

Invasive approaches in operative dentistry, focusing on techniques such as restorations and selective carries removal

¹Dr Ahsan Ali, ²Iqra Ejaz, ³Dr Muhammad Abdul Wajid Khan, ⁴Dr Ejaz Hussain Sahu, ⁵Dr Jayyad Salim Awal, ⁶Dr. Fariha Naz, ⁷Kashif Lodhi

¹Assistant Professor, Operative Dentistry, Rehman College of Dentistry Peshawar

²Assistant Professor, Oral Biology Department Bakhtawar Amin Medical and Dental College, Multan

³Senior Lecturer, Community Dentistry Dental Section Frontier Medical College

⁴Professor, Department of Community Dentistry, Multan Medical and Dental College, Multan

⁵Watim Dental Hospital.

⁶University College of Medicine and Dentistry, University of Lahore

⁷Department of Agricultural, Food and Environmental Sciences. Università Politécnică delle Marche Via Brece Bianche 10, 60131 Ancona (AN) Italy

Keywords: Operative Dentistry, Restorations, Selective Carries Removal, Minimally Invasive Approaches, Minimally Invasive Dentistry.

Abstract

INTRODUCTION

Every dentist's main goal is to preserve the healthy set of the natural teeth of the patient. The primary goal of all the work done in the health sector is the preservation of body of human and its functions. Even the loss of a minor portion of a finger or toe is deemed tragic by the surgeon, despite the fact that the patient will still have nine more. Similar to how losing even a small portion of tooth of human must be treated as the serious injury that should not be taken lightly, the teeth are unquestionably deserving of most meticulous restoration.¹ The main idea in contemporary technique to the role of dentist in the treatment of the dental caries is that damage of even small portion of the teeth of human must be considered as the injury, and the goal of the dentistry must be the preservation of the natural, and healthy structure of tooth. A study summarised this concept

in their statement.² Given our current state of scientific knowledge and our ability to carry out his vision, his comments may be even more pertinent now than they were fifty years ago. The dental science of identifying, the diagnosing, preventing, and the treating of the dental caries at the microscopic level is the component of the minimally intrusive method of treating the dental caries. In addition to a number of nonsurgical treatment options, the fundamental idea behind this strategy for treating dental caries is that it should be treated like an infectious condition. Dental caries, an infectious, contagious illness brought on by oral biofilm, dental plaque, and exposure to fermentable carbohydrates, has long been recognised as such. When fermentable carbohydrates are present, plaque bacteria release acid. As a result of acid dissolving, calcified portion of the dental hard tissues, the

infection results, followed by the gradual structural loss of the teeth, the pulpal disease, as well as ultimately the teeth loss. In past, the method used to cure caries by dentistry was the surgical removal of the diseased tissue and the replacement with the material for dental restorative. Given frequency of sickness, the disease process's understanding, limitations of the materials at our disposal, and dearth of effective therapeutics alternative, this approach was required.^{3,4}

Dentists had historically had difficulty preserving tooth structure due to a lack of knowledge about the process of caries and their shortcomings in materials of restoration that were readily available. The capacity to recognise the earliest symptoms of disease is another significant restriction that will continue to influence decisions for restoration rather than continuously monitoring carious lesions. When used to identify caries, dental radiography and visual inspection are not accurate enough.

In order to completely integrate innovative methods for management of the dental caries, the researches are ongoing for enhancing the methods of the earlier caries diagnosis.¹ Additionally, novel caries care techniques that distinguish between individuals with various caries risk categories have been created.⁵ Dentistry must accept that no strategy will be effective in stopping additional caries activity, including fluoridation and preventing the micro-leakage of bacteria in between the tooth and repair. Patients must be actively involved in the management of their conditions by their dentists. All restorative operations must thus only be occurred in the conjunction with the clear preventative measures and education of patient.⁶ It is now possible for dentists to perform procedures other than just removing and replacing damaged tissue because to the advent of the adhesive dentistry and the advances in our caries's understanding. The concept of "minimally intrusive dentistry" has replaced the idea of "extension for prevention," as evidenced by revised the model of the care which have been updated from the presented by a study 5 and incorporates following ideas:

- The early detection of the caries;
- Utilizing radiographs to classify the depth and advancement of dental caries;
- Evaluation of a person's caries risk (moderate, low, or high);

- To lessen the risk of the additional demineralization and cavitation, cariogenic bacteria must be reduced;
- Active lesions being stopped;
- Remineralization & monitoring of the halted non-cavitated lesions;
- Utilizing the minimal cavity designs, restorations are placed in teeth having cavitated lesions;
- repairing rather than replacing faulty restorations;

Disseminating illness management outcomes at predetermined periods.⁷ This article summarises the scientific evidence on the development of caries, preparation design, early detection, and the selection of material to provide overview for the least invasive approach for diagnosing, treating, and also detecting of the dental caries.

EARLY DIAGNOSIS

Cariou lesion detection is simply one element of the caries diagnosis. The activity of Caries, which might be much essential, and must be assessed also but was sometimes not easy for quantifying. The activity of Caries is a process which would begins with the presence of the connected dental plaque and progresses for the demineralization of underlying tooth structures. It was critical for that caries activity couldn't be detected at a single point within time; and it should be determined by lesion monitoring throughout the period. The clinical and Radiographs info were typically utilised for establishing that determination, via new methods of diagnosis are developing.⁸ Sever approaches were superior for the detection of the occlusal caries, whereas the other are better for the detection of the smooth-surface or proximal lesions. The new technologies that include the electrical conductance techniques, laser fluorescence, quantitative laser fluorescence, optical coherence tomography, and tuned-aperture computed tomography.⁹ There are obvious need for the research for improvement of the accuracy of the procedures of diagnosis. Furthermore, therapeutic and diagnostic methods were being established to help in the treatment decisions that is grounded on the clinical markers of the activity of caries and the risk.¹⁰ Obviously, there was a requirement to establish the indicators' site-specific for future risk of caries.¹¹⁻¹³

MATERIALS

Due to adhesive dental materials that do not require the insertion of the mechanical retention elements, they allow for the preservation of the structure of tooth with preparations of least invasive cavity. Options include the GICs, the resin-based dentin/composite bonding agents, also the layered combination of the composites based on resin and the GICs applied via the procedure known as lamination.^{14,15}

Glass ionomer cements (GICs): The benefits of the GICs include the adhesion of tooth and the fluoride as well as some other ions' release. They work effectively in the environments of the low-stress. Calcium, aluminium, and the Fluoride ions are released into saliva and tooth by the GICs. Furthermore, the set glass ionomer was rechargeable, which means it may absorb the environmental fluoride, which was made available by fluoride toothpaste and treatments exposure.¹⁶ The uptake of fluoride and gradual release will have the anticariogenic impact, but the clinical investigations had yet to confirm it. One of the drawbacks of GICs is method sensitivity. By the addition of resin for material, the qualities of handling and the brittleness of material could overcome. The RMGICs, are easy for apply, the light-cure, and had superior aesthetic attributes as a result. The addition of a resin component, on the

other hand, has disadvantage of introducing the polymerization shrinkage. fissure sealants, Cervical restorations, anterior permanent teeth proximal lesions GICs and RMGICs can be used to treat, and the proximal lesions anteriorly and primary teeth's posterior.^{17,18}

Resin based dentin/composite bonding agents:

The excellent connection/bonding of the resin to the enamel is an important consideration when selecting those materials. The preparations of Cavity that were designed to preserve as much the enamel as possible can obviate the requirement for macro mechanical retention. However etching enamel and dentin, as well as the development of the layer, have enhanced the quality of the bond, and technology is continually advancing, the shrinkage of polymerization as well as the marginal leakage remain issues when margins are in dentin.¹⁹ Because of their low viscosity, newer flowable resin-based composites are frequently employed in the preparations of preventive resin-type and cavities of class V.²⁰

Lamination: The Lamination, often called the sandwich methods, that took advantage of the physical qualities of the both the resin-based composite and GIC. The GICs was inserted initially due to their dentin adherence and release of fluoride. The GIC is laminated with a resin-based composite for enhanced the occlusal wear or aesthetics.¹⁸



Figure 1.



Figure 2.



Figure 3.



Figure 4.

MINIMAL CAVITY DESIGNS

The natural teeth structure's preservation is guiding element for both minor and major cavities. Occlusal load and wear considerations influence design of cavity preparation and the material choices. A study have proposed replacing G.V. Black's categorization of designs of cavity with the new system of classification.²¹ The Traditional preparations of cavity were created at the time when the carious lesions had typically discovered at later stage than with incipient lesions that is detect by dentists. The technological advancements in the fast rotary hand-pieces, the materials, the bur-design, and the earlier diagnosis of the lesions that allows for the preparation of considerably much conservative designs of preparation than were previously taught. The other reason due to which dentists have changed their approaches for restoring and preparing teeth would be that conservative approach for caries prevention invariably results in the destructive cycle: The reduction of Tooth was excessive for a considerably minor lesion, that is followed by replacement, the restoration and more

tooth structure's loss. This irreversible cycle results in progressive tooth structural loss and, in some circumstances, tooth loss.²² The idea behind Mount and Hume's cavity classification method is that all that is required is access to lesions and removal of sections that were sick and the break-down to a part, where no longer remineralization is possible. The classification method was location-based and the size of cavity.²¹ A cavity will be analogous to preventive resin restoration's preparation under this new classification scheme (Figure 1 and Figure 3). The profession is steadily adopting technology advancements and, with this, the less invasive approach. Though, several dentists continue to cut huge traditional preparations because they found it more difficult to shift their mindsets away from the "prevention extension." A recent study found that the 72 % of the states authorised the lesion that is restricted to the enamel that are repaired as the part of the examination's requirements of clinical board, in spite of research demonstrating suitable and the efficient treatment for such earlier carious lesions.²³



Figure 5.

PREPARATIONS OF MINIMAL INTERVENTION TOOTH

Preparations utilizing fast handpieces: Tunnels and the preparations that are for the proximal surface lesions are two examples of the modified designs. The cavity was prepared with the tiny bur and a fast handpiece. When preparing a tunnel, carious dentin is accessed from occlusal surface whereas marginal ridge is kept intact (Figure 4). The tiny amount of tooth structure lost, access issues, and visibility make tunnel preparations technically challenging. 4,5,8 The proximal surface enamel and the marginal ridge are protected by internal preparations. 4,5,8 According to a recent study, slot

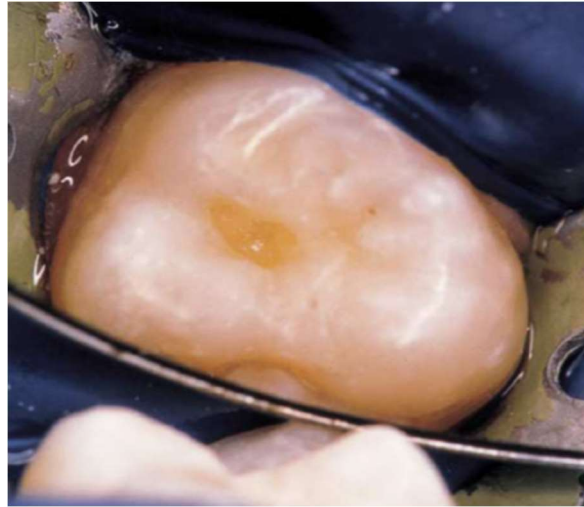


Figure 6.

class II restorations failed to achieve the same results as tunnel preparations after three years. Class II conventional amalgam restorations had higher survival rates than tunnel or slot preparations after five years. 5 If the caries treatment in these locations is not required, the slot or the minibox preparations only to remove the marginal ridge and to leave the occlusal pits and the fissures alone. These cavities could be filled with either amalgam or resin-based composite and can have either a box-shaped or saucer-shaped shape. 70% of these conservative restorations survived after an average of seven years in clinical investigations.²³



Figure 7.

Air abrasion-based preparations: Air abrasion is a method for removing carious tooth structure that uses kinetic energy. Aluminium oxide particles move in a strong, constrictive stream that was directed on surface that needs to be cut. These abrasive particles that scratch the teeth surface without creating the heat, noise, or vibration. It is an end-cutting device since particles exit at handpiece's tip. The Air pressure, the flow of powder, the size of particle, the size of tip, the angle, and proximity to teeth are some of the factors that determine cutting speed. It has been suggested that the early occlusal-surface lesions can be detected with air abrasion technology and treated with the least amount of the preparation of tooth. The utilization of the magnification using this approach is encouraged by several authors. Reduced noise, sensitivity, and vibration are among the claimed benefits of air abrasion, albeit these are patient-specific and susceptible to change. Internal contours of cavities made with the air abrasion are much rounded than that prepared using the handpiece and the straight burs. Due to lower internal stresses than those seen in angular preparations, this may prolong the lifetime of restorations since it lowers the likelihood of fractures (Figure 5 and Figure 7). Not all patients can benefit from air abrasion. It must be avoided in situations of the asthma, severe dust allergy, recent extractions or other oral surgery, chronic obstructive pulmonary disease, open wounds, extensive periodontal disease, recently placed the orthodontic appliances, subgingival caries treatment or oral abrasions. The risk of the air embolism in soft tissues of oral is raised by many of these disorders.²⁴ The usage of the rubber dams and the evacuation in high-volume are necessary for dust management, which is a difficult task.

A randomised controlled clinical trial assessed the effectiveness of employing air abrasion to treat suspect occlusal incipient lesions in the early stages. A study, in which the 223 teeth having occlusal carious lesions possible were randomly allocated for moreover the control group or the treatment group. To a tooth of group of treatment underwent the air abrasion and the flow-able resin-based on the restoration of composite as shown in Figure 7. Every six months, the teeth in both the groups were

examined again. Two of the 113 resin restorations preventively in the therapy group that were left after a year needed to be retreated. Only nine of the 86 remembered teeth in the control group had caries determined and received treatment. This was less than was anticipated. The authors came to the conclusion that after a year, there was no evidence supporting the benefits of the treating fissure carious lesions and suspect incipient pit. It is still unclear from ongoing long-term studies if treating suspect occlusal incipient lesions is beneficial.²⁵

Preparation of Laser cavity: Dental hard tissues are sliced using erbium, chromium, and yttrium-scandium-gallium-garnet lasers as well as erbium: yttrium aluminium garnet lasers. Both soft and hard tissue can be removed by these lasers. According to reports, dental lasers can help keep healthy dentin and enamel while selectively removing cavities. The majority of the time, they can be utilised without anaesthesia. For restoration, adhesive dental materials must be employed; the preparations are comparable to that which are done with the air abrasion. Benefits include the absence of anesthesia-related numbness, vibration, noise, odour, and vibration. The Excessive heat production and their damaging effects upon the dental pulp could be prevented when dental lasers are utilized properly.²⁶

REPLACEMENT VS. REPAIR OF THE DEFECTIVE RESTORATIONS

The replacement of current restorations is thought to make up between 50 and 71 % of each general activity of dentist globally. As resin and amalgam restorations are replaced, the larger restorations are created, and each succeeding generation has a shorter lifespan than the one before it. The Recurrent caries restoration around the margin suggests the enhanced risk of the caries developing in the other sites, that including the restorations existing.²⁷ That and other reasons for the replacement of the restorations either of the repairing them including the apprehensions about the strength of the bond to the placed materials previously, the residual caries leave behind. Repairing damaged the restorations either than the replacing them are the viable and the more traditional course of the treatment when all of

the aforementioned factors are taken into account, along with the fact that the caries undergone appropriately sealed the restorations that fails for progressing and that it advances gradually in the majority of the populations. For the repair, the cavity preparations shall provide the independent retention and resistant shape. Due to the potential for fluoride leakage and the high adherence of GICs, repair along with the GIC might be superior in the regions of cervical.¹⁸ The pro's assessment of advantages vs. dangers and the cautious cavity preparation standards must always be used to determine whether to restore a restoration rather than replace it.

DISEASE CONTROL

Clear rules should be developed for the treatment of the caries as the infectious disease. The creation of the personalized treatment plan and risk assessment for each of the patient that including the appropriate techniques for reduction of the risk make up individually of this component. The utilization of the topical fluorides, the analysis of diet and modification, monitoring, the bacterial detection, and the anti-microbial drugs utilized are amongst the approaches.²⁸ Our information of the disparities of the oral health and the detection for the factors of risk in the individuals for the risk populations was improving thanks to the research. Increasing access to the care, the educated patients as well as the parents, and utilizing the preventive therapies targetedly, such as treating of family in the effort to reduce the transmission for the virulent *Streptococcus mutans* and another species of bacteria from care-giver for the child, are all possible ways to lower the prevalence of caries in young children. The Caries vaccines and the treatment of replacement bacteria, which had so far only been explored in the rodents, are examples of emerging technology in this field. Through gene engineering, a strain of *S. mutans* that cannot ferment carbohydrates to make lactic acid, is produced for use in bacterial replacement therapy.²⁹ It has been demonstrated that the bacterial strain JH1140 can colonize teeth successfully, replace wild type the *S. Mutans*, create them less acidic, and cause the less carious lesions than those the wild type of *S. Mutans*. It would be utilized for the treat

people at high risk for dental caries by taking the place of wild-type *S. mutans*.²⁹

THE ISSUE OF REIMBURSEMENT

If profession wants to completely embrace new paradigm of the minimally invasive dentistry, reimbursement was another important issue that needs to be addressed. The dentist is currently only compensated if they do an action; this could lead to a disagreement when inaction is the right course of action. A minimally invasive approach's cost-benefit analysis and presentation to the general public and third-party payers are required. To motivate medical professionals to treat patients appropriately, reimbursement mechanisms will need to reform. The advantages will increase public oral health, lower long-term health care expenses, and satisfy dentists because they know that they would have done everything possible for retaining the original tooth structure of the patients.

CONCLUSION

The dental caries' management had changed from the G.V. Black's minimally invasive and extension for the prevention due to development of new materials of dental restorative and advancements in the dentistry, as well as improvements in our consideration of the caries process and potential of the teeth for the remineralization. Early lesion detection, risk assessment of personal caries, the nonsurgical interventions, the improved surgical approach that would includes the delayed restoration, preparations of smaller tooth along with the designs of the improved cavity and the adhesive dental materials, and the repair somewhat than the replacement of the failing restorations are all part of this concept. The natural tooth structure preservation is the aim. The significant corpus of the studied and the shared scientific information which utilized as a foundation for the minimally invasive dentistry. The Emerging technologies for the prevention, diagnosis, and the treatment will enable further progression toward the more primary preventive approach in the future. For this to be completely realised in clinical practice, however, there are technical, cultural, and financial barriers that must be surmounted.

REFERENCES

1. Holm-Pedersen P, Lang NP, Müller F. What are the longevities of teeth and oral implants? *Clin Oral Implants Res.* 2007;18:15-19. doi:10.1111/j.1600-0501.2007.01434.x
2. Rathee M, Sapra A. Dental Caries. *StatPearls.* Published online June 21, 2023. Accessed August 27, 2023. <https://www.ncbi.nlm.nih.gov/books/NBK551699/>
3. Mosley WH, Chen LC. An analytical framework for the study of child survival in developing countries. *Child Surviv Strateg Res.* Published online 1984:25-45. doi:10.2307/2807954
4. Kenny C, Priyadarshini A. Review of Current Healthcare Waste Management Methods and Their Effect on Global Health. *Healthcare.* 2021;9(3):284. doi:10.3390/healthcare9030284
5. Ahmadian E, Shahi S, Yazdani J, Maleki Dizaj S, Sharifi S. Local treatment of the dental caries using nanomaterials. *Biomed Pharmacother.* 2018;108:443-447. doi:10.1016/J.BIOPHA.2018.09.026
6. Khattak O, Iqbal A, Nadeem Baig M, et al. Prevalence of Caries in Anterior Teeth in Adults; An Epidemiology Study. *Pakistan J Med Heal Sci.* 2021;15(11):3421-3423. doi:10.53350/PJMHS2115113421
7. Frencken JE, Sharma P, Stenhouse L, Green D, Laverty D, Dietrich T. Global epidemiology of dental caries and severe periodontitis – a comprehensive review. *J Clin Periodontol.* 2017;44:S94-S105. doi:10.1111/JCPE.12677
8. Luiz MT, di Filippo LD, Dutra JAP, et al. New Technological Approaches for Dental Caries Treatment: From Liquid Crystalline Systems to Nanocarriers. *Pharm 2023, Vol 15, Page 762.* 2023;15(3):762. doi:10.3390/PHARMACEUTICS15030762
9. Srilatha A, Doshi D, Kulkarni S, et al. Advanced diagnostic aids in dental caries – A review. *J Glob Oral Heal.* 2020;2(2):118-127. doi:10.25259/JGOH_61_2019
10. Bashir NZ. Update on the prevalence of untreated caries in the US adult population, 2017-2020. *J Am Dent Assoc.* 2022;153(4):300-308. doi:10.1016/J.ADAJ.2021.09.004
11. Sun C, Xie Y, Hu X, Fu J, Zhou J, Wu L. Relationship between Clinical Symptoms and the Microbiota in Advanced Caries. *J Endod.* 2020;46(6):763-770. doi:10.1016/J.JOEN.2020.02.011
12. Frencken J. Caries Epidemiology and Its Challenges. *Monogr Oral Sci.* 2018;27:11-23. doi:10.1159/000487827
13. Nguyen S, Hiorth M. Advanced drug delivery systems for local treatment of the oral cavity. *Ther Deliv.* 2015;6(5):197-210. doi:10.4155/TDE.15.5
14. Jandt KD, Sigusch BW. Future perspectives of resin-based dental materials. *Dent Mater.* 2009;25(8):1001-1006. doi:10.1016/j.dental.2009.02.009
15. McFadzean RW, Gibson E, Newcombe RF, Nataraja R, Santini A. Resin-based composites and dentine-bonding agents. Which, who and why? A study in the East of Scotland. *Prim Dent Care.* 2009;16(2):59-66. doi:10.1308/135576109787909364
16. Saketh Rama Rao B, Krishna Reddy Moosani G, Shanmugaraj M, et al. Fluoride Release and Uptake of Five Dental Restoratives from Mouthwashes and Dentifrices. *J Int Oral Heal JIOH.* 2015;7(1):1. Accessed August 27, 2023. </pmc/articles/PMC4336652/>
17. Kervanto-Seppälä S, Lavonius E, Pietilä I, Pitkäniemi J, Meurman JH, Kerosuo E. Comparing the caries-preventive effect of two fissure sealing modalities in public health care: A single application of glass ionomer and a routine resin-based sealant programme. A randomized split-mouth clinical trial. *Int J Paediatr Dent.* 2008;18(1):56-61. doi:10.1111/j.1365-263X.2007.00855.x
18. Sikka N, Brizuela M. Glass Ionomer Cement. *StatPearls.* Published online March

- 19, 2023. Accessed August 27, 2023. <https://www.ncbi.nlm.nih.gov/books/NBK582145/>
19. Al-Nahedh HN. Influence of selective etching on the enamel and dentin leakage of three low shrinkage composites in class v restoration. *Mater Express*. 2020;10(11):1941-1949. doi:10.1166/MEX.2020.1845
 20. Baroudi K, Silikas N, Watts DC. Edge-strength of flowable resin-composites. *J Dent*. 2008;36(1):63-68. doi:10.1016/J.JDENT.2007.10.006
 21. Mount GJ, Rory Hume W. A new cavity classification. *Aust Dent J*. 1998;43(3):153-159. doi:10.1111/J.1834-7819.1998.TB00156.X
 22. Loesche WJ. Microbiology of Dental Decay and Periodontal Disease. *Med Microbiol*. Published online 1996. Accessed August 27, 2023. <https://www.ncbi.nlm.nih.gov/books/NBK8259/>
 23. Gugnani N, Pandit I, Srivastava N, Gupta M, Sharma M. International Caries Detection and Assessment System (ICDAS): A New Concept. *Int J Clin Pediatr Dent*. 2011;4(2):93. doi:10.5005/JP-JOURNALS-10005-1089
 24. Jeong CH, Yoon S, Chung SW, Kim JY, Park KH, Huh JK. Subcutaneous emphysema related to dental procedures. *J Korean Assoc Oral Maxillofac Surg*. 2018;44(5):212. doi:10.5125/JKAOMS.2018.44.5.212
 25. Hudson P. Conservative treatment of the Class I lesion: A new paradigm for dentistry. *J Am Dent Assoc*. 2004;135(6):760-764. doi:10.14219/JADA.ARCHIVE.2004.0303
 26. Lau XE, Liu X, Chua H, Wang WJ, Dias M, Choi JJE. Heat generated during dental treatments affecting intrapulpal temperature: a review. *Clin Oral Investig*. 2023;27(5):2277. doi:10.1007/S00784-023-04951-1
 27. Ferracane JL. Models of Caries Formation around Dental Composite Restorations. *J Dent Res*. 2017;96(4):364. doi:10.1177/0022034516683395
 28. Okocha RC, Olatoye IO, Adedeji OB. Food safety impacts of antimicrobial use and their residues in aquaculture. *Public Health Rev*. 2018;39(1):1-22. doi:10.1186/S40985-018-0099-2/TABLES/3
 29. Matsui R, Cvitkovitch D. Acid tolerance mechanisms utilized by *Streptococcus mutans*. *Future Microbiol*. 2010;5(3):403. doi:10.2217/FMB.09.129.