

Minimum intervention dentistry in resource challenged practice environments.

¹Arotiba G. T., ²Loto A. O., ¹Ijarogbe O., ¹Ajayi Y., ¹Umesi D., ²Menakaya I.

Faculty of Dental Sciences, College of Medicine, University of Lagos, PMB 12003, Lagos, Nigeria.

Faculty of Dentistry, College of Medicine, Lagos State University, Ikeja, Lagos.

ABSTRACT

This paper highlighted the clinical strategies for implementing minimum intervention dentistry (MID) in dental practice and in dental education in resource challenged practice environments (developing economies). The objectives of each of the 4 phases of minimum intervention treatment plan (MI Identify, MI Prevent, MI Restore and MI Recall) were highlighted and three levels of caries risk (Low risk, High risk and Super high risk) were adopted with the appropriate targeted preventive non restorative treatments. Three evaluation rating scales were introduced (early recall evaluation rating scale, caries control evaluation rating scale and oral health outcome evaluation rating scale) for monitoring the success or failure of counselling, the targeted preventive (non-surgical) treatments and the oral health outcome. Practitioners and academics in resource challenged practice environments should embrace MID with open minds, its goal is maximum preservation of healthy oral tissues with oral health promotion and targeted preventive non- surgical treatments as its cornerstones. Furthermore, MID is mercury free and will safeguard our environment from mercury pollution for the benefit of future generations.

Keywords: Minimum intervention dentistry, mercury free dentistry, dental practice, dental education, resource challenged practice environments.

INTRODUCTION: Dental caries is one of the most prevalent diseases with 91% of adults experiencing caries in their lifetime¹. It has been estimated that 40% of children have tooth decay by the time they reach kindergarten². The International Dental Federation and the World Health Organization have reclassified dental caries as a chronic non-communicable disease³. Management of dental caries has therefore shifted from the “engineering” (‘surgical’ or ‘drill and fill’) approach to minimum intervention dentistry⁴. However, there has been a slow implementation of this philosophy in dental education and in general dental practice in developing economies^{4,5}. Minimum Intervention Dentistry (MID) is a philosophy of caries management that emerged from 21st century caries research which redefined dental caries as a complex, dynamic, behavioral multifactorial lifestyle disease with a bacterial component⁶. MID emerged as a result of a combination of factors; a better appreciation of the

etio-pathogenesis of the caries process, particularly the role of dental plaque biofilm⁷; the cycle of demineralization and remineralization of enamel and dentine⁸; the role of saliva in maintaining oral health⁹ and the development of new adhesive biomimetic /bioactive restorative materials^{5,6}. The world wide agreement to phase out dental amalgam by the year 2022 (the Minanata convention on mercury) has resulted in a new drive to implement minimum intervention dentistry in developing economies¹⁰. The cornerstone principles of MID include early diagnosis of dental caries, caries risk and activity assessment, targeted preventive non-surgical therapies, frequent recalls adjusted to the risk level and minimally invasive restorative operative techniques^{4,8}.

This paper will highlight the principles and clinical strategies for implementing minimum intervention dentistry in general dental practice and in dental education in resource challenged practice environments.

20th Century Dentistry.

Twentieth century dentistry was characterized by the “drill and fill” approach to the management of dental caries¹¹. This was probably because there was a simplistic understanding of the etio-pathogenesis of the caries process which describes caries as resulting

Correspondence: Arotiba G. T.

Faculty of Dental Sciences, College of Medicine,
University of Lagos, PMB 12003, Lagos, Nigeria

E-Mail: gtarotiba@gmail.com

Tel: 0803 752 0961

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from an interplay of four factors namely, a susceptible host, microflora, diet and time. This resulted in the treatment of the cavity which is a manifestation of the disease rather than the cause of the disease. Epitomizing this era was GV Black's classification of caries and his principles of cavity preparation (extension for prevention, undercuts for retention, sharp internal line angles and cavo-surface line beveling). This is the so called 'surgical' or 'engineering' approach to caries management. Some have also attributed this approach to the historical emergence of Dentistry from Surgery^{4,11}. The end result of this approach to caries management is the eventual loss of the tooth (the 'restorative cycle spiral')¹². This 'engineering' or "surgical' approach was not without some caution from three leading researchers of 20th century caries management. Magitot in 1886 admonished dentists to shift focus from cavity that must be drilled and filled to detecting the early stages of the caries process¹¹. Furthermore, GV Black in 1910¹³ and Gies in 1912¹¹ also warned that Dentistry should not embrace its technological base at the expense of its biological foundations. However, the 'drill and fill' approach to caries management persisted well into the twenty first century^{4,11}.

21st Century Dentistry

It became obvious gradually that the "drill and fill" approach to caries management led to eventual loss of the tooth¹². There were some scientific reports during the 20th century which were not in support of the predominant 'drill and fill' approach to caries management which were poorly interpreted and ignored (for example the publications of Dirks et al 1961¹³, Massler 1967¹⁴, Mount 1991¹⁵, Dawson and Makinson 1992¹⁶, Fusayama 1997¹⁷ and Anusavice, 1998¹⁸). The major findings of these reports include:

- i. Fluoridation of public drinking water reduces the occurrence of dental caries by 50%;
- ii. The caries inhibitory action of fluoride can also be achieved by the application of high concentration of fluoride (varnishes) on the tooth surface;
- iii. The 'drill and fill' approach to the management of caries did not control the disease and resulted in the eventual loss of the teeth and;
- iv. A move away from GV Black's drill and fill restorative philosophy to the use of adhesive

dental materials, remineralization techniques and monitoring of early carious lesions.

One landmark research which shaped further development of 21st century caries management was reported by ten Cate in 2001¹⁹. He reported the remineralization of caries lesions extending into dentine and concluded with Kidd's recommendation that "restorative treatment should be delayed to provide maximum possibilities for lesion repair and arrest"¹⁹. Two other developments, contributed to the emergence of new approaches to caries management: The development of new adhesive restorative materials (composites and glass ionomer cements)^{4,5,6} and the global concern with the adverse environmental and human health impacts of mercury in dental amalgam¹⁰.

Cariology researchers then correctly interpreted the results of emerging 21st century caries research and constituted themselves into groups to implement new approaches to caries management. They now heeded Magitot's¹¹ admonition to study early caries lesions and developed caries staging systems with prevention focused treatment recommendations based on the stage of the disease. Two of such systems stood out: American Dental Association Caries Classification System (ADA CCS)²⁰; and International Caries Diagnosis and Assessment System (ICDAS) –First reported by Nigel Pitts in 2004¹². The Cariogram, an interactive computer based program for patient education and motivation was developed by University of Malmo in Sweden in 2002²². The Cariogram graphically illustrates caries risk, the interaction between the various caries risk factors, the chance to avoid new caries lesion development in the near future and to what extent the various factors will affect this chance²².

Caries Management Pathways

A caries management pathway is essentially a step-by-step protocol that assists clinicians to systematically collect and analyze personal and clinical data in order to develop comprehensive, patient centered (holistic) treatment plans for minimum intervention dentistry^{4,5,6}. Further refinement of caries staging systems resulted in the development of 4 major caries management pathways (CaMPs) for implementing minimum intervention dentistry (MID) in dental practice:

1. Caries management by risk assessment (CAMBRA) first reported by Featherstone et al. in 2002²³

It is the first CaMP that pioneered 21st century caries management. Many of its preventively focused features were incorporated into other CaMPs. CAMBRA has 4 caries risk assessment groups: Low, Medium, High and Extreme with prevention focused therapeutic interventions. It has been widely adopted in North America with clinical and homecare solutions provided by 3M ESPE^{24,25}.

CAMBRA introduced the concept of evaluating the balance between pathological factors and protective factors for the disease which determines whether the caries process progresses, reverses or is in equilibrium^{8,24} (Fig 1). CAMBRA also introduced the risk based (oral physician) approach to prevent, reverse and when necessary repair damage to teeth using minimally invasive methodologies. In its simplest form it consists of 4 clinical strategies^{8,24,25}:

- I. Assessing the risk for developing future caries;
- ii. Reducing the pathological factors;
- iii. Enhancing the protective factors and;
- iv. Minimally invasive restorative care.

CAMBRA has been further enhanced by the introduction of age specific, occlusal site and approximal site specific protocols. These protocols are adjusted according to risk level and integrated with the ICDAS classification system²⁵.

2. Caries management System (CMS) by Evans RW et al. in 2008^{26, 27}. Caries management system was first reported in 2008 by RW Evans from the university of Sydney, Australia. This CaMP consists of the following ten steps:

1. Diet assessment
2. Plaque assessment
3. Bitewing radiographic survey
4. Diagnosis and caries risk assessment
5. Preparation of treatment plan
6. Case presentation to patient about
 - a. Dental caries (caries risk and activity status, homecare, clinic care)
 - b. Results of diet assessment
 - c. Treatment recommendations
7. Oral hygiene coaching
8. Topical fluoride application (both professional and homecare)
9. Monitoring of plaque control and treatment

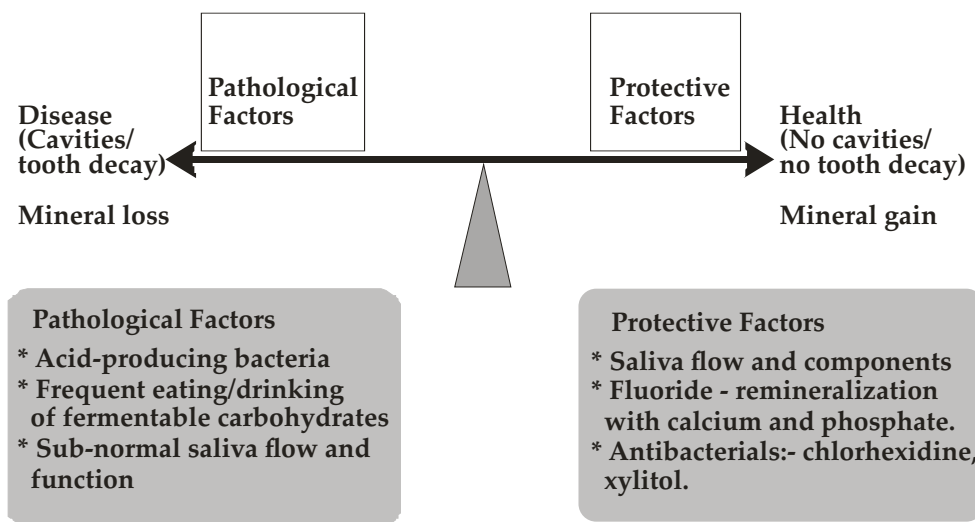


Figure 1: The caries balance concept pioneered by CAMBRA (Adapted from Featherstone et al^{18,24,25})

Caries Management System is not concerned directly with the management of cavitated or symptomatic caries lesions other than recognizing their need for operative care. It is also not concerned with the management of patients with acute rampant caries due to extreme salivary insufficiency^{2,28}. Outstanding features of CMS include a 24 hour snacking questionnaire, inclusion of the plaque index of Silness and Loe, tooth decay information leaflet, oral hygiene instruction leaflet, bite wing caries rating scale, lesion management protocol, home care, professional care and a recall protocol. These resources will be useful for practitioners just starting to implement MID in their practices^{26,27}.

1. Minimum Intervention Treatment Plan (MITP) by GC Corporation Europe MID Advisory Board in 2009^{5,24}. GC Corporation (GCC) adopted the MID philosophy in 2000 following the publication of a review of MID principles by the International Dental Federation (FDI) report by Tyas et al²⁸. GC Corporation has partnered with the International Dental Federation (FDI) and The International Association for Dental Research (IADR) in promoting MID

philosophy with symposia, workshops and conferences in different parts of the world. It is therefore not surprising that GCC has developed solutions for every phase of MID²⁹. In 2007 it constituted the MID Advisory board consisting of academics, clinicians, researchers and general practitioners from Europe and Japan. The board published 'a vision for caries management in the 21st century in 2009⁵ and the definitive guide –The MID Handbook in 2017²⁹. The objective was to provide an easy stepwise guide for implementing MID in general dental practice. The GC Corporation MID advisory board developed the concept of the minimum intervention treatment plan (MITP). The MITP consists of 4 cyclical phases^{5,29} (Fig 2):

- i. Minimum intervention identify (risk factors);
- ii. Minimum intervention prevent (risk factors from re-occurring);
- iii. Minimum intervention restore/repair/replace (minimally invasive) and;
- iv. Minimum intervention recall (according to risk level)

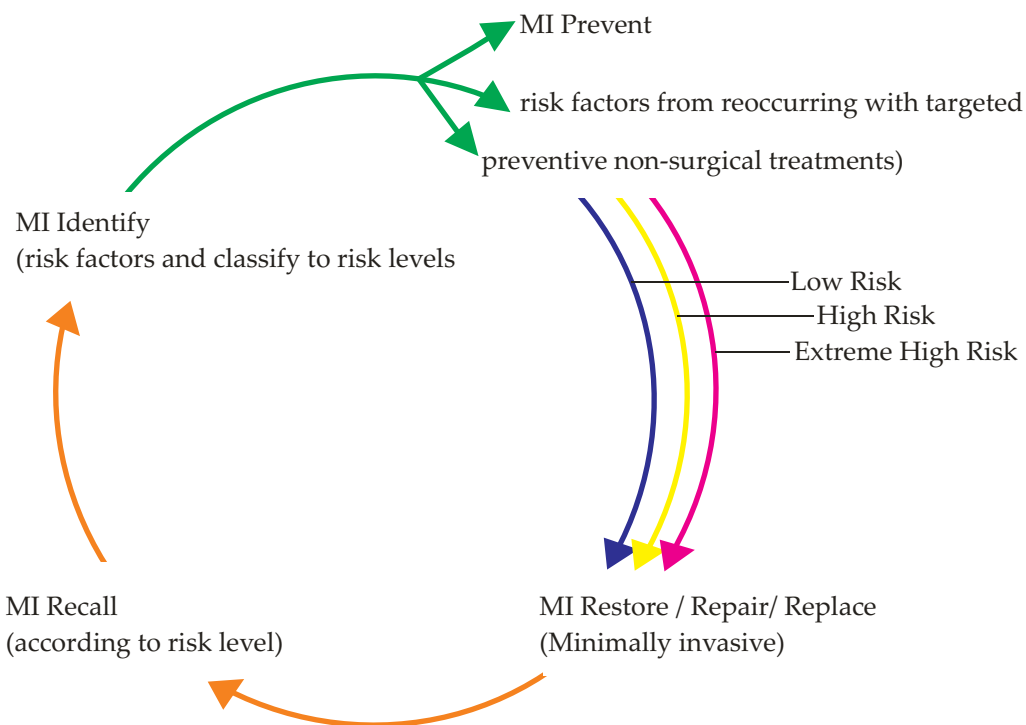


Figure 2: The 4 cyclical phases of GC Corporation MITP (adapted from Domejean et al^{5,29}).

4. International Caries Classification and Management System (ICCMS)⁶

In May 2012 cariologists, dentists, representatives of dental organizations, manufacturers and third party payers from several countries met in Philadelphia, USA with a view to harmonize the goals and strategic approaches to caries management in the 21st century⁶. The objective was to stimulate changes in academia, clinical practice and public health to reflect the new emerging scientific evidence on caries management. CAMBRA, MID and CMS groups participated actively in the proceedings. The participants agreed on a new mission for all caries management approaches: 'To preserve tooth structure and restore only when necessary'⁶. The workshop also recommended continuing management of the etiological factors of caries and the use of evidence-based preventive regimens to prevent recurrence and re-restoration. The workshop admonished all oral health professionals to "focus on the promotion of oral health and the preservation of sound tooth tissue rather than counting the number of surgical-restorative procedures performed"⁶. The International Caries Classification and Management System (ICCMS) was eventually published in 2015 by Ismael et al⁶. It is noteworthy that both GCC Minimum Intervention Treatment Plan (MITP)^{5,29} and ICCMS⁶ caries management pathways (CaMPs) adopted a modified ICDAS²¹ caries staging system. The modification involved a compression of the original 7 staged caries progression classification stages into 4 stages with appropriate treatment recommendations^{5,6,29}.

Definitions, Principles and Strategies of MID

Tyas³⁰ defined minimal intervention dentistry as an approach to the management of dental caries with the aim of minimizing the loss of tooth structure by disease or by iatrogenic intervention.

Brostek and Walsh³¹ defined MID as "a philosophy of caries management that is focused on risk assessment of individual patients; early detection of oral disease, targeted preventively oriented strategies and limited surgical intervention related to the level of disease".

GC Europe MID Advisory Board defined Minimum Intervention Dentistry as "a holistic, patient-centered, evidence based approach to caries management with preservation of healthy tooth tissue"⁵.

Minimum intervention dentistry is the 'oral physician' model of management of oral disease which is focused

on risk assessment, oral health promotion, targeted preventive (non-surgical) treatments, maximum preservation of healthy oral tissues, active involvement of the patient and all members of the dental team in disease control^{4,5,6,29, 31}. The concept of MID though mainly applied to management of dental caries, has applications in periodontology, oral rehabilitation and oral surgery⁴.

The guiding philosophy of MID is Kidd's conclusion that 'restorative treatment should be delayed to provide maximum possibilities for natural lesion repair and arrest'¹⁹. Domejean et al identified the six principles of MID as consisting of^{5,29}:

1. Early caries diagnosis and caries risk/activity assessment;
2. Prevention;
3. Re-mineralization of early caries lesions;
4. Minimally invasive operative techniques;
5. Repair of defective restorations; and
6. Patient education and motivation (Oral health promotion).

Tyas et al²⁸ pointed out that the aim of MID is to keep teeth healthy and functional for life and specified the following five strategies to achieve this objective:

- i. Early caries detection and risk assessment;
 - ii. Optimal caries preventive measures (both in the clinic and at home);
 - iii. Remineralization of demineralized enamel and dentine;
 - iv. Minimally invasive operative intervention; and
 - v. Repair rather than replacement of restorations
- Frencken et al³² further reinforced Kidd's conclusion by explicitly stating that the first three of Tyas et al's²⁸ MID strategies should be employed throughout a patients' life time and only when oral health maintenance has failed (cavitation) should minimum operative intervention be employed.

Implementing Minimum Intervention Dentistry in Resource Challenged Practice Environments (Developing economies).

The MITP^{5,29} is a simple approach to implementing MID in General Dental Practice in developing economies for the following reasons:

1. It is a practical approach to implementing MID in a busy General Dental Practice;
2. It uses only 2 caries risk assessment

classifications: Low risk and High Risk groups;

3. It also uses a simple modified ICDAS caries assessment and staging system;
4. It is backed by solutions for every phase of MITP by GC corporation;
5. It enhances active participation of all members of the dental team in patient management; and
6. It encourages active patient participation in caries management.

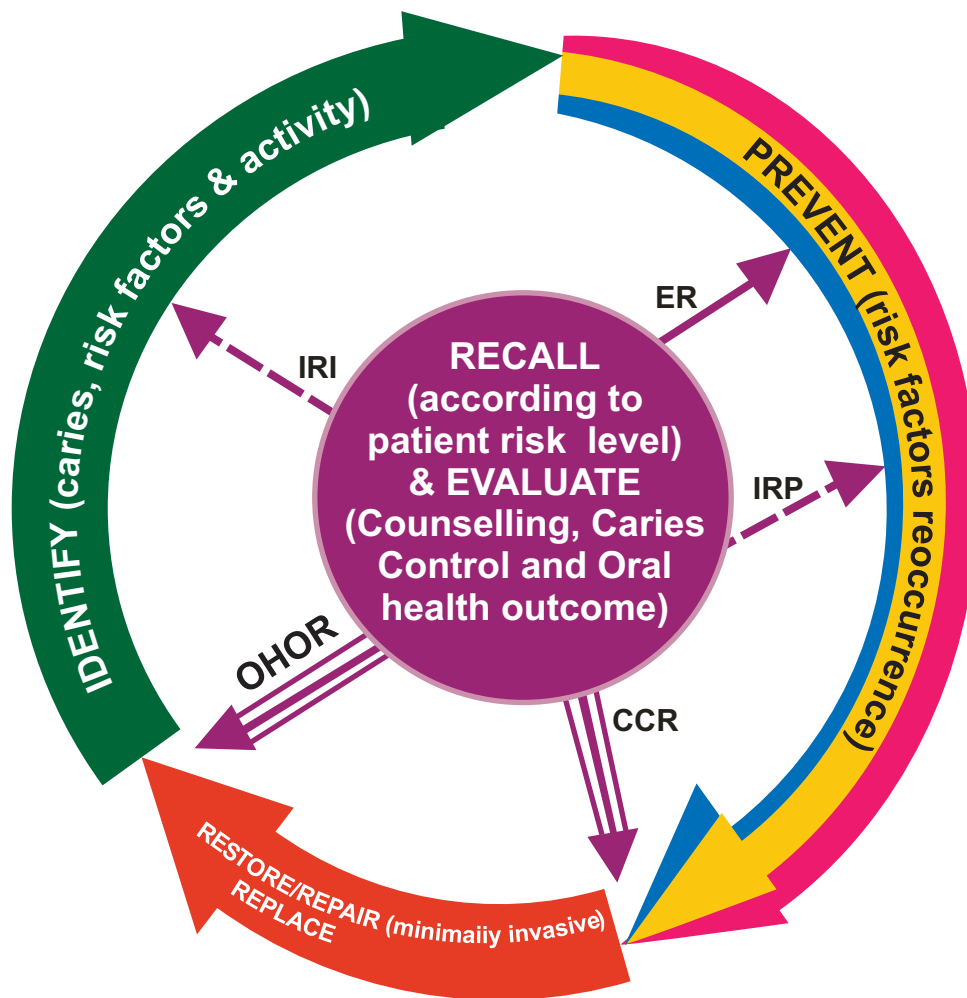
Objectives of minimum intervention dentistry:

Domejean et al^{15,29} specified the objectives of minimum intervention dentistry to consist of the following 4

components:

- i. To identify and assess any potential caries risk factors early (MI Identify);
- ii. To prevent caries occurring by eliminating or minimizing risk factors (MI Prevent);
- iii. To restore demineralized enamel and protect against further damage (MI Restore); and
- iv. To offer patient recall periods depending on their caries risk level. (MI Recall).

These four objectives are organized into a cyclical framework- the minimum intervention treatment plan (MITP) for easy implementation in general dental practice. (Fig3).



Colour Codes: ■ MI Prevent low risk ■ MI Prevent high risk ■ MI Prevent super high risk
■ MI Identify ■ MI Restore/Repair/Replace ■ MI Recall

CCR = Caries control recall OHOR = Oral health outcome recall

ER= Early recall IRI = Interim recall identify IRP = Interim recall prevent

Figure 3: The color-coded, modified MITP cyclical framework for dental practice and dental education (Adapted from Domejean et. al^{15,29}).

For ease of implementation in a busy dental practice, the 4 cyclical phases of MITP will be broken down into its essential components^{5,29}:

I. MI IDENTIFY – Caries and risk factors (Fig 2)

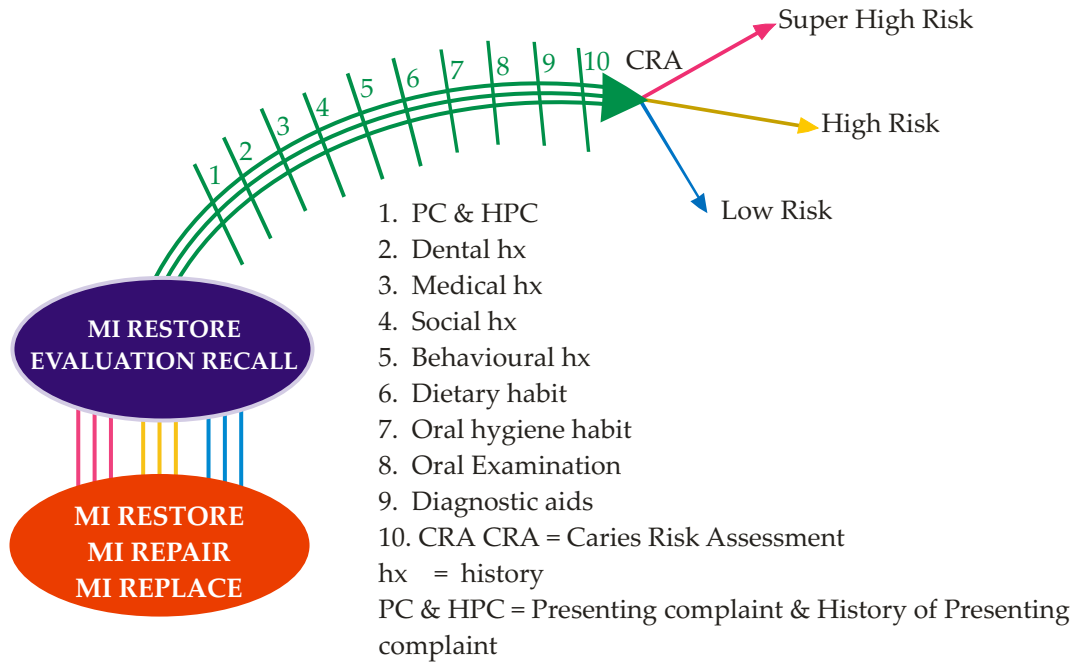


Figure 4: MI Identify (risk factors)-Adapted from Domejean et al^{5,29}.

The objectives of MI identify include:

- i. To take a comprehensive history (anamnesis);
- ii. To detect caries using a modified ICDAS visual detection and scoring system;
- iii. To identify caries risk factors (caries risk/activity assessments);
- iv. To assess plaque level; and
- v. To assess salivary function.
- vi. Anamnesis (the complete history recalled and recounted by a patient)

i. MI identify begins with anamnesis (in contrast to CAMBRA and CMS because dentists are accustomed to taking history first. A comprehensive history in MID should include: Presenting complaint and history of presenting complaint, Dental history, Social history, Behavioral history, Medical history, Dietary habits, Oral hygiene procedures

ii. The Examination (Extra-oral and Intraoral)
It is essential to briefly examine the extra-oral tissues for symmetry, change in color, swellings and lymphadenopathy. The intraoral examination should start with a brief examination of intraoral soft tissues after which attention should be focused on the teeth.

The diagnosis of dental caries is an important part of the Identify process. This is usually by visual examination and the use of a ball ended explorer. A bite wing radiographic examination is an important part of this process for posterior teeth. The bitewing radiograph is also used to follow-up the activity (active or inactive/arrested caries) of interproximal surface posterior teeth caries during the Recall phase. MITP uses a simple grading system for staging posterior teeth interproximal caries. An Orthopantomogram equipment that can take bitewing view will be of immense value for an MID practice^{4,5,6,29}.

The use of new diagnostic technologies is an essential component of MI identify. Such technologies should include new caries diagnostic devices (Fibre Optic Transillumination-FOTI³⁵, plaque disclosing tablets⁵, plaque indicator kit⁵, plaque PH tests⁵, saliva buffer tests⁵ and bacterial tests⁵. Cariscreen^{33,34} is a hand held chair side device that uses adenosine triphosphate (ATP) bioluminescence to quantify plaque bacteria and the metabolic output of the plaque biofilm. The advantages of using the new diagnostic tests include^{5,24}:

- a. Facilitation of patient communication and

- motivation;
 - b. Encouraging patient attendance on a regular basis;
 - c. Reducing the fear of pain and discomfort; and
 - d. Facilitating the participation of the whole dental team in patient management. It is essential that the Dentist performs all procedures in the MI identify phase during the first MID cycle. In the subsequent cycles, simple tasks (eg. Plaque, PH, saliva buffer, bacterial tests etc.) can be performed by a trained member of the dental team.
- iii. Caries Risk and Activity Assessment. This is the cornerstone of MID philosophy of caries management^{5,24}. Caries risk is the likelihood of a person having new or extended tooth decay in the future^{26,27,28}. This is influenced by three factors; risk factors, disease indicators and protective factors. These factors are used to determine caries risk assessment (CRA) level by most caries risk assessment tools. However, in recognition of the varying risk factors in different age groups and special needs/elderly/disabled

individuals, the MITP CRA tool is structured into 3 groups²⁹:

- a. MI early care (0-6 years and 6-14 years)
- b. MI Active care (14 years and above); and
- c. MI Care plus/Special care (Elderly, disabled and special care patients).

It is also important to establish the activity of old and new caries lesions as this influences the treatment options (preventive or restorative) to be instituted. If the lesion is inactive all that may be required is monitoring at recall sessions and oral health maintenance. The ICCMS⁴ caries activity rating instrument is highly recommended.

Challenges to implementing MI identify in developing economies will be the poor availability or access to advanced diagnostic technologies (eg Cariscreen^{33,34}). This should not however be a serious limiting factor because with good training, the risk assessment can still be determined without the deployment of advanced diagnostic technologies which may be out of the reach of the average practicing dentist.

II. MI PREVENT (risk factors from reoccurring)

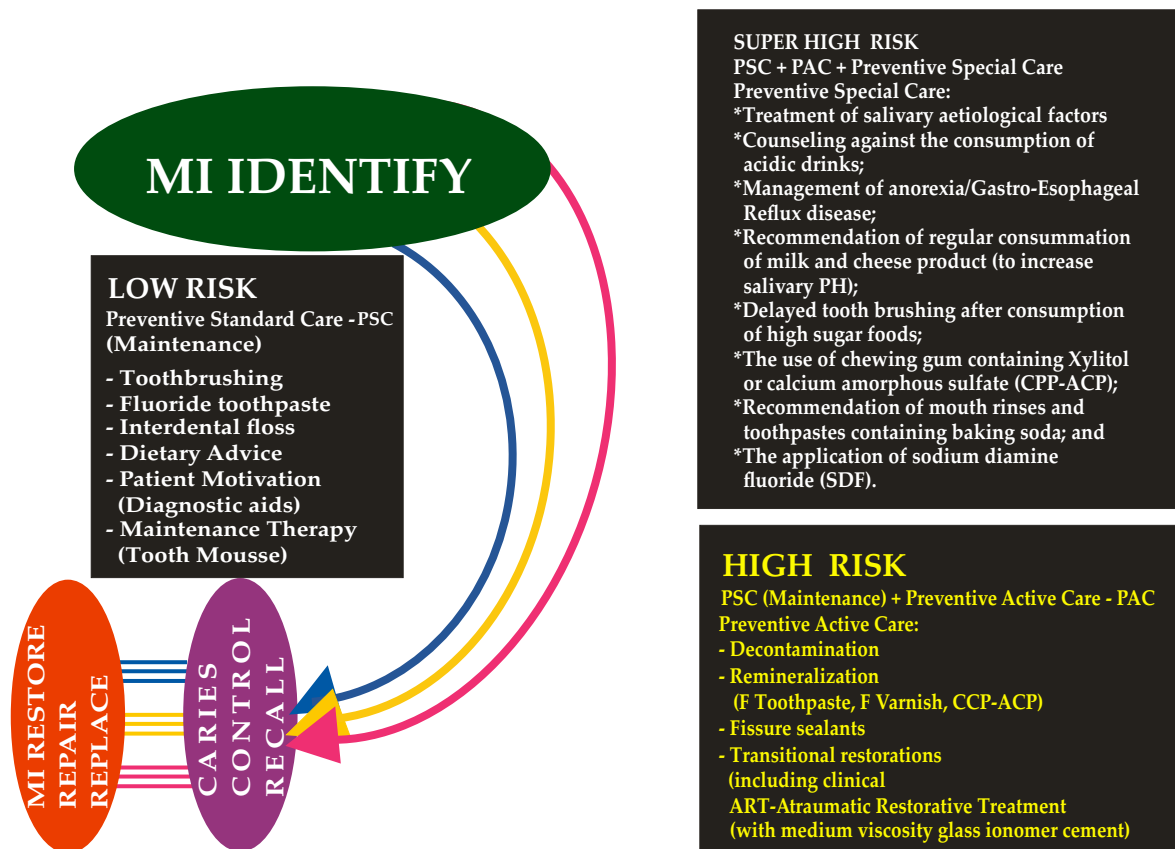


Figure 5: MI Prevent (risk factors from reoccurring)-Adapted from Domejean et al^{5,29}.

Prevention is the cornerstone of 21st century caries management. This is because dental caries is a chronic behavioral multifactorial lifestyle disease that requires diet, lifestyle habit and behavioral changes to reduce risk factors.^{5,29} Objectives of MI prevent phase include^{5,29}:

- i. Prevention of the initiation of new lesions
- ii. Remineralization of early caries (non-cavitated) lesions
- iii. Dietary and lifestyle counselling
- iv. Caries counselling
- v. Oral hygiene education
- vi. Placement of transitional/provisional (interim therapeutic restorations) biomimetic/bioactive restorations.

Depending on the risk status, preventive therapies of MITP CaMP are divisible into two groups:

a. Preventive Standard Care (Maintenance)^{5,29}. This is indicated for low caries risk patients and consists of:

- i. Oral hygiene education/instruction (tooth brushing); recommendation of fluoride tooth paste (500ppm); interdental flossing instruction
- ii. Dietary Counselling with documented charts
- iii. Patient education and motivation
- iv. Maintenance of oral balance (Tooth Mousse)

The use of standard oral hygiene instruction leaflets (e.g. where to brush by CMS) and 24hour snacking charts (CMS) or other diet prescription forms allows progress to be monitored and documented at recall intervals.

b. Preventive Active Care^{5,29}

This is indicated for high caries risk patients and consists of the above standard care regimen plus the following preventive therapies:

- i. Professional decontamination which includes -PMTC (professional mechanical tooth cleaning); -the use of chlorhexidine mouth wash; -excavation of caries infected dentine; and, -placement of transitional /stabilizing restorations.
- ii. Remineralization therapies which entail the recommendation of the use of Fluoride tooth paste, Fluoride varnish, Fluoride gel, Fluoride mouth wash and Casein Phosphopeptide -Amorphous Calcium Phosphate (CPP-ACP)
- iii. Management of salivary etiologic factors

- iv. Fissure sealant application is indicated for temporary teeth, immature permanent teeth and high risk patients. The material of choice for fissure sealing is high viscosity glass ionomer cements.

In developing economies where there is poor oral health awareness and poor health infrastructure, a significant proportion of patients will present with large lesions (ICDAS^{5,6,7}); for these group of patients, excavation of caries infected dentine and placement of a high viscosity glass ionomer cement restoration will be required for caries control. Such transitional restorations (interim restorative therapy) are preventive therapies because they eliminate pain by protecting the exposed sensitive dentine and allow the performance of oral hygiene homecare procedures by the patient. Atraumatic Restorative Treatment (ART) is a minimally invasive technique that does not require electrically driven equipment and running water^{36,37,38}. ART fulfills the objectives of MI prevent; it can therefore be used as either a transitional or long-term restoration in a clinical setting by practitioners in resource limited environments whose patients often present with advanced caries lesions. However, whenever a high viscosity glass ionomer restorative is used, this preventive transitional restoration may be the eventual long term restoration required. All the patient will require subsequently will be regular oral health maintenance, regular dental check-ups and repair of defective restorations. This will be a cost effective strategy for practitioners in developing economies. Advanced preventive solutions (eg. Recaldent^R) may not be widely available or affordable in developing economies. Our governments need to consider reduction or removal of import duties and taxes on such products. Material science experts in our universities and research institutes should be actively supported to research and develop local alternatives.

Management of salivary etiologic factors

It is noteworthy that the presence of a salivary dysfunction automatically places the patient in the super high risk (SHR) category. The management of salivary etiologic factors may include one or more of the following interventions^{5,929}:

- i. Counseling against the consumption of acidic drinks;

- | | |
|---|--|
| <ul style="list-style-type: none"> ii. Management of anorexia/Gastro-Esophageal Reflux disease; iii. recommendation of regular consumption of milk and cheese product (to increase salivary PH); iv. Delayed tooth brushing after consumption of high sugar foods; | <ul style="list-style-type: none"> v. The use of chewing gum containing Xylitol or calcium amorphous sulfate (CPP-ACP); vi. Recommendation of mouth rinses and toothpastes containing baking soda; and vii. The application of sodium diamine fluoride (SDF). |
|---|--|



Figure 6: MI Restore / Repair / Replace (Restore with long-term restoratives only after good caries control has been achieved)-Adapted from Domejean et al^{5,29} and Ismael et al⁶

The MID philosophy emphasizes that definitive (long term) restorations are used as a last resort—they are only placed after recall has indicated that there is good control of caries risk factors and after good compliance with dietary, oral hygiene and lifestyle counselling has been achieved. Restorations are also placed only for cavitated lesions with maximal preservation of natural tooth structure. Biomimetic/bioactive restorative materials are preferred. Objectives of MI restore phase include^{4,5,6,29}:

1. To seal the carious cavity in order to protect exposed enamel and dentine and the pulp);
2. To facilitate pain-free oral hygiene homecare measure by patient; and
3. To replace the transitional restoration with a definitive biomimetic/bioactive restoration.

Depending on the extent of loss of tooth structure, depth of carious lesion and caries risk assessment the clinician has two choices of therapeutic intervention in MI restore;

- a. Noninvasive restorative treatment (in-office) for non-cavitated lesions with re-mineralization agents such as Tooth Mousse, MI paste plus, Fluoride gel and Fluoride varnishes.
- b. Minimally invasive restorative treatment placement of definitive biomimetic/bioactive restorations.

III. MI repair/replace

A cornerstone principle of MID is the preference for repair rather than replacement of defective restorations. This principle emerged from the research reports of Gordan et al^{39, 40,41} and Moncada et al⁴² which highlighted the advantages of repair: Maintenance of the restorations original form thereby reducing or eliminating stress of the tooth; damage to adjacent teeth is avoided; prevents postoperative sensitivity as a result of re-exposure of dentinal tubules; and avoids more complex restorations. With MI restore and the use of bioactive/biomimetic restorative materials, repair of defective restorations is preferred to their total replacement. Replacement will only be justified when there is recurrent caries that cannot be accessed without removing the restoration or when there is evidence of pulpal involvement.

With more patient awareness of the human toxicity potential of mercury dental amalgam, demand for their removal may become common even in resource limited environments. Stringent conditions and advanced equipment have been recommended for this purpose by the International academy of biological dentistry and medicine. These recommendations can be assessed at <http://iabd.com>⁴³. The major limitation to implementing MI

restore/repair/replace in developing economies will be the availability and affordability of cost effective long term mercury free restorative materials. Our governments should move speedily to remove or reduce substantially import duties and taxes on long

term restoratives (high viscosity glass ionomer restoratives and bioactive composites) before implementing phase down of dental amalgam in vulnerable groups.

IV. MI RECALL (+ Caries Control And Outcome Evaluation)

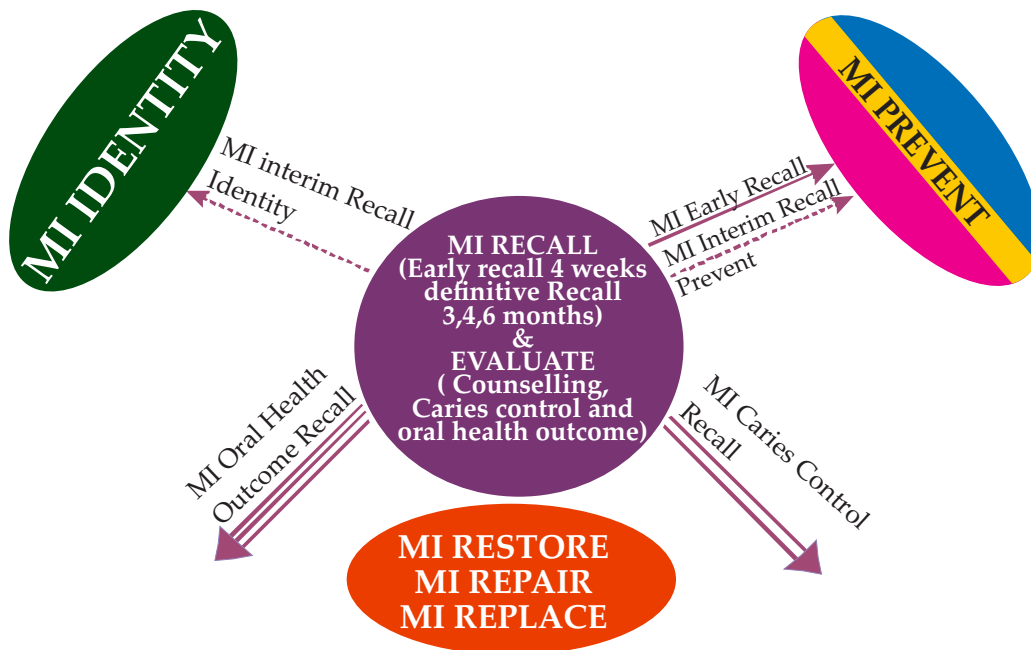


Figure 7: MI Recall (+ oral health outcome evaluation)- Adapted from Domejean et al^{5,29}, Bostek and Walsh³¹ and Ismael et al⁶

The recall frequency in MID is dependent on the caries risk level. Low risk patients and adults can be recalled at 6monthly intervals while high risk patients and children can be recalled at 2-3 monthly intervals. Elderly patients and special needs patients can be recalled at 2/3 month intervals or 6 months intervals depending on their caries risk assessment.

The objectives of MI recall include^{4,5,29}:

- i. To control oral balance;
- ii. To prevent new caries;
- iii. To detect and treat new caries at an early stage;
- iv. To re-evaluate caries risk and activity;
- v. To evaluate patient motivation and compliance with counselling (oral hygiene, diet and lifestyle); and
- vi. To evaluate caries control and decide whether to restore or continue the MITP cycle;
- vii. To evaluate oral health outcome.

Brostek and Walsh³¹ proposed an innovative MID recall protocol in two parts:

A. Early recall visit at 4 weeks after completion of preventive or restorative treatments. The objectives

are to evaluate patient compliance with:

- i. Home care oral hygiene instructions
- ii. Lifestyle changes and
- iii. Dietary counselling.

This early recall is essentially a counselling (lifestyle, dietary and oral hygiene)compliance recall.

B. Definitive recall visits at 3, 4, 6 monthly intervals adjusted according to risk level (low risk, high risk and super high risk). The objectives include^{4,5,6,29}:

- i. To monitor the status of white spot lesions (Fibre optic transillumination-FOTI³²) will be a good additional equipment to use if available).
- ii. To monitor compliance with home care mechanical plaque control (oral hygiene instruction)
- iii. To monitor the level of plaque acid production (Plaque Indicator Kit); and
- iv. To monitor gingival soft tissue inflammatory changes.

Definitive recalls are MITP recalls necessitated by the need to monitor progress or otherwise of the targeted

preventive (non-surgical) treatments and the oral health outcome after completion of MI restore or replace or repair with long term restoratives. In this regards objective (measurable) instruments (rating scales) were introduced for both dental education and general dental practice (Tables 1, 2 and 3).

Interim (non-evaluative) recalls are recalls necessitated by non-availability of requisite diagnostic (MI identify or preventive (MI prevent) clinic solutions/consumables that will enable the practitioner to arrive at the appropriate caries risk assessment classification or complete the targeted in clinic preventive treatments (eg non- availability of expensive re-mineralization agents-Recaldent^R). This may frequently occur in developing economies. Interim recalls should therefore not be billed.

In this model of MITP there will be three types of definitive (evaluation recalls) with appropriate rating scales:

- i. Early recall (Brostek and Walsh³¹);
- ii. Caries control evaluation recall (Ismail et al⁶) and
- iii. Oral health outcome evaluation recall (Ismail et al⁶)

The ICCMS outcome assessment framework should be integrated into MI recall as follows:⁶

- a. Health Promotion
 - i. Number of sound teeth maintained sound
 - ii. Number of previously treated teeth maintained free of new caries
- b. Disease control
 - i. No of initial (active or arrested) caries lesions that remained unchanged or reversed.
 - ii. Number of radiographically detected lesions that did not progress or were treated preventively,
 - iii. Change in number of teeth with PUFA (pulp, ulceration, fistula and abscess)
- c. Patient centered quality matrices
 - i. Patients satisfaction with their dental health status
 - ii. Patients change in care pattern from high to medium or low status or stabilized if the baseline level was medium or low status
 - iii. Patients' demonstrate improvement in oral hygiene and dietary practices
 - iv. Reduced cost of overall caries care

A rating scale based on the ICCMS oral health outcome evaluation criteria⁶ is illustrated in Table 1.

The poor awareness of oral health generally in developing economies and the poor appreciation of the relationship between oral health and general well-being is responsible for the poor attitude of patients visiting dentists generally for regular check-ups and keeping their review appointments as scheduled. This will be mitigated by training in motivational counselling for both undergraduate students and general dental practitioners. Practitioners should also devote clinical time to engaging patients in dietary, lifestyle and oral hygiene counselling sessions in the clinic. The objective is to empower patients to be in charge of controlling their oral disease. If this approach is adopted, patients will appreciate the importance of keeping their scheduled recall appointments. The national health insurance scheme (NHIS) should consider a new payment structure for oral health services to accommodate caries risk assessment, new in-clinic caries diagnostic technologies, counselling sessions, recall appointments and targeted preventive therapies of MID. Constraints to implementing MID in a developing economy

The philosophy of MID evolved gradually and preceded the Minamata convention on mercury which was globally adopted on 16th August 2017. However, the slow implementation of MID in general dental practice in developing economies may be due to the following factors^{4,5,29}:

1. Reluctance of practitioners to change. They were trained in mercury amalgam and some argued that there were no better alternatives.
2. The new adhesive restorative materials (Glass ionomers, Composites, Resin Reinforced Glass ionomers etc.) are more expensive.
3. Poor dissemination of the philosophy of MID by stakeholders through workshops and conferences.
4. Poor coverage of Dental Services in the National Health Insurance Scheme (NHIS).
5. Poor oral health awareness and poor health infrastructure.
6. Reluctance of Dental educators to change.

Health Promotion				
1. No of sound teeth maintained sound	(↑:~:↓)	1	2	
2. No of previously treated teeth maintained free of new caries	(↑:~:↓)	1	2	
Disease Control				
iii. Native versus active lesions	(↑:~:↓)	1	2	
iv. Stable radiographically detected lesions	(~:~:↓)	1	2	
v. Change in number of teeth with PUFA	(↓:~:↑)	1	2	
Patient Centered Quality Matrix				
vi. Patient satisfaction (good; poor)		1	2	
vii. Patient compliance with appointments(good; poor)		1	2	
viii. Reduction in caries risk	(↓:~:↑)	1	2	
ix. Patient compliance with OHI and Dietary counselling (good; poor)		1	2	
x. Cost of care (↓se :↑sc)		1	2	
GOOD OUTCOME = 10 - 12		POOR OUTCOME = 13 - 18		

PUFA = Pulp Ulceration, Fistula and Abscess ↑ = increased ~ = unchanged ↓ = decreased

Table 1: Oral Health Outcome Evaluation rating scale (adapted from Ismael et al⁶)

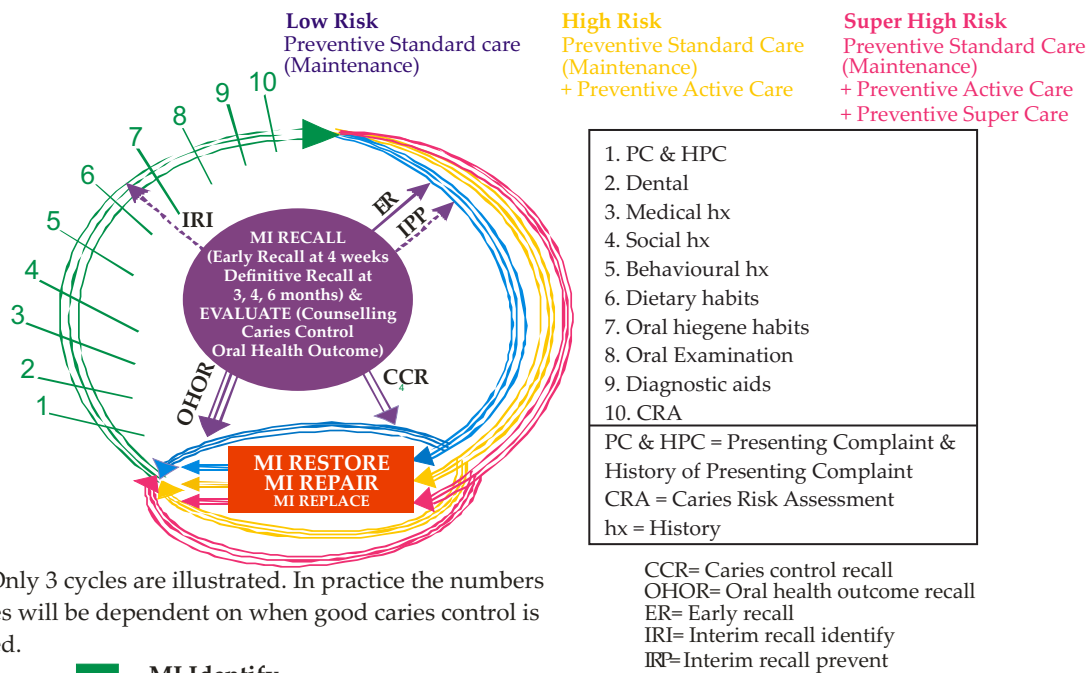


Figure 8: The Modified, Color-coded Mitp Framework For Dental Education And General Dental Practice Pri(adapted From Domejean^{5,24}, Ismail Et Al⁶ And Brostek And Walsh³¹).

For a more pragmatic implementation of MID in resource challenged environments, the MITP framework has been modified as illustrated in Fig 6. The essential features of this modification include:

- i. Integration of Brostek and Walsh's³¹ early recall (lifestyle, dietary and oral hygiene counselling recall);
- ii. Incorporation of ICCMS oral health outcome evaluation criteria⁶;
- iii. Recall appointments at 5 levels; MI interim recall identify, MI interim recall prevent, MI early recall (lifestyle, dietary and oral hygiene counselling recall), MI caries control recall and MI oral health outcome evaluation recall⁶; and
- iv. Integration of rating scales for early, caries control and oral health outcome evaluation recall rating scales (Tables 1,2 and 3).

	Good	Poor
Compliance with lifestyle counselling	<input type="checkbox"/> 1	<input type="checkbox"/> 2
Compliance with oral hygiene counselling	<input type="checkbox"/> 1	<input type="checkbox"/> 2
Compliance with dietary counselling	<input type="checkbox"/> 1	<input type="checkbox"/> 2
3 = Commendation & Encouragement		
4 - 6 = Repeat Counselling indicated (motivational counselling)		

Table 2: Early Recall evaluation rating scale (adapted from Brostek and Walsh 31)

	No	Yes
White spot lesions / new caries / recurrent caries present?	<input type="checkbox"/> 1	<input type="checkbox"/> 2
↑ Plaque biofilm activity (acid production)	<input type="checkbox"/> 1	<input type="checkbox"/> 2
Grugival soft tissue inflammatory changes present?	<input type="checkbox"/> 1	<input type="checkbox"/> 2
3 = Good Proceed to MI Restore		
4 - 6 = Poor Continue the MITP cycle until good caries control is achieved		

Table 3: Caries Control Recall evaluation rating scale (adapted from Ismail et al ⁶)

CONCLUSION

Minimum intervention dentistry (MID) is the current global gold standard for managing dental caries- one of the most prevalent diseases in mankind. Practitioners in resource challenged environments should embrace it with 'open minds'. The goal of MID is to keep oral tissues (including teeth) healthy and functional for life. This should also be the goal of every 21st century dentist and all members of the dental team. Dental training institutions in resource challenged environments should integrate MID into their curricula (including simulation laboratory training, clinical practice, assessments, professional and licensing examinations. Adherence to the principles and strategies of MID is still possible with poor access to new technological aids for early caries diagnosis. This is very important in resource challenged environments with poor infrastructure for managing the environmental health impacts of mercury pollution from dental amalgam. Partnerships with international MID experts will be essential for training workshops for both faculties and general dental practitioners. The Dental faculties, dental professional bodies, regulating agencies and other stakeholders should work together to achieve these objectives. Further research should focus on using the modified MITP framework for undergraduate simulation training, dental practice and in-course and end of course assessments.

REFERENCES

1. Julian Fisher, Benoit Varenne, Desire Narvaez, Carolyne Vickers: The Minamata convention and the phase down of dental amalgam. *Bull World Health Org* 2018 96:436-438 doi.http://dx.doi.org/10.2471/BLT.17.203141
2. Bentley IP: Disparities in children's oral health and access to care *J Calif Dent Assoc* 2007;35: 618-623.
3. Resolution WHA60.17. Oral health: action plan for promotion and integrated disease prevention. In: Sixtieth World Health Assembly, Geneva 23 May 2007 Agenda item 12.9. Available from :http://apps.who.int/iris/bitstream/handle/10665/2590/A60R17-en.pdf;jsessionid=667ABD4923E73849B2DD DCFBDB231D16?sequence=1.
4. Ismael A, Tellez M, Pitts NB, et al.: Caries management pathways preserve dental tissues and promote oral health *Comm Dent Oral Epidemiol* 2013;41: e12-e40
5. Domejean-Orliaguet S, Banerjee A, Gaucher C et al: Minimal Intervention Treatment Plan (MITP) Practical Implementation in General Dental Practice. *J. Minim. Interv. Dent* 2009 (2): 103-123.
6. Ismail AI, Pitts NB, Tellez M: The international caries classification and management system (ICCMS) an example of a caries management pathway *BMC Oral Health* 2015; 15 (Suppl. 1): 59
7. Flocke S Wong L, Sissons CH: Oral Biofilms: Emerging concepts in microbial ecology *J Dent Res* 2009;89(1)6: 8-18
8. Featherstone JD, Adair SM, Anderson, MH et al: Caries management by risk assessment: consensus statement. *J Calif Dent Assoc* 2002;31: 257-269.
9. Walsh L J : Clinical aspects of salivary biology for the dental clinician. *J Min. Intervention in Dentistry* 2008;1 (1): 1-14.
10. G T Arotiba, A O Loto, O Ijarogbe, Y Ajayi, I Menakaya, D Umesi and L Adogame: Lessons from mercury dental amalgam phase down for developing economies. *African Journal of Oral Health / Volume 8 No 2, 2019: 29-39*
11. Ismail A, Hasson H, Sohn W: Dental caries in the second millennium *J Dental Education* Oct 2001; 953-959 Tyas MJ: Minimum intervention dentistry: Essential concepts . *Thai Dental Association* June 2009. Bangkok 2009
12. Elderton R: Principles in the management and treatment of dental caries. In: Elderton R editor *The Dentition and Dental Care*. Oxford: Heinemann Medical Books 1990 p.237-262.
13. Backer Dirks O, Houwink B, Kwant GW: The results of 61/2 years of artificial fluoridation of drinking water in the Netherlands. The Culemborg experiment *Arch Oral Biol* 1961;5: 284-300.
14. Massler M: Pulpal reactions to dental caries *Int Dent J* 1967; 17:441-460
15. Mount GJ: Minimal treatment of the carious lesion. *Int Dent J* 1991 41: 55-59.
16. Dawson AS and Makinson OF: Dental

- Treatment and dental health. Part 1. A review of studies in support of a philosophy of minimum intervention dentistry. *Aust Dent J* 1992a;37:126-132.
17. Fusayama T: The process and results of revolution in dental caries treatment *Int Dent J* 1997;47:157166.
 18. Anusavice KJ: Criteria for placement and replacement of dental restorations *Fla Dent J* 1988;59:30-31.
 19. ten Cate JM: Remineralization of caries lesion extending into dentin *J Dent Research* 2001; 80:1407-1410 *cda journal*, vol 35, n°11 November 2007 799- November 2007 805
 20. ADA CCS *JADA* 146(6) <http://jada.ada.org> June 2015 365
 21. Pitts NB: 'ICDAS': an international system for caries detection and assessment being developed to facilitate caries epidemiology, research and appropriate clinical management (editorial). *Community Dent Health* 2004;21:193-8
 22. Hanse-Petersson G, Twetman S, Brathall D: Evaluation of a computer program for caries risk assessment in school children. *Caries Res* 2002;36:327-340.
 23. Featherstone JD, Adair SM, Anderson, MH et al: Caries management by risk assessment: consensus statement. *J Calif Dent Assoc* 2002; 31:257-269.
 24. Featherstone JD: The caries balance: the basis for caries management by risk assessment *Oral Health Prev Dent* 2004; 2 (suppl 1): 259-264.
 25. Young DA, Featherstone JD, Roth JR et al: Caries management by risk assessment : Implementation guidelines *J Calif Dent Assoc* ;2007; 35 (11): 799-805.
 26. RW Evans, A Pakdaman, PJ Dennison, ELC Howe: The Caries Management System: an evidence-based preventive strategy for dental practitioners. Application for adults. *Australian Dental Journal* 2008; 53: 83-92 doi:10.1111/j.1834-7819.2007.00004.
 27. RW Evans, PJ Dennison: The caries management system: an evidence -based preventive strategy for dental practitioners. Application for children and adolescents. *Aust Dental J* 2009;54: 381-389
 28. Tyas MJ, Anusavice KJ, Frencken JL, Mount GJ: Minimum Intervention Dentistry-A review. *Int. Dent J.* 2000;50:1-12
 29. Domejean-Orliaguet S, Basso M, Miletic I, Kargul B et al: *MI Dentistry Handbook: A comprehensive guide to treatment plans and practice implementation of minimum intervention dentistry* GC corporation 2017.
 30. Tyas M J : Minimum intervention dentistry : Essential concepts. Thai Dental Association Bangkok .June 2009 .
 31. Brostek AM, Walsh, LJ: *Minimal Intervention Dentistry in General Practice* OHDM 2014;13(2): 285-294.
 32. Frencken JE, Peters MC, Manton JD, et al: Minimum Intervention Dentistry for managing dental caries – a review – Report of the FDI task group *Int. Dent. J.* 2012;62: 223-243.
 33. Kutsch VK Young DA: New directions in the etiology of dental caries disease. *J Calif Dent Assoc* 2011;39:716-721.
 34. Kutsch V K: Dental caries: an updated medical model of risk assessment. *The J ProsthetDent* 2014;111:280-285.
 35. Tassery H, Levallois B, Terror T et al.: Use of new minimum intervention dentistry technologies in caries management *Aust. Dent J.* 2013 58 (1 Suppl.): 40-59.
 26. Frencken JE, Songpaisan Y, Pantumvanit P: Atraumatic Restorative Treatment (ART): Rationale, Technique and Development *J Public Health Dentistry* 1996;56 (3): 135-140
 37. Mandari GJ, Truin MA, van Hof MA, Frencken JE: Effectiveness of three minimal intervention approaches for managing dental caries: Survival of restoration after 2 years. *Caries Res* 2001;35: 90-94.
 38. van 't Hof MA, Frencken JE, Helderma WH van P, Holmgren CJ: The atraumatic restorative treatment (ART) approach for managing caries: A meta-analysis. *Int Dent j* 2006;(56):345-351
 39. Gordan VV, Garvan CW, Blasser PK et al: A long term evaluation of alternative treatments to replacement of resin-based composite restorations" results of a seven year study. *J Am Dent Assoc* 2009 140: 1476-1484.

40. Gordan VV, Riley JJ III, Gorvan CW et al: & year results of alternative treatments to defective amalgam restorations J Am. Dent Assoc. 2011;142:842-849.
41. Gordan VV, Mjor IA, Blum I et al: Teaching students the repair of resin based composite restorations: a survey of North American dental schools. J Am Dent Assoc. 2003 134:317-323
42. MoncadaG, Martin J, Fernandez et al: Sealing, repair and refurbishment of class I and class II defective restorations : a three year clinical trial J Amer. Dent Assoc. 2009 140: 425-432.
43. <http://iabdm.org> (Protect Protocol-patient, dental staff, environment)-Assessed on 28th September, 2019.