). Applying ergonomic principles in the workplace will reduce WMSDs and improve work performance.

Objectives: The study aimed to determine the prevalence and risk factors of WMSDs and evaluate the effectiveness of the DentErgo module in improving knowledge (K), attitude (A) and practice (P) of dental ergonomics among dental therapists (DTs) in Northern Malaysia.

Methods: A quasi-experimental study was conducted from December 2022 until March 2023 among 236 DTs in Pulau Pinang and Kedah, in which the DTs were assigned to an intervention group ($n = 117$) and a control group ($n = 119$). The intervention group received an intervention programme using the newly developed DentErgo module and the control group received a lecture on infection control. The changes in the mean K, A, P score at baseline, 2 weeks and 4 weeks after the intervention were evaluated. SPSS version 25.0 was used and analysis using an independent *t*-test, Pearson's chi-squared test and multiple logistic regression were performed to determine the risk factors for WMSDs. RM-ANOVA and RM-ANCOVA were used to analyse the effectiveness of the DentErgo module on the dental ergonomics K, A, P.

Results: All DTs were female and mostly Malay (88.9%). The mean (SD) age was 35.2 (7.34) and 39.0 (6.99) years old in the intervention and control groups, respectively. The prevalence of WMSDs over a 12-month period in DTs was 90.3%. The neck was most commonly affected (82.6%), followed by the shoulder (78.4%), back (68.6%) and wrists (64.8%). The significant risk factor associated with the work-related musculoskeletal symptoms was the mean dental ergonomics practice score (OR: 0.04; 95% CI: 0.005, 0.331; $P = 0.003$). The within-group comparison showed a significant increase in the mean dental ergonomics K, A, P scores from baseline to post-intervention phase in the intervention group ($P < 0.001$). In contrast, only the mean dental ergonomics knowledge score showed a significant increase in the control group ($P = 0.001$). Significant differences were observed in the mean scores of dental ergonomics K, A, P between the intervention and control groups, before and after the intervention ($P < 0.001$).

Conclusion: The prevalence of WMSDs among DTs was high and the work-related musculoskeletal symptoms were associated with the dental ergonomics practice. The DentErgo module was effective in improving the dental ergonomics K, A, P among DTs. The module can also be

used by all categories of dental personnel as a guide to apply ergonomic principles in their clinical practice.

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DEVELOPMENT OF A NEW HYBRID REGRESSION MODEL: AN APPLICATION OF FUZZY REGRESSION AND MULTILAYER FEEDFORWARD NEURAL NETWORK METHODS IN HERBAL MEDICINE RELATED TO ORAL HEALTH KNOWLEDGE AND PRACTICE

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Introduction: Herbal extracts have been utilised in oral health to treat various ailments, including inflammation, as antimicrobial plaque agents, antiseptics, antioxidants, histamine release prevention, and as antibacterial, antifungal, antiviral and antimicrobial analgesics. Herbal medication also functions in healing, plaque reduction in the oral cavity and immune enhancement.

Objectives: To develop a hybrid model by considering bootstrap, neural network, and fuzzy regression for HMOH KP, to measure the efficacy and efficiency of the developed hybrid model for HMOH KP and to validate the newly developed hybrid model.

Methods: This study aims to develop the best strategy for handling data analysis, especially in HMOH KP, which combines fuzzy regression and Multi-layer Feedforward Neural Network (MLFFNN). R-programming software is used to write the developed syntax. All the essential steps are summarized in the R syntax.

Results: The new hybrid regression model incorporating bootstrapping, MLFFNN, and fuzzy regression increases the precision of the estimated parameters and compensates for the ambiguous relationship between the dependent and independent variables. The MLFFNN method has successfully measured the effectiveness, efficiency, and accuracy of the new hybrid model. The R^2 value and the predicted value obtained are used to validate the derived model.

Conclusion: This thesis presents a new methodology for creating precise and validated regression models through the utilisation of the HMOH KP dataset. Moreover, this approach can be extended to any other dataset that aligns with the provided assumptions.

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DEVELOPMENT OF A NOVEL BIOCERAMIC ROOT CANAL SEALER AND ITS EFFECT ON THE DISLODGEMENT RESISTANCE AND DENTINAL TUBULE PENETRATION

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Introduction: Root canal treatment preserves teeth by sealing the root canal system with ideal sealer materials. Incorporating bioactive glass and alginate into hybrid sealers presents a promising approach to improve root canal treatment outcomes, combining bioactivity, biocompatibility and strong sealing capabilities for enhanced clinical performance.

Objectives: The present study aimed to fabricate and characterise novel algin-incorporated bioactive glass 58S calcium-silicate root canal sealer (Bio-G) and evaluate its effect on the dislodgement resistance and dentinal tubule penetration to root dentinal walls in comparison to commercially available bioceramic-based sealers (BioRoot RCS and iRoot SP).

Methods: Three groups of bioactive glass (BG) 58S powders were synthesised using sol-gel method and characterised using SEM, HRTEM and FTIR for optimisation: BG-1 (no ammonia), BG-2 (3 ml of ammonia) and BG-3 (5 ml of ammonia). Optimised BG-3 was used to fabricate the powder form of experimental Bio-G sealer with the addition of calcium silicate, zirconia dioxide, calcium carbonate and alginic acid powder. Meanwhile, the liquid form composed of 5% calcium chloride solution. The experimental 0%–5% algin Bio-G sealers were then compared with BioRoot RCS and iRoot SP. Standardised disc specimens of mixed sealer materials (n = 5 per group) were prepared and placed in an incubator to allow setting before characterising under SEM, HRTEM, EDS, FTIR and XRD. Next, 176 mandibular premolars were randomly assigned (n = 16 per group): control, gutta-percha + 0%–5% algin Bio-G, gutta-percha + BioRoot RCS and gutta-percha + iRoot SP groups, with the exclusion of the control group in adhesive pattern and dentinal tubule penetration tests. They were instrumented, obturated and placed in an incubator for 72 h to allow sealer set. For the dentinal tubule penetration test, sealers were mixed with 0.1% of rhodamine B dye. Subsequently, teeth were cut into a 1-mm-thick cross-section at 5-mm and 10-mm levels from the root apex, respectively. Push-out bond strength, adhesive pattern and dentinal tubule penetration tests were performed.

Results: Experimental Bio-G sealer revealed irregular micro-sized particles with a higher content of oxygen, silicon and calcium, as well as trace of aluminium and chloride. Meanwhile, FTIR and XRD findings suggested that all sealers predominantly contained calcium silicate hydrate, calcium carbonate and zirconium dioxide, while calcium aluminium silicate oxide was detected in 0%–5% algin Bio-G. 5% algin

Bio-G showed the highest mean push-out bond strength ($P < 0.05$) with more favourable adhesion pattern, while iRoot SP showed the greatest sealer penetration ($P < 0.05$). In addition, no significant association was noted between the dislodgement resistance and dentinal tubule penetration ($P > 0.05$).

Conclusion: The present novel Bio-G sealer demonstrated desirable particle size distribution and acceptable degree of purity. Algin-incorporated Bio-G showed favourable adhesive pattern with comparable dislodgement resistance and dentinal tubule penetration values to commercialised bioceramic-based sealers.

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ANTIBACTERIAL ACTIVITY EVALUATION OF MALAYSIAN PROPOLIS AND PIPER BETLE TOWARDS ENTEROCOCCUS FAECALIS AS INTRACANAL MEDICAMENT

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Introduction: A favourable endodontic treatment outcome of teeth with apical periodontitis depends on the effective control of root canal infection. Chemomechanical cleaning and shaping of the root canal able to greatly reduce the number of microorganism but not completely eliminate them. Thus, an effective antimicrobial therapy was recommended to reduce the bacterial load and eventually provide a conducive environment for healing. Calcium hydroxide ($Ca(OH)_2$) is the most commonly used intracanal medicament (ICM) due to its wide range of antibacterial effect against common endodontic pathogen. However, its effectiveness against *Enterococcus faecalis (E. faecalis)* is limited and lead to exploration of other alternative agent.

Objective: To assess the antibacterial effect of $Ca(OH)_2$, propolis and *Piper betle (P. betle)* extract, and combinations of $Ca(OH)_2$/propolis and $Ca(OH)_2$/*P. betle* extract as ICM against *E. faecalis* within 24 h, 48 h and 7 days.

Method: Propolis and *P. betle* ethanolic extracts were prepared to determine the minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) towards *E. faecalis*. The effective ratio for combination $Ca(OH)_2$/propolis and $Ca(OH)_2$/*P. betle* were fixed. Following that, a total of 90 specimens of 5 mm length were obtained from extracted single rooted intact human teeth. The chemomechanical preparation of the root canals was completed before sterilisation procedure. Following sterilisation, 15 samples were kept sterile and the remaining samples were inoculated with pure culture of *E. faecalis*. After 21 days of incubation, pre-medication colony forming unit (CFU) were recorded. Then, the samples were randomly divided into five groups (n = 15). Each group was then exposed to different intra canal medicament namely $Ca(OH)_2$ (group 1), propolis (group 2), *P. betle* (group 3), combination $Ca(OH)_2$/propolis (group 4) and combination $Ca(OH)_2$/*P. betle* (group 5). The antibacterial effectiveness of these intracanal medicament were recorded by determining the reduction in colony count (RCC) at the end of 24 h, 48 h and 7 days. The data were statistically analysed using analysis of variance (ANOVA) and Tukey's post hoc test.

Results: The MIC and MBC for ethanolic extract of propolis were 0.392mg/mL and 0.783mg/mL, respectively. *P. betle* extract showed MIC and MBC at 0.783mg/mL and 1.564mg/mL, respectively. Propolis, *P. betle*, combination $Ca(OH)_2$/propolis and $Ca(OH)_2$/*P. betle* exhibited comparable reduction of colony count as $Ca(OH)_2$ following period of medicament application. Further analysis showed that $Ca(OH)_2$, propolis, *P. betle*, combination $Ca(OH)_2$/propolis and $Ca(OH)_2$/*P. betle* exhibited significantly better antibacterial properties after 7 days of medicament duration ($P < 0.05$). There was also statistically significant interaction between different group of medicament and duration of medicament application.

Conclusion: All tested ICM exhibited comparable antibacterial effect towards *E. faecalis* nevertheless the significant effect was observed on day 7 of application.

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