

# Outlining a Preventive Oral Health Care System for China

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*The most recent Chinese health care reform, scheduled to run until 2020, has been underway for a number of years. Oral health care has not been explicitly mentioned in the context of this reform. However, oral health is an integral part of general health and the under-servicing of the Chinese population in the area of dental care is particularly high. The article describes how this problem could be addressed.*

*Based on present scientific knowledge, specifically on evidence-based strategies and long-term empirical experience from Western industrialised countries, as well as findings from Chinese pilot studies, the author outlines a preventive oral health care system tailored specifically to the conditions prevailing in China. He describes the background and rationale for a clearly structured, preventive system and summarises the scientific cornerstones on which this concept is founded. The single steps of this model, that are adapted specifically to China, are presented so as to facilitate a critical discussion on the pros and cons of the approach.*

*The author concludes that, by implementing preventive oral care, China could gradually reduce the under-servicing of great parts of the population with dental care that largely avoids dental disease and preserves teeth at a price that is affordable to both public health and patients. This approach would minimise the danger of starting a cycle of re-restorations, owing to outdated treatment methods. The proposal would both fit in well with and add to the current blueprint for Chinese health care reform.*

**Key words:** *early caries diagnostics, minimal invasive treatment, non invasive caries management, preventive dentistry, risk-oriented prevention.*

The author had the opportunity to be one of those who actively shaped the process of reorientation from restorative to prevention-oriented dentistry in Germany<sup>1</sup>. He now wishes to pass these positive experiences and insights on to countries that do not yet have a firmly established dental care system and are therefore particularly open to best practice solutions. Due to its pragmatic, goal-oriented and population-centred health policy, that expanded medical insurance coverage in the last decade

from 15% (2003) to 90% (2011) and established a blueprint for basic health care up to 2020, which would provide the entire population with safe, effective, convenient and affordable health services<sup>2</sup>, China's health policy is now open for such suggestions. A 3-year action plan running from 2009 to 2011, funded with 124 billion USD, was also set up with the aim of strengthening primary care focus and improving evidence-based pharmaceutical use<sup>3</sup>.

Although the provision of dental care is not explicitly mentioned in the blueprint, the Chinese government took action in this field and, in 2008, by starting a programme to control the oral diseases of 7- to 9-year-old children in the Mid-Western provinces. The programme comprised of oral health education, oral examination as well as pit and fissure sealing to the first permanent

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molars. In 2012, a fluoride application project for 3- to 6-year-olds was started in some regions, the aim being to prevent caries in this decisive age group. Nearly 200 oral health education centres were set up in the public hospitals of the 22 provinces in order to promote and support the hospitals in conducting oral health education. Furthermore, the government intensified the basic training of oral health care staff who would later serve China's extensive rural regions<sup>4</sup>.

The intention of this discussion paper is to outline a preventive oral health care system that can overcome neglect and under-service in the treatment of the main oral diseases, caries and periodontitis, in large parts of the Chinese population; and in doing so provide an effective and evidence-based approach at an affordable cost in terms of public and private resources.

The author aims to encourage oral health researchers, dentists, as well as policy and decision makers in China, to make use of the great opportunities that preventive dentistry can also offer to populations in low- and middle-income countries.

## Materials and methods

The proposed system is based on the latest scientific research on evidence-based strategies and long-term empirical experience gleaned from highly industrialised countries, including results from Chinese pilot studies on preventive programmes. The concept takes into account the fact that China, as a newly industrialising low- and middle-income country, cannot adopt a Western-oriented dental care model because it would be too expensive and the impact on the incidence and distribution of disease in the population would be too limited<sup>5</sup>. The concept relies on numerous empirical data from country-wide successes of preventive dentistry in children and adolescents in Switzerland, the Netherlands, the Nordic countries, Australia and Germany. With reference to the adult population, the arguments are based on empirical material from countrywide Swedish experiences and partial successes in Switzerland, Australia and Germany.

## Arguments for envisaging efficient dental care structures now

In industrialised countries, the traditional restorative treatment of oral disease is very costly, which is why it is the fourth most expensive disease to treat<sup>6</sup>. These countries have to spend between 4% and 8% of total health care expenditure on oral care<sup>7</sup>. For emerging low- and middle-income countries, such dimensions are hardly acceptable.

Experience in low- and middle-income countries, where adequate oral health care structures are lacking, shows that as the standard of living rises, lifestyles and dietary habits (higher sugar consumption) change and, consequently, dental disease levels for adults increase. Data from Hong Kong and Guangdong province<sup>8,9</sup>, two of the most prosperous regions, prove that this connection is also true for China.

If oral diseases occur and are not adequately treated they might affect a person's overall health. Oral health is essential for general health<sup>10</sup>, particularly in older age groups.

In a rapidly changing country like China, where oral health services are still in their infancy, or in a process of reorientation, it would be naive not to establish coordinated and clearly structured supply facilities that aim to serve the entire population in an effective way. When a dental service which is incorrectly designed and unregulated exists, it is extremely difficult to change such a structure<sup>1</sup>. As a result Chinese newspapers were right in demanding that it is 'time for dental care'<sup>11</sup>. Unless regulatory steps by health policy makers are envisaged, public dental providers tend to offer their patients the traditional invasive surgical approach<sup>5</sup> starting the 'vicious cycle of re-restorations'<sup>12</sup>. Private dentists could be misled into taking a 'business-like approach' providing 'high-end procedures' which would result in offering 'Hollywood smiles' or 'expensive trinkets'<sup>13</sup>. In several of China's larger cities, the latter danger is already obvious<sup>14</sup>.

## Background and rationale for the preventive dentistry approach

Unless teeth are affected by oral diseases or interventions by dental personnel, teeth last a lifetime<sup>15,16</sup>. Their longevity depends mainly on caries activity, the health status of the periodontium and the extent of reconstructions. In general, teeth surrounded by healthy periodontal tissues, have a lifespan of over 50 years. More than 90% of periodontally compromised teeth that are treated and maintained regularly also have a high survival rate (> 10 years). The same is true for endodontically compromised teeth<sup>16</sup>.

As long as dental science considered the caries process to be irreversible, 'the logical treatment was the surgical excision of pathological tissue and replacement with a restorative material'. Since the causes of caries and periodontitis are widely known and it is well accepted that both diseases do not progress continuously but discontinuously, with alternating phases of active, stagnating and inactive periods, this symptomatic,

restorative or surgical approach in dentistry has become outdated and is no longer tenable<sup>17</sup>. Nevertheless, it still dominates adult provision in many high-income countries although the focus of the treatment given to children and adolescents has mostly switched to prevention<sup>18</sup>. Referring to the relatively high extraction rates per person in these countries, resulting from this outdated dental approach, Elderton<sup>12</sup> characterises this sort of dentistry as ‘not necessarily good for the dentition’.

For a few decades now, scientific knowledge has made it possible to treat these diseases causally using a biological therapeutic approach. The international scientific community (World Health Organization, International Association for Dental Research, World Dental Federation and International Federation of Dental Educators and Associations) agrees that prevention is the key to oral health<sup>19</sup>.

The following prevention concept is based on this knowledge and is being widely practised by general practitioners in the Nordic countries, especially in Sweden, since the 1990s<sup>20</sup>. Over the last 10 years, this approach, which is known as CAMBRA (Caries Management By Risk Assessment), has also been introduced in more than nine US universities and quite a few private dental practitioners in the US have incorporated it into their daily routine<sup>21,22</sup>. At about the same time, a very similar concept called the ‘Caries Management System’ was developed in Australia. It is taught at the University of Sydney and practised by many private general dental practitioners<sup>23-25</sup>. Some universities in Germany teach this approach (for example Cologne and Witten-Herdecke) and, for quite some time now, a number of private practices have pursued a preventive concept that also extends to adults<sup>26</sup>.

### Cornerstones of a causal, preventive Caries Management System (CMS)

A Caries Management System (CMS) concept for children, adolescents and adults generally comprises the following five principles<sup>17,27</sup>.

- Remineralisation of early lesions.
- Reduction of cariogenic bacteria in order to eliminate the risk of further demineralisation and cavitation.
- Minimally invasive treatment of cavitated lesions.
- Repair instead of replacement of defective restorations.
- Regular monitoring for early identification of active caries.

The CMS model aims to treat the aetiological causes of caries: ‘the infectious cariogenic biofilm in a predomi-

nantly pathologic environment’<sup>22</sup>. The starting point in this strategy is the Caries Imbalance model developed by Featherstone<sup>28</sup>, where pathological factors (bacteria, absence of saliva and poor dietary habits) fight for predominance against protective factors (saliva and sealants, antibacterials, fluoride and a tooth-friendly diet). The balance amongst disease indicators (white spots, restorations < 3 years, enamel lesions, cavities/dentin), pathological and protective factors, which normally change several times a day, determines whether caries progresses, comes to a halt or regresses<sup>21</sup>.

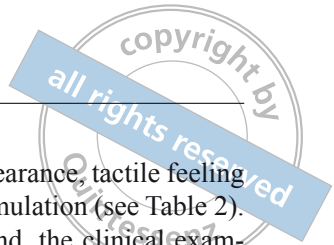
In order to implement the CMS model in a cost-effective way, it is decisive to take a caries risk assessment approach<sup>29,30</sup> and to perform improved caries diagnostics.

How a patient’s caries risk can be assessed reliably and which corresponding treatment steps are indicated as a result of the assessment, is described, based on typified instructions. The aim of describing this procedure in detail is to facilitate the possible implementation of a CMS model into Chinese praxis.

At first a more sophisticated clinical caries diagnosis is necessary to record initial lesions as well, because only then can enamel lesions be remineralised. For this purpose the traditional caries lesion detection, which relies on physical criteria (the size, depth and presence/absence of cavitation) has to be combined with the assessment of caries lesion activity and severity<sup>31-33</sup>. A visual inspection system, such as the International Caries Detection and Assessment System (ICDAS) - was created in 2002 by international dental scientists and has since been modified to become what is now known as the ICDAS II system<sup>32,33</sup>. Though some scientists still question the reliability of caries activity assessment<sup>34</sup>, the ICDAS II system, embedded in the three-tier Fédération Dentaire Internationale (FDI) Caries Matrix<sup>33</sup>, was internationally accepted and approved by the general assembly of the FDI at its meeting in Mexico City in 2011<sup>35</sup>. Visual examination ‘is the only effective method available to assess caries lesion activity’ and should be used in daily clinical practice<sup>31</sup>.

Other methods for monitoring the early caries process (fiber optic transillumination, electronic caries monitor, fluorescence-based methods) can be useful for research purposes but offers no significant benefits for daily clinical routine<sup>31</sup>. ICDAS II diagnostic tools for use in dental practices are shown in Table 1.

The teeth are examined and classified according to the severity code of the particular lesion. The clinical assessment of caries activity (active or inactive) of enamel lesions on smooth and occlusal surfaces is per-



**Table 1** Definitions of ICDAS II Caries Classification (level 2) of FDI Caries Matrix<sup>1</sup>.

Code	Description
0	Sound tooth surface: no evidence of caries after prolonged air drying (5s)
a	First visual change in enamel: opacity or discolouration (white or brown) is visible at the entrance to the pit or fissure after prolonged air drying, which is not or hardly seen on a wet surface. Or distinct visual change in enamel: opacity or discolouration distinctly visible at the entrance to the pit and fissure when wet, lesion must still be visible when dry.
b	Localised enamel breakdown due to caries with no visible dentin or underlying shadow: opacity or discolouration wider than the natural fissure/fossa when wet and after prolonged air drying.
c	Underlying dentin shadow ± localised enamel breakdown.
d	Distinct cavity with visible dentin: visual evidence of demineralisation and dentin exposed. Or extensive distinct cavity with visible dentin and more than half of the surface involved.

1) Middle tier (level 2) of FDI Caries Matrix. In level 2 the ICDAS-II Codes 1 and 2 (from level 3) for early stage decay are combined as Code a and the Codes 5 and 6 for severe decay are combined as Code d. References: 32,33,36.

formed on the basis of visual appearance, tactile feeling and the potential for plaque accumulation (see Table 2).

If no obvious cavities are found, the clinical examination of approximal caries in the case of new patients is done by means of bitewing radiography. To identify changes between examination appointments and to quantify the rate of progression, the unrestored approximal surfaces are radiographed at certain intervals and scored according to the following five category system (Table 3).

The results are recorded on a bitewing radiographic assessment form, from which the status of distal, occlusal and mesial surfaces of the posterior teeth and possible changes can be observed<sup>24</sup>.

Because gingivitis and moderate periodontitis are common findings in China<sup>38,39</sup>, early diagnosis of periodontal disease signs is also necessary with a view to prevention. To this end, the Periodontal Screening Index (PSI) has been developed and is widely used in Western dental practices. A therapeutic recommendation is given along with the PSI scores. As the PSI-Index tends to overestimate the disease progression and the treatment need, a full mouth recording including radiography is indicated in cases of suspected aggressive periodontitis. For this purpose a cluster analysis, e.g. the hexagon after Lang and Tonetti, has proven to be valuable<sup>40</sup> and has demonstrated its reliability in a major long-term study<sup>41</sup>. This method takes into account the following risk factors: bleeding on probing in %, amount of teeth with probing depth ≥ 5 mm, number of missing teeth, bone loss in relation to age, systemic/genetic disposi-

**Table 2** Criteria for differentiating active and inactive initial lesions at smooth and occlusal surfaces within the framework of the FDI-ICDAS-II System (level 2).

ICDAS-II Code	Criteria	Active lesion	Inactive lesion
a or b	Colour	Chalky, whitish	Yellowish, brownish or black
	Surface after drying	Loss of lustre	Shiny
	Location	Gingival	Mostly at some distance from the gingival margin
	Plaque	Mostly with plaque	Often without plaque
	Gingiva	Mostly gingivitis with bleeding disposition	Sound gingiva, no bleeding disposition
c	-	Probably active	-
d	-	Cavity feels soft or leathery on gently probing the dentin.	Cavity may be shiny and feels hard on gently probing the dentin.

References: 20, 32.

tion (e.g. diabetes, HIV, Down's syndrome) and smoking. For the classification of a patient's periodontal risk as low, medium or high according to this method see Jordan and Zimmer<sup>40</sup>. A less complex method, which is likely to be more suitable for the circumstances relating to China, defines moderate and severe periodontitis in terms of probing depth (PB) and clinical attachment level (CAL)<sup>38,42</sup>.

The CMS itself, in the modified German version<sup>18,43</sup> that will later be adapted to the Chinese framework, consists of seven steps (Table 4) including: a risk assessment of the patient, the status of existing lesions, clinical management and recall. Determination of the caries risk and the treatment of caries follows a defined protocol that is strictly evidence-based and focused on non-invasive measures which simultaneously aim for primary and secondary prevention (arrest and/or regression of the incipient lesion)<sup>24</sup>.

*Anamnesis, dietary habits, oral environment (step 1)*

The patient's case history, clinical examination, if the patient shows high caries activity and his/her diet analysis, determines whether an individual is exposed to potential caries risk factors. These would include: high and frequent sucrose intake, insufficient fluoride use, dental plaque, tooth morphology, salivary flow and cariogenic bacteria. The diet-related risk of patients with high caries activity is easy to identify by means of a 24 hour questionnaire on snack behaviour<sup>24</sup>, which the patient fills out and which is later discussed with him/her.

In order to evaluate the quality of oral hygiene, the clinical examination of recall patients is performed by means of the Papillary Bleeding Index (PBI). The index measures the degree to which the dentition is free from inflammation and assesses the extent of bleeding. This PBI does not only give a snapshot of oral hygiene, like any plaque index, but simultaneously shows the regularity with which a patient performs oral hygiene<sup>18</sup>.

The measurement of the amount (ml/min) of stimulated salivary flow in 2 to 5 min is only indicated when the patient's caries risk is assumed to be high<sup>45</sup>. Values of 0.5 ml/min place the patient in the 'high-risk' category<sup>21</sup>.

*Diagnosis and risk assessment (step 2)*

Risk assessment for new patients is conducted by means of clinical examination, including a bitewing survey<sup>46</sup>. For recall patients, the assessment is carried out according to the incidence of new lesions and/or the progres-

**Table 3** Criteria for scoring bitewing radiolucencies on occlusal and approximal surfaces.

Grade	Criteria
C 0	No radiolucency evident (not recorded)
C 1	Radiolucency is evident within the outer half of enamel
C 2	Radiolucency extends to the inner half of enamel and may reach the DEJ <sup>1</sup>
C 3	Radiolucency extends just beyond the DEJ
C 4	Radiolucency is evident within the outer third of dentin
C 5	Radiolucency extends to the inner two thirds of dentin and may reach the pulp

1) DEJ = Dentin-enamel junction.  
References: 37, 24.

**Table 4** Seven-step Caries Management System.

Steps	Action
1	Anamnesis including risk factors (diet, oral hygiene, bacteria, saliva)
2	Diagnosis and caries risk assessment
3	Treatment planning and case presentation at which patient is informed about caries: – Quantity and status of existent lesions – Preventive measures – Remineralisation (arrest of caries/natural repair) – Role of dental team in caries management – Role of home/self care in caries prevention – Current caries risk status – Result of diet assessment and recommendations – Oral hygiene counselling and monitoring
4	Professional mouth cleaning, fluoride application, Chlorhexidine application, oral hygiene instruction
5	Sealings
6	Restorative care
7	Recall programme tailored to caries and periodontitis risk status

References: Modified after 24,44 by 18.



**Table 5** Criteria for assigning caries risk status.

Caries risk grade	New patient	Recall patient
Low	No clinical signs of caries; Radiolucencies ≤ C3	< 1 new lesion/year or no progression of existing radiolucency
Medium	No frank cavitation; sticky pits or fissures and/or radiolucencies ≤ C4	1 lesion/year and/or progression of radiolucencies
High	Untreated frank cavities and/or extensive white spot lesions and/or C5 radiolucencies	> 1 new lesion/year

References: 24.

sion status of existing lesions. The determination of the three caries risk categories is shown in Table 5.

In cases where caries and periodontitis risk classes diverge, the highest risk class determines the patient’s overall risk<sup>40</sup>. For example, if a patient shows a low or medium caries risk but a high periodontitis risk, the patient belongs to the highest risk group and vice versa.

Applying the classification based on the three caries risk categories to the current morbidity status of the Chinese adult population reveals that the percentage of patients needing treatment (D-T > 0) is very high. About 80% to 90% of carious teeth in adults are left untreated

and two thirds of the fillings are in need of repair or replacement or have secondary caries underneath<sup>47</sup>. In numbers, this means that one third of adults belong to the low-risk group and the majority of adults fall into the medium-risk group.

*Treatment planning and case presentation (step 3)*

Patients have to be convinced that proper daily oral hygiene with fluoridated toothpaste is the key to their dental health. The dental team has to inform the patient of the causes of both caries and periodontitis as well

**Table 6** Protocol for managing lesions following caries diagnosis based on bitewing radiography.

Lesion score	Treatment
C1	No restoration – topical fluoride application and monitoring
C2	No restoration – topical fluoride application and monitoring
C3	No restoration – topical fluoride application and monitoring
C4	Maybe restoration, but only after further consideration
C5	Restoration – it is almost certain that cavity has breached the DEJ
Caries risk	Further considerations for surfaces scoring C4
Low and Medium	<ul style="list-style-type: none"> <li>• Restoration only if radiolucency extends a full 1/3 into dentin, or following tooth separation when cavity is confirmed.</li> <li>• Otherwise no restoration because it is most likely that:                             <ul style="list-style-type: none"> <li>- the approximal surface is not cavitated</li> <li>- the lesion has arrested.</li> </ul> </li> <li>• Application of topical fluoride and monitoring:                             <ul style="list-style-type: none"> <li>- to arrest and remineralise active lesions</li> <li>- to maintain arrested lesions.</li> </ul> </li> </ul>
High	<ul style="list-style-type: none"> <li>• Immediate restoration</li> <li>• Application of topical fluoride and monitoring:                             <ul style="list-style-type: none"> <li>- to arrest and remineralise lesions not yet showing radiolucencies</li> <li>- to prevent recurrent caries.</li> </ul> </li> </ul>

References: 24.

**Table 7** Professional care topical fluoride protocol for adolescents (> 10 years) and adults.

Caries risk	Fluoride varnish Duraphat (22.600 ppm) or Elmex fluid (10.000 ppm)	Sealings composite or GIC (e.g. Fuji 7)
Low	1. Varnish application on newly erupted molars 2. Yearly applications on lesions until arrested	GIC on newly erupted molars
Medium	1. Varnish application on newly erupted molars 2. Varnish application to all lesions at each treatment session 3. Varnish application every 6 months on lesions until patient becomes low risk	GIC on newly erupted molars. Composite only indicated if fissures are very profound
High	1. Varnish application on newly erupted molars 2. Varnish application to all lesions at each treatment session 3. Varnish application every 3 months on lesions until patient becomes medium risk	GIC on newly erupted molars. Additionally, composite sealings on very profound fissures or if caries risk can not be reduced

References: Modified after 24, 55 by 43.

**Table 8** Home care topical fluoride protocol for adolescents and adults.

Caries risk	Toothbrushing with fluoride tooth paste (1.000-1.500 ppm F)	Toothbrushing with fluoride gel 12.500 ppm F	Fluoride rinse 0.05% (250 ppm) NaF for 1 min	Chlorhexidine (CHX) rinse (0.12%/0.2%) or gel (1%)
Low	2x daily using > 1.000 ppm	Not applicable	Not applicable	Not applicable
Medium	2x daily using > 1.000 ppm	1x weekly	1x daily, at separate time from tooth brushing	Not applicable
High	2x daily using 5.000 ppm	2x to 3x weekly	1x daily, at separate time from tooth brushing	1x daily/1 min gargling before bed or applying CHX gel using a toothbrush

References: Modified after 24, 55, 21 by 43.

as the prophylactic options for avoiding these diseases. For this purpose, Evans et al<sup>24</sup> developed a ‘tooth decay information leaflet’ which also contains the patient’s caries situation and the necessary treatment measures. Depending on their caries and periodontal risk, patients should also be given written recommendations for their daily oral hygiene.

The dentist has to ascertain that patients have understood the diagnosis as well as the treatment plan and that they are ready to collaborate. In Western industrialised countries, with a well developed oral care system, this precondition is met in 70% to 75% of adults<sup>21,48</sup>. Patients who are not willing to cooperate are treated in the traditional manner.

Particularly in patients with high caries activity, it is the dentist’s duty to assess the dietary risk and to give adequate advice<sup>24</sup>. In addition to a sufficient intake of fluoride and proper oral hygiene, both of which can sig-

nificantly neutralise the harmfulness of sugar consumption on teeth<sup>49</sup>, the chewing of sugar-free gum after lunch and snacking is one evidence-based measure for achieving remineralisation<sup>50</sup>. Although the remineralising effect of chewing sugar-free gum results primarily from stimulating the flow of saliva, preference should be given to Xylitol-containing products<sup>51</sup>.

The promising approach to enhancing the remineralisation of dental hard tissues by means of products containing casein phosphopeptide-amorphous calcium phosphate (CPP-ACP) nanocomplexes is not yet recommended for broad introduction into daily use because controlled clinical studies are still limited in number<sup>24,52</sup>. In contrast, the advocates of the CAMBRA model<sup>45</sup> and other groups<sup>44</sup> argue that CPP-ACP products have already proven to be beneficial in treating high-risk patients and are therefore recommended for this patient group.

### *Clinical management (steps 4 and 5)*

After encouraging patients to enhance their oral hygiene and diet habits through oral hygiene instruction and training, patients are taught how quickly gingivitis can be reversed by regular and proper toothbrushing. Normally, a patient needs at least two intensive sessions to reach a level of skill and self-motivation that enables him/her to establish a lifelong habit of careful toothbrushing twice a day<sup>24</sup>.

Incipient lesions and fissure lesions with enamel cavities are sealed without removing tooth structure<sup>53</sup> and checked regularly because the permanent termination of the caries process depends on the durability and excellence of the sealing<sup>54</sup>. Most of the other active lesions, discovered by bitewing radiography, are brought to a halt using non-invasive measures (Table 6). Cavitated lesions are treated using minimally invasive techniques.

The application of topical fluorides is done according to protocols that differentiate between professional and home care use (Tables 7 and 8). As soon as the dental team has ascertained that the patient is cooperating reliably, home measures should be given priority as their cost-effectiveness is significantly higher.

Although there is only weak evidence in support of the use of chlorhexidine varnish (CHX-V) or gel for high-risk patients<sup>56</sup>, the short-term use of a chlorhexidine rinse for home care is justified because no better alternatives for caries control exist for individuals at high risk<sup>18,27</sup>.

As C5 lesions are associated with the cavitation into dentin, they require urgent, minimally invasive surgical interventions to avoid pulp complications<sup>24</sup>. With a view to preventing secondary caries in the remaining peripheral rim, the dentist has to make sure that primary caries activity has been reduced and halted, before carrying out minimally invasive surgical procedures<sup>57</sup>.

The utmost attention has to be paid to C4 lesions. They are to be surgically treated in a minimally invasive manner only if patients are categorised as high-risk or in cases of medium- and low-risk, 'when the lesion depth extends through a full one-third of the dentin thickness or when, following tooth separation, cavitation into dentin is confirmed'<sup>24</sup>.

Observant non-invasive clinical management of C4 lesions is justified if cavities remain within the enamel and the underlying dentin, although affected, remains uninfected and the 'risk of rapid lesion progression is minimal'<sup>24</sup>. It takes at least 4 years for lesions to progress from enamel to dentin<sup>58</sup>. In populations with good oral hygiene and high fluoride intake, this process can take up to 6 to 8 years. The same is true for progress

through dentin<sup>17</sup>. Therefore, the discovery of a C4 lesion does not signify an urgent need for surgical treatment. Such lesions can frequently be halted by laying emphasis on the 'natural repair mechanism of remineralisation'<sup>24</sup>. Patients at low- or medium-risk do not need restoration because arrested C4 lesions that have not been restored cause no harm to sound surfaces, even if they show white spot lesions without cavitation<sup>24</sup>. Should the dentist, at a recall visit, recognise that a C4 lesion is an enamel cavity and/or radiography indicates lesion progression, it can then be restored.

### *Restorative therapy (step 6)*

Where restorative measures are necessary, they are, whenever possible, to be performed in a minimally invasive manner. How this is to be done is described in detail by Fejerskov and Kidd<sup>59</sup> and Reich and Brauchle<sup>60</sup>.

### *Patient monitoring and recall intervals (step 7)*

In order to monitor caries activity and the quality of oral hygiene, patients are recalled at regular intervals based on their caries risk status (Table 9). Monitoring at each recall appointment includes: clinical status, if necessary supported by bitewing radiography, diet assessment, oral hygiene status, fluoride exposure and in extreme cases of hyposalivation, saliva control<sup>24</sup>.

The most reliable instrument for monitoring caries progression on approximal surfaces is bitewing radiography. Approximately half of the lesions can be discovered by this method alone<sup>61,62</sup>. The intervals recommended for bitewing radiographs in Table 9 are largely in accordance with the scientific guidelines obtained in Europe and the USA<sup>63-65</sup>. However, the dentist should always bear in mind that employing the non-invasive method, to arrest incipient lesions as early as possible, reduces the caries incidence rate and consequently leads to less radiography<sup>66</sup>.

### **Adjusting the CMS to the Chinese framework**

The possible introduction of preventive dentistry for the entire Chinese population would have to recognise the country's great regional diversity, its differing stages of development as well as its three-tier health system (at national, provincial and county level). Dental care facilities in deprived, rural regions need different preventive approaches from urban and more developed rural areas. For deprived communities in developing countries, dental scientists have developed a proven, effective and applicable system of prevention-oriented care. This



**Table 9** Recall protocol to monitor caries activity and bitewing surveys.

Recall protocol		
Caries risk	Caries activity	Bitewing survey
Low	<ul style="list-style-type: none"> <li>- 6 to 12 months following completion of first treatment plan</li> <li>- Then recall every 12 months</li> </ul>	<ul style="list-style-type: none"> <li>- At first visit</li> <li>- Then 24 months later</li> <li>- Then every 24 to 48 months</li> </ul>
Medium	<ul style="list-style-type: none"> <li>- 6 months following completion of first treatment plan</li> <li>- Then every 6 months until patient is classified as low risk</li> </ul>	<ul style="list-style-type: none"> <li>- At first visit</li> <li>- Then every 18 to 24 months until patient becomes low risk</li> </ul>
High	<ul style="list-style-type: none"> <li>- 3 to 4 months following completion of first treatment plan</li> <li>- Then every 3 to 4 months, until home care goals are achieved for oral hygiene, fluoride therapy, and lesion progression has arrested/reversed and patient is reclassified as medium or low risk</li> </ul>	<ul style="list-style-type: none"> <li>- At first visit</li> <li>- Then every 6 to 18 months until patient is reclassified as low risk</li> </ul>

References: Modified after 24, 21.

so-called Basic Package of Oral Care (BPOC) consists of three essential components: urgent oral treatment, affordable fluoride dentifrice and atraumatic restorative treatment (ART), accompanied by community-wide oral health promotion measures. This concept is described in detail by Frencken et al<sup>67</sup> and could be integrated into the primary health care concept for remote areas in China. For areas without any dental service, mobile outpatient clinics, which have proved valuable in several European countries could serve to ease the paucity of care facilities.

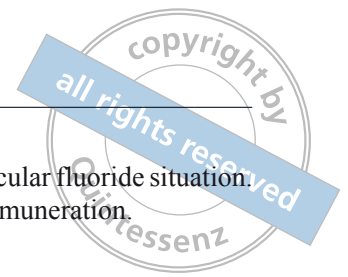
In this article, the focus is on the more sophisticated preventive dentistry approach suited to the steadily growing population in the more well-to-do provinces/counties and urban areas, from where it might spread, in the long run, to the entire country. However, as the Chinese government will be spending considerable sums on community healthcare centres, it might be feasible to use this initiative to implement preventive oral care in these centres as well.

The CMS model, developed in high-income countries with their individualistic societies, will need to be adjusted to the specific conditions prevailing in China as a whole. In some instances, these conditions favour such an approach, but in others they are unfavourable. Favourable aspects include:

- Dental caries in the Chinese population is still at low levels and in the early stages<sup>68</sup>, however, the accumulated treatment needs are high. Gingival bleeding and calculus is widespread but periodontal breakdown is still low and does not cause major tooth loss<sup>39</sup>. Thus,

relieving the pain of dental disease, which is relatively easy to achieve, is the predominant task to be fulfilled by Chinese dental services<sup>5</sup>.

- China is in the comfortable position of being able to select the best therapeutic and cost-efficient system or approach from among those embraced by a number of high-income countries. By modifying these experiences, China can adopt proven oral management and treatment methods and dental structures, without having to deal with the negative aspects of these experiences.
- Dental health in China is predominantly provided by hospital-based public health services on province, county, rural level; community health care centres, school dental clinics and sometimes factory clinics<sup>69</sup>. Over 80% of all treatments are carried out by these facilities<sup>70</sup>. In urban areas most people use provincial dental hospitals whereas, in rural areas, it is the county hospital dental departments that are most frequented<sup>69</sup>. These centralised structures facilitate the implementation of a population or group-oriented preventive approach. As high and frequent sucrose intake, smoking and alcohol abuse, are major risk factors for oral and chronic diseases (e.g. cardiovascular disease, cancer, obesity, diabetes), it is beneficial to tackle these common risk factors by means of integrated approaches<sup>71</sup>. This again is most effectively done by centralised public health facilities and mass media. A very good example of this is the successful Love Teeth Day (LTD) campaign that currently reaches about 600 million people<sup>72</sup>.



- In many parts of China, tap water contains fluoride, though most often not in a sufficiently high concentration (< 0.5 ppm F)<sup>73</sup>. As for most people, drinking water is the main source of fluoride exposure<sup>74</sup>, overall intake of fluoride is deficient.

Disadvantages primarily include the lack of supply structures in rural areas<sup>75,76</sup>, extremely poor attitudes to oral health, lack of knowledge and the inauspicious oral hygiene habits of children, adults and even dental students<sup>69,70,77-79</sup>, the fact that the use of dental services is predominantly pain-driven if at all and the paucity of public financing<sup>80,81</sup>.

The fact that yearly dental visiting rates among the population are very low (around 10%<sup>4</sup>) and that 35% of adults have never visited a dentist in their lifetime<sup>70</sup> might be seen as an exclusion criterion for the implementation of preventive oral care in China. However, such a conclusion would overlook the fact that low dental attendance rates have negative effects on any oral health care system, be it preventive or symptomatic-oriented. Furthermore, given the right incentives, dental visiting habits can be changed. In this context, the German example is helpful. By introducing a bonus scheme in the statutory health insurance system for regular dental checkups (once a year), the dental visiting rate rose, within 8 years, from under 30% (1989) to almost two thirds (1997)<sup>7</sup>.

Most people are uninsured against dental disease. Over 85% of total dental costs are paid out of pocket<sup>47</sup>. Human dental resources and education about preventive measures in Chinese dental schools are in short supply, and this is almost everywhere.

Owing to these shortcomings, a CMS model cannot be introduced with a single push, but must be done step by step and possibly by encouraging pilot projects at selected sites on a local level, from where they can spread further afield. This course of action has proved successful in the area of economic policy and should be emulated as well in health policy. However, when pursuing an incremental policy, it is fundamental that the gradual implementation of a preventive system follows a consistent red line of development and strategic operational planning at national, provincial and county levels. An essential requirement of all proposed preventive strategies is cost-effectiveness.

Adjustment of the CMS model to Chinese conditions will be needed in the following four fields in particular:

- Population or group-centred activities.
- Preventive education and training of the dental workforce.

- Consideration of China's particular fluoride situation.
- Legal regulations including remuneration.

#### *Giving priority to population or group-centred CMS activities*

In a country as vast as China, where the rural population (about 70%) is underserved and neglected<sup>74</sup> only population and group-centred strategies are promising and cost-effective. It has been proven that relatively-simple structured, population-based programmes can serve to control dental caries and most periodontal diseases if proper oral hygiene habits, involving daily toothbrushing with fluoride toothpaste, are practised<sup>5</sup>. Chinese studies, also from remote and underdeveloped counties, further document this outcome<sup>82-86</sup>. In a modified population-centred CMS model, the risk-oriented component is implemented, in the first instance, by directing preventive strategies to known high-risk subpopulations or groups (e.g. kindergartens, schools, factories in remote areas, poverty stricken regions and communities with unfavourable living conditions). However, the risk of caries development also varies according to the age group, teeth and surfaces involved. Therefore, as a next step, activities must be directed towards risk from age group down to individual key risk tooth surfaces. Key risk groups are the ages of 5 to 7 years old (eruption of first molars) and the 11 to 14 years old (eruption of second molars). Key risk teeth are the molars and key risk surfaces are the fissures of the molars 'and the approximal surfaces from the mesial aspect of the second molars to the distal aspect of the first premolars'. If the preventive programme is focused on these general risk groups and risk teeth, the probability is high enough that the 'intact teeth surfaces will remain intact for the individual's entire life'<sup>87</sup>.

The selective group-oriented approach, especially among children and adolescents, which is carried out in school dental clinics or by public health dentists in cooperation with private practitioners who regularly visit kindergartens and schools, and which is financed by statutory health insurance funds (as is the case in Germany, for example) is successfully operated in many European countries<sup>88,89</sup>. This approach, which is also recommended by Chinese researchers, is effective in terms of time, costs and the large-scale involvement of patients. Although the age group between 15- and 19-year-olds is considered a low-risk group, special attention has to be paid to the eruption of third molars as they may cause the same problems as erupting first and second molars<sup>87</sup>.

The population-centred CMS, which is directed at children and adolescents, can be extended to groups of adults working in factories. For factories without a fac-

tory clinic, Westermann<sup>90</sup> has described a concrete and successful preventive programme for the workplace.

### *Reinforced preventive education and training of dental workforce*

Although, over the last decade, the number of dental schools and the rate of undergraduate enrolment increased significantly, mainland China actually has only just over 60,000 dentists, 17,000 to 25,000 dental therapists including dental hygienists and 21,000 dental laboratory technicians<sup>47,91,92</sup>. From a dental workforce of just over 100,000 professionals, only a few at best are preventive and tooth preservation-oriented. One report, based on the traditional surgical approach, estimated that by 2030, China will need 136,000 to 400,000 dentists<sup>93</sup>. In light of the fact that currently 2,500 students enrol annually<sup>76</sup>, it is hard to imagine that so many new dentists can be trained by 2030. Even more important is the fact that, as several examples (e.g. Syria, Philippines) show, an increase in trained dentists scarcely raises the Care Index (F/DMFT x 100) in low- and middle-income countries. Without improving public financing for dental treatment, educating more dentists results, at best, in better access to services for more affluent people in urban areas, while the scarcity of care for the majority of the poor persists. In the worst cases, many of the newly trained dentists might even leave the country for better paid jobs abroad, and China would hardly benefit from this strategy<sup>5</sup>.

Therefore, it is imperative that China finds another way to tackle the shortage of human resources, while taking advantage of international experience and recommendations. Proper legislation should make it possible to overcome the shortfall of dentists by strengthening mid-level training of 'dental therapists'. This generic term comprises dental assistants, dental hygienists and preventive oral health care workers<sup>92,94</sup>. This differentiation of oral health personnel is in line with the philosophy of the Fédération Dentaire Internationale<sup>95</sup> and with international experience shared by more developed countries (e.g. Sweden, New Zealand, Australia, The Netherlands and Great Britain). Multiple studies have documented that appropriately trained dental therapists provide quality dental care comparable to that of a dentist, thereby reinforcing prevention<sup>29,30,94,96,97</sup>.

Following a standard 2-year training program and a supplementary 1-month intensive preventive dentistry course, dental assistants in Sweden provide professional mouth cleaning, topical application of fluoride varnish, application of fissure sealants; and salivary and microbiology testing. Dental hygienists perform tasks such as scaling and root planing, finishing fillings, removing

overhangs, recontouring in cases of furcation involvement, diagnosis and epidemiology<sup>30</sup>. In addition to these services, trained dental therapists in Great Britain may, if a dentist has examined the patient and drawn up a concrete treatment plan; take dental radiographs, perform routine restorations in deciduous and permanent teeth and extract deciduous teeth under local infiltration analgesia<sup>98</sup>.

The advantages of dental therapists over dentists are: much shorter training times, a special focus on preventive dentistry often on a group basis, and a significantly lower cost to society.

Long-term preventive programmes for children and adults in Sweden, mainly conducted by preventive-trained dental assistants, resulted in low caries incidence and almost no periodontal disease<sup>29,30,87</sup>. 65% of adult patients visited the dental assistant/dental hygienist only once a year, 30% two times/year and for high-risk cases three to six times/year. Once every 3 to 4 years, the dentist checked the patient's oral health or had to take some preservation measures. 90% of the 20- to 35-year-old age group would have remained healthy without seeing a dentist<sup>29</sup>.

These preventive programmes in Sweden are very cost effective and their benefit/cost ratio is high. In 1999, the average treatment time by a dentist per child was 20 min per year. Most of the dentist's time was needed for examinations. Only minimal time had to be spent for restoring measures. Total yearly costs for preventive measures, treatment by dentists and orthodontic treatment by specialised orthodontists, which is free of charge under the national dental insurance scheme for children and young people up to the age of 20 years old, was about 120 USD per child (2001)<sup>87</sup>.

The dental manpower needed for these programmes was: 70% preventive dental assistants, 20% dental hygienists and 10% dentists. Table 10 describes in detail the type of professional required and the time invested by each.

More detailed and updated information about methods, preventive programmes which are related to specific patient needs and analytical epidemiology for quality control is offered by Axelsson<sup>100</sup>. The book is explicitly designed as a 'cookbook' for preventive dentistry.

Long-term study results from different countries prove that it is possible to largely maintain oral health in children and adults by stimulating self care and regular, appropriate professional support provided, in the main, by preventive personnel with mid-level training<sup>41,100-104</sup>. Consequently, priority should be given to the speedy prevention-oriented training of dental therapists who, generally, already exist in China. Dental therapists



**Table 10** Risk-oriented preventive programme for adults in Värmland, Sweden.

Risk group selection	Initial treatment			Secondary prevention <sup>1</sup>		Recall (diagnosis and monitoring)
Preliminary diagnosis	New patients (diagnosis and preventive treatment)					
Professional category	Dental therapist <sup>2</sup>		Dentist	Dental therapist		Dentist
Type of patient	Number of visits	Min/visit	Visit interval	Visits/year	Min/visit	Visit interval
Low- or medium-risk (80%)	1-3	30-60	1 year	1-2	30	1x every 2 to 4 years
High caries risk (10%)	4	30-60	2 months	3-4	30-45	1x yearly
High periodontal risk (5%)	4-5	30-60	3 months	3-4	30-45	1x every 1 to 2 years
High caries and periodontal risk (5%)	5-6	45-60	2 months	4	30-45	1x yearly

Prevent recurrence of caries, gingivitis and periodontitis.  
 Dental therapist = dental assistant, dental hygienist or preventive oral health care worker.  
 References: Modified after 99.

who lack sufficient preventive training, should receive a special, intensive 1-month training course. Thus, in a manageable period of time, the acute shortage of preventive personnel could be remedied in a cost-effective manner. Simultaneously, the curriculum of Chinese dental schools will need to be changed to give more time to the teaching of preventive dentistry<sup>76</sup>. In the meantime, it could be made mandatory for dentists who have been practising for over 10 years since receiving their licence, to undergo advanced training in preventive care.

The positive effects of this shift in teaching approach will be visible only in the long run. However, in light of the problems facing Chinese oral health care, it is important to start as early as possible and to set up beacon projects to inspire others. When planning, with a focus on preventive capacity, the majority of newly trained dental personnel should be dental therapists.

*China's special fluoride situation*

Fluorides are essential for preventing dental caries. However, China is in a unique position owing to the existence of endemic fluorosis caused by coal burning in 14 provinces. This has led to many people suffering from skeletal and dental fluorosis. Thus, it is crucial that fluoride exposure is properly regulated in order to obtain the benefits of fluorides while avoiding their side effects<sup>74</sup>. It would therefore be necessary to review the specific recommendations for fluoride use given above, based on conditions prevailing in Germany or in the developed

world (in the majority of which drinking water does not contain fluorides), whilst bearing in mind the conditions specific to China. In general, the most effective strategy for reducing oral health inequalities is adopting population-wide, automatic fluoridation (water, milk, salt) complemented by adequate use of fluoride-containing dentifrices. Detailed proposals for modelling adequate strategies for China are put forward by Petersen et al<sup>74</sup>.

*Necessary legal regulations*

If Chinese authorities wish to introduce a stepwise implementation of preventive oral health care for the entire population, it would be essential to formulate legal cornerstones at national level. Although Chinese provinces and communities are very diverse and are subject to different preconditions, these guiding rules are needed to avoid contradictory, uncoordinated initiatives. At the same time, however, these rules must leave space for finding best practice solutions within the given legal framework and should allow incentives to create many public and private initiatives adapted to the local environment. Regular evaluation should accompany these efforts in order to allow adjustment in the event of unforeseen outcomes.

In the light of the experience gained in Europe the following national regulations are considered essential:  
 1. Prevention and tooth preservation in oral health care should be given priority status by statute, as is the case in the German Social Code. All public health care providers should be obliged to follow this principle.

As private providers presumably cannot be obliged directly to follow this paradigm, national legislation should at least set incentives to encourage private practitioners to voluntarily adhere to this concept. This could take the form of public/private partnership, in cases where private providers that have contracts with public providers are allowed to provide the population with preventive services and receive the same remuneration as public providers. Partnerships of this type are widely practised in Sweden<sup>105</sup>. As the existing Chinese regulations do not allow for this method of financing by means of public/private partnerships, the relevant regulations would need to be altered. Such a move would only have positive effects because the proposed partnership could ease the fundamental lack of supply structures and could, at the same time, ensure the desired quality of care (contractually) without generating excessive costs.

2. Making prevention and tooth preservation a priority also implies reimbursement for these treatments under the public health insurance system, as is already called for by Chinese dental researchers<sup>38,47</sup>. If public resources are not sufficient for the entire population, it would be preferable to begin with the younger generation (0 to 17 as in Germany or 0 to 20 years of age as in Sweden) because they represent the country's future and the proper oral health habits they acquire will be maintained throughout their lifetime. To further strengthen oral prevention for children and adolescents, daily toothbrushing and annual serial dental examinations in schools should be made a mandatory component of school education. For adults without social insurance for dental health (45% and 79% of the urban and rural population, respectively)<sup>76</sup>, some form of copayment for these measures could be introduced, otherwise many of the uninsured would not be able to afford dental treatment. Crowns and, even more so, prosthetic and maximally invasive measures (implants), should not be reimbursed by the public health insurance so as to provide strong incentives for preventive demand and high individual motivation for oral self care. Furthermore, oral diseases that require these treatments are generally preventable. For extremely rare, catastrophic oral diseases (e.g. oral cancer) exceptions can be defined, which has been carried out in Switzerland<sup>106</sup>. Patients who want to have coverage for normal prosthetic treatments should obtain private insurance or pay out of their own pockets.
3. Prevention, minimally invasive dentistry and dental preservation should also be the priority and the focus for training in dental school curricula. Only if this is

achieved (in combination with remunerating preventive treatments) will the professional focus switch to prevention. As the international scientific community agrees that preventive and minimally invasive dentistry is state-of-the-art dentistry, there are strong arguments for health policy-makers in China to take action in this direction.

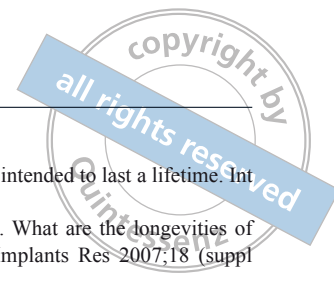
By introducing a preventive CMS model in oral health care, caries incidence decreases and, as a consequence, so does the need for restorative work. Overall, oral health status will improve. Patients at high risk benefit most from this approach<sup>107</sup>. Researchers estimate that, in such a system, 50% of restorations can be prevented<sup>108</sup>.

The exact legislative steps Germany has taken to promote preventive oral care, and their consequences, are described in detail by Saekel<sup>1</sup> and Bauer et al<sup>7</sup>. Although this process lasted for two decades, the first positive effects of this paradigm shift on the oral health of the younger generation, along with significant reductions in total expenditure on dental care, were already visible in the medium term<sup>7</sup>. China should be able to implement the necessary legislative reforms much faster.

As dentists have an exemplary function in maintaining the oral health of patients and in treating them in an evidence-based, up-to-date manner, the Chinese Stomatological Association should take a leading role in the reform discussion on oral health care. In the 1960s the Swiss Dental Association, for instance, was at the forefront of the drive advocating preventive dental care for children, adolescents and adults. By acting in this way, they won the confidence of the public and of health policy-makers, and had a decisive influence on Switzerland's oral health care system. The same is true for the Swedish Dental Association. Such outcomes should also be possible in China.

## Conclusion

Summarising the previous reports, scientific knowledge and empirical experience, the following conclusions would appear to be justified. If Chinese health policy-makers decided to emphasise changing people's oral health attitudes by large-scale oral health promotion; through the strengthening of primary care by introducing the BPOC approach to improve the dental service in deprived rural regions; and by implementing a Chinese adapted CMS model into public provision of oral care, which is targeted to urban and high-income regions; the country could gradually solve the critical shortage of dental services and the lack of adequate treatment for



many of China's citizens. This could be put into practice at a financial cost that would be affordable, both to the public health care system and to patients, and in a manner which meets current tooth-preservation needs while simultaneously minimising the danger of starting the cycle of re-restorations due to outdated treatment methods. These proposals would fit in well with and, further, add to China's overall Health Care Reform scheduled for completion in 2020.

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## Comments on “Outlining a preventive oral health care system for China” by Saekel

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In order to promote oral health, researchers, clinicians and policy makers in China need to establish an evidence-based and affordable oral health system that could be suitable to China’s current situation. A German author proposed some suggestions for the Chinese oral health care system using data from the dental care systems of some Western developed countries, such as Germany, Switzerland and countries in the North of Europe.

Firstly, the author introduced the dental health care systems in these developed countries, emphasising an aetiology-based system – Caries Management System (CMS). The core philosophy of this system is to prevent caries through a caries-risk assessment approach. Through the application of fluoride, caries can be eliminated by remineralisation and the minimal invasive treatment of cavitated lesions. The CMS has seven steps, which include assessment, diagnosis, treatment, prevention and monitoring.

As there are significant differences between China’s current situation and Western developed countries, the author suggested that China should establish an oral health care system relevant to its current position. This system should have the following functions: using the high caries risk population priority principle; emphasising the training and education of dentists in the oral health care field; applying the appropriate fluoride

based on the fluoride distribution in different regions of China; and formulating new rules to increase the effectiveness of oral health care and decrease overall costs. Therefore the author proposed some ideas and suggestions in this article.

These suggestions are valuable to help establish and improve the Chinese oral health care system. For example, the author emphasised that this system could focus much more on the oral health care of children and adolescents, the appropriate application of fluoride, the education of preventive dentistry and minimal invasive dentistry in dental schools in order to sharpen the skill and understanding of clinicians in oral health care.

The author also offered other suggestions, such as amending public medical insurance to cover oral health care items and making laws and regulations to encourage private clinics to take part in oral health care, in order to improve the current insufficiency of the oral health care service. These suggestions are reasonable and can offer great insight. However, it is not easy for all of these suggestions to be accepted immediately in China. It requires a series of policies being made by the National Health Administration and related ministries. We believe that some of these suggestions should be incorporated into the Chinese oral health care system while the medical reform is going on.

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