

China's Oral Care System in Transition: Lessons to be Learned from Germany

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Abstract

Aim The objective of this discussion paper is to investigate whether the experience gained through the German paradigm shift in dental care can be of benefit in China's deliberations on the introduction of universal dental care for its people.

Methodology A comparison of representative oral health outcome data from China and Germany, two countries at different stages in their development, is presented here in order to analyse whether the findings meet expected outcome and confirm the presumption that more developed countries perform better.

Results The epidemiological comparison reveals surprising findings concerning the severity of dental diseases and, in particular, missing teeth per person in adults and rates of total edentulousness in seniors. In all of these areas German adults and seniors show significantly inferior outcomes compared with the Chinese population. The main

reason for these striking discrepancies, as it turned out, is the decisive role played by the treatment philosophies and strategies of German dentists.

Conclusion and recommendations If dentists take a less interventionist approach, checking as well as treating dental diseases with preventive and strictly tooth-preserving methods, dental treatment results in oral health. Under these conditions it can be assumed that modern dentistry is generally good for the teeth. These findings are important for developing countries that are seeking to integrate dental care into their health care system. On the basis of long-term experience from highly industrialized Western countries and especially from Germany we will attempt to put forward proposals for creating an effective and efficient dental care system in China.

Keywords dental care systems, preventive oral care approach, minimal-invasive dentistry, oral health outcomes, restorative treatment in high-income countries

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Introduction

While China's economic development and its market-oriented reform policies performed extremely well in the last thirty years following the "opening-up" process (1978), social security and health care coverage, in particular, were unable to keep pace. During the planning period (1949–1978) governments devoted more than 90% of medical expenditure to urban residents and 90% of rural residents enjoyed simple but almost free primary health care (International Social Security Association – ISSA, 2009). During this period China accomplished dramatic achievements in reducing

mortality, increasing life expectancy and providing primary health care (Blumenthal and Hsiao, 2005). Beginning in the early 1980's and up until 2003 China changed its health system by extending market-oriented reforms to the health care sector as well and by shifting the entire system towards individual responsibility. Between 1978 and 1999 the central government's share of national health care spending halved (Blumenthal and Hsiao, 2005). This led to a drop in the coverage ratio to less than 10% of the rural population and to a complete failure of the market-oriented health care approach (ISSA, 2009; Blumenthal and Hsiao, 2005). From this failure, the Chinese government

concluded that the marketization of social health care insurance has its own narrow limits and that it is essential for the State, to maintain an adequate budgetary input. The State also has to enforce appropriate regulations in order to avoid social division and system fragmentation, to improve the coordination and integration of different schemes as well as to supervise the quality of care (ISSA, 2009).

Chinese pragmatic policy-makers analysed the mistakes from this period (1980–2003) and corrected this undesirable development step by step. They introduced mandatory employer insurance in 1998 for all private and state-owned enterprises which had to offer their workers medical savings accounts combined with catastrophic insurance (Blumenthal and Hsiao, 2005). Nowadays China operates four different medical care schemes: The Urban Employees' Medical Insurance (UEMI), the Urban Residents Basic Medical Insurance Scheme (URBMI), the New Rural Cooperative Medical Scheme (NRCMS) and a tax-financed medical assistance programme for the needy in urban and rural areas. With these programmes China increased the medical insurance coverage from 15% of the population in 2003 to 85% in 2008 (ISSA, 2009), thereby approaching universal coverage. Of course, a multitude of problems remain: for example, low levels of pooling, low compensation rates, a lack of reimbursement for outpatient care and the absence of prevention measures for most of the people insured under URBMI and NRCMS programmes (ISSA, 2009). Furthermore, among health care professionals, particularly among physicians and dentists, an ethic of professionalism has to be instilled so as to ensure that the treatment dispensed is in the interest of the patient and the care provided is in accordance with reasonable quality standards (Blumenthal and Hsiao, 2005).

In 2009, the Government announced "Guidelines on Deepening the Reform of the Health Care System", a blueprint for health care over the next decade as well as a three year action plan for 2009 to 2011, slated to cost 124 billion USD. The blueprint aims to implement a basic health care system that provides "safe, effective, convenient and affordable" health services for all citizens by 2020. The core objective of the blueprint is the provision of primary health care as a public ser-

vice (ISSA, 2009).

After this short excursion into general health insurance and general medicine let us now concentrate on dental care. There is not much information on dental insurance and dental care in China. In a country where the basic health care needs are yet to be met sufficiently for the average Chinese person and as dental problems are for the most part not life-threatening, this comes as no surprise. On the other hand, caries prevalence is widespread in the Chinese population and as oral health is an integral part of a person's general health, it therefore deserves its own focus. Oral health and general health are particularly interrelated among the older population. Poor oral health may increase risks to general health and vice versa, may affect eating abilities and nutritional intake (Petersen, 2003) and can have a considerable impact on self-esteem.

In discussing the creation of a dental care system in a developing or fast developing country like China, one always has to keep in mind that oral diseases are the fourth most expensive diseases to treat in industrialized countries. In high-income countries on average 5%–10% of total health spending is needed for oral health care (Petersen *et al.*, 2005). On a population basis, teeth are even the most expensive part of the human body to treat (Sheiham, 2001). Therefore, questions of effectiveness and efficiency must play a fundamental role in designing dental care systems for low and middle-income countries.

Until now, dental health care in China has predominantly been provided by the public health service that is usually hospital-based. Over 80% of all treatments are carried out there. These treatments are covered by medical insurance and are less expensive than in private dental clinics. However, as approximately 45% of urban and 79% of rural inhabitants do not have medical insurance, many people cannot afford dental treatment (Ling and Fu, 2007). Some adults obtain dental care through factory health services. In recent years, as well, an increasing number of private dental clinics have been established. They also serve the public but their prices are on average two times higher than in public hospitals. Chinese insurance does not reimburse treatment provided by private clinics (de Beer, 2009). About 1% of private dental

clinics have specialised on the high-end demand. They are mainly concentrated in well-off areas like Beijing, Shanghai and Guandong (Tse, 2005). Normally people have to pay on a fee-for-service basis. Only some industrial employees benefit from reimbursement systems. Prosthetic services always have to be paid for by the patients themselves (Zhu *et al.*, 2005).

A country that is designing its own dental care system has to fulfil two main tasks. Firstly, a decision has to be taken as to which therapeutical approach should be chosen: the conventional symptomatic and restorative approach, that will lead to lifelong re-dentistry and which will be extremely costly for the individuals and/or for society as a whole, or a causal and preventive approach, aimed at avoiding dental diseases from the very beginning of life. Where they exist, initial lesions would be remineralized and active lesions would be treated in a minimally invasive way so that the patients can maintain their own teeth throughout lifetime.

The second decision is whether the country should adopt a community-based approach or an individualized one as is mainly found in the sophisticated dental care systems of high-income countries. Once these overarching decisions have been made, Government has to decide which organizational and financial system is to be chosen. The spectrum of possibilities is rather broad. It ranges from a tax-financed dental care system (Sweden, Denmark, Great Britain) through a system financed by employer and employee contributions (Germany, Netherlands) to a more or less privately financed dental care system (USA, Australia, Switzerland, Norway). Good oral health outcomes may be achieved by any of these systems if the overarching decisions have been properly made and the dental supply structures are appropriate. However, which of these systems is the most efficient one, is another question.

In this article the focus is on the two priority decisions: which therapeutic approach – the restorative or the preventive approach – and in which form – community-based or individualized. Particularly in the case of China, this question is essential because – compared with industrialized countries – the caries and periodontal disease levels are relatively low. However, there are fears

that with continuing economic progress and improving standards of living, changes in diet will occur which will probably lead to a deterioration in oral health as was the case in some developing countries and in many Western countries from the 1950's to the 1980's (Davies, 2001).

This article investigates, whether this result is inevitable for China. The paper concentrates, in particular, on the German experience in the context of the findings of research conducted in industrialized countries over the last 50 years. During the period 1978 to 2008, in Germany, there was a paradigm shift not only in dentistry but also in the social dental care system. As a result, the starting point of our analysis in today's China (with only very rudimentary dental care structures) is similar to that of Germany at the end of the 1970's when the design of dental care structures was fundamentally flawed. We will leave aside the fact that it is generally much easier to create new structures from scratch (China's situation) than to repair already functioning (but flawed) structures (Germany's situation in the 1970's).

In the following chapters we will begin by describing the shift in dental care. We will then proceed to compare German oral health outcome data with corresponding Chinese data. This will be followed by a discussion of explanations for the surprising discrepancies between the two countries. The next chapter describes the choices China has at its disposal in its quest to create a well-functioning dental care system. Finally, conclusions are drawn and recommendations for China are derived.

Germany's paradigm shift in dental care

At the end of the 1970's the treatment catalogue of Germany's statutory health insurance, by which 90% of the population were insured, was extensive and also included nearly all forms of prosthetic care. The health insurance funds paid for every treatment. There was no co-payment for the patients. Under these conditions dentists and patients always chose the most expensive treatment possible, when there was a choice (mostly in prosthetic dentistry). This "perfect system" for both the provider and the patient led to an absurd domination of prosthetic

treatments over conservative treatments. In 1970, the ratio of conservative dental procedures to prosthetic dentistry was 65 : 35. By 1982, the ratio had changed completely to 46 : 54. In those days German dentists accounted for one-third of the world's consumption of dental gold. The outlay for dental care amounted to half the amount spent on hospital care and was almost as high as the expenditure on all ambulatory medical care services. Thirty-thousand German dentists and dental technicians consumed almost as much in terms of resources as 63 000 medical doctors in private practice.

In 1980, spending on dental care accounted for 14.7% of total health expenditure or 1.15% of gross domestic product (GDP). This was two to three times more than in other Western countries. At that time, Germany had the most expensive dental care system in the world but the oral health of the German population was "catastrophic" and the country was "world champion in caries prevalence" (Naujocks and Hüllebrand, 1985; Naujocks, 1986). Less than 4% of 6-year-olds were caries-free and their mean dmft was 7.5. DMFT scores for 12, 35 to 44 and 65 to 74-year-olds were 6.8, 17.1 and 23.0, respectively. At the age of 20 and in the 35-44 and 65-74 age groups, persons were missing 1.6, 4.8 and 17.8 teeth on average.

This situation was completely unsatisfactory and could not be allowed to continue. As dental caries and periodontal diseases are largely preventable diseases, dental scientists and health economists pointed out that the restorative therapeutic approach fails to address the fundamental bacterial nature of dental diseases and only leads to a repeat restorative cycle (Elderton, 1985; Elderton and Osman, 1991; Axelsson *et al.*, 1991; Dawson and Makinson, 1992a; Dawson and Makinson, 1992b; Axelsson *et al.*, 1993; Elderton, 1993; Saekel, 1981; Expert Advisory Council for the Concerted Action in Health Care, 1987). The predominantly invasive and prosthetic treatments in Germany and other industrialized countries generated and perpetuated an unacceptable lifelong chain of events (Elderton, 2003). The majority of dentists presumed that dental caries and periodontal diseases could be "treated away" and that mechanistic dental treatment automatically resulted in oral health (Elderton and Mjör, 1992). The consequence of

such thinking and acting was an ever-increasing demand for invasive dentistry and a dental care system that was no longer affordable.

Only a paradigm shift in dentistry and dental provision could alter this undesirable development. Priority had to be given to preventive care and to conservative instead of prosthetic treatment. Health policy implemented this paradigm shift in the dental care system by switching to a causal and preventive approach. Step by step Government initiated the necessary legislative reforms to usher in that process. The most important changes were:

1978: Introduction of a 20% co-payment for prosthetic treatments.

1982: Financial incentives for tooth preserving measures and reduced fees for prosthetic and orthodontic treatments.

1989: Introduction of group prophylaxis in nursery schools and schools and individual prophylaxis (fissure sealants) in dental practices.

Introduction of a bonus scheme for regular dental check-ups (once a year).

Doubling of the co-payment for prosthetic treatments to 40%.

1993: Introduction of preventive and paediatric dentistry in the dental curriculum.

Exclusion of large bridges with more than two telescopic crowns.

1998: Introduction of early detection examinations for infants (0–3).

2000: Legislative anchoring of the new preventive approach in dental care.

These new regulations proved extremely successful as far as oral health outcomes and necessary resources for dental care were concerned. Today over 50% of 6-year-olds are caries-free with a mean dmft of 2.2. Twelve-year-olds have the best oral health worldwide (DMFT: 0.7). Caries decline is to be observed in all social groups. DMFT values for 20-year-olds have halved since 1978. Missing teeth in 35 to 44-year-olds decreased from 4.8 to 2.4 and in the age group 65-74 from 17.8 to 14.1. In summary, oral health in all age groups improved dramatically. Depending on the age group, treatment needs diminished by between 50% and 75%. The effects on the financial resources needed for dental care were also significant. Nowadays, expenditure for dental care as a share of total healthcare costs, is almost half (7.8%) the amount

expended in 1980 (14.7%). The share of GDP spent on dental care dropped to 0.83% (1980: 1.15%).

Germany, nevertheless, still faces deficits in certain fields: the prevalence of periodontitis is extremely high (Holtfreter *et al.*, 2010). Total edentulousness among seniors is relatively high, the process and outcome quality of treatments is suboptimal, the Regulation on the Licensing of Dentists is outdated and in urgent need of modernisation, many universities are devoid of their own preventive and paediatric dentistry departments and prophylaxis personal is scarce – all of this despite the fact that Germany has one of the highest dentist to population ratios in the world (2008: 1 : 1 247). These deficits aside, the change in the therapeutic approach is mainly responsible for the dramatic improvement in the oral health of the population and the reduction in treatment needs, as well as the remarkable decrease in relative expenditure on dental care in Germany. Furthermore, to a certain extent, the introduction of co-payments for prosthetic care positively influenced the efficiency of the dental care system. However, in spite of significant reductions in the sums expended on dental care, Germany still has the most expensive dental care system in the world (Bauer *et al.*, 2009).

Following this description of Germany's paradigm shift in dentistry and dental care, let us now take a look at a contemporary comparison of oral health outcome data from China and Germany. Per-

haps this will offer further insights into the topic.

Oral health comparison China - Germany

In Germany, over 50% of the 5 to 6-year-olds have caries-free deciduous teeth. The mean dmft of 6 to 7-year-olds is 2.2 (Pieper 2005). Corresponding data for caries-free Chinese 5 to 6-year-olds are 23.4% and a mean dmft of 3.5 (Shang *et al.*, 2008). On average, the oral health of deciduous teeth (5 to 6-year-olds) in Germany is twice as good as in China. Considering living conditions, oral hygiene practices and prophylactic dental structures in Germany, this outcome is not surprising. However, the results for caries and periodontal diseases in the permanent teeth of adults present a completely different picture. Table 1 gives an overview of caries data in different age groups. Unfortunately, most of the Chinese data from the 3rd national survey (2005) have not yet been published. We must therefore rely on Chinese data from the 2nd survey done in 1995–1996. As the findings for the 3rd survey are likely to be rather similar to those of the 2nd survey (China Daily, 2007) – as confirmed by new representative Chinese provincial and regional studies (Tai, 2009; Lo and Xiao, 2009; Li *et al.* 2004; Hu *et al.* 2008; Lu *et al.*, 2007) – it is justifiable to compare Chinese data from 1995/96 with the newest representative German data from 2005.

Table 1 Development of DMFT and its components, and number of functioning natural teeth (FST)¹ throughout the lifetime in China (1995/1996) and Germany (2005)

Age	China					Germany				
	DT	MT	FT	DMFT	FST	DT	MT	FT	DMFT	FST
12	0.9	0.01	0.1	1.0	–	0.2	0.0	0.5	0.7	–
15	1.2	0.02	0.2	1.4	–	0.4	0.1	1.4	1.8	–
18	1.2	0.04	0.4	1.6	26.8	–	0.6	–	5.7–7.5	–
35–44	1.1	0.6	0.4	2.1	26.3	0.5	2.4	11.7	14.5	25.2
65–74	2.2	9.9	0.3	12.4	15.9	0.3	14.1	7.7	22.1	13.6

FST = Filled and Sound Teeth.

Source: Wang *et al.*, 2002; Micheelis and Schiffner, 2006; Bauer *et al.*, 2009; own calculations.

Only minor differences in DMFT could be observed between Chinese and German adolescents. However, individual values on the DMFT index show that, in Germany, cavities are being

filled whereas this is not the case in China. This explains why D-values in Germany are three to four times lower than in China, where almost no treatment is administered.

Although caries is also not treated in Chinese 18-year-olds, no missing teeth per person were found in this age group among the Chinese, whereas Germans of this age already had 0.6 caries-related missing teeth. The far higher DMFT value in Germany reflects the high Care Index ($\frac{F}{D+F} \times 100$) of around 80% for this age group (Micheelis and Schiffner, 2006).

In middle-aged (35–44) adults and seniors (65–74) the D-values in China are more than two times and seven times higher, respectively, than in Germany and caries cavities remain largely untreated. However, the level of caries experience (DMFT) in China is much lower than in Germany. Owing to the fact that the DMFT index, as an indicator of oral health, only expresses treatment experience without giving information on the function and status of the subject's natural dentition, the index of Filled and Sound teeth (FST) should also be collected if countries with different development stages are to be compared (Baelum *et al.*, 2007). In addition, this index reveals that Chinese adults have, on average, more functional natural teeth in middle and older age groups than German adults (see Table 1).

Even more surprising, and highly implausible, is the fact that the number of missing teeth per person – as the most important indicator of oral health – is significantly lower in China than in Germany (see Figure 1), although German figures already improved against 1997.

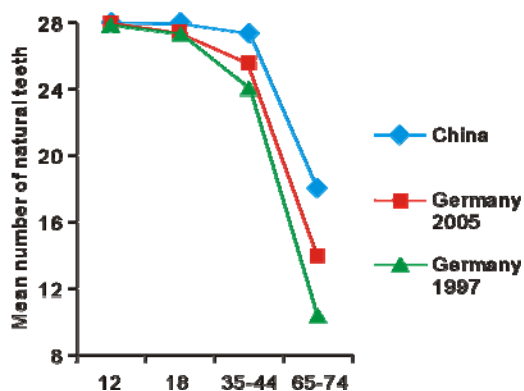


Figure 1 Number of natural teeth in different age groups in China (1995/1996) and Germany (2005 and 1997)

Source : Own calculation based on data from Table 1.

The rates of total edentulousness in the Chinese adult population are also lower than in Germany. Only 0.2% of the middle-aged adults (35–44) and 10.5% of seniors (65–74) in China are totally edentulous (Wang *et al.*, 2002), whereas the corresponding figures for Germany are 1% and 22.6%, respectively (Micheelis and Schiffner, 2006).

Moderate and severe periodontal diseases are also surprisingly low in China, while both gingival bleeding and calculus in adults are more frequent than in Germany (see Table 2). As the oral hygiene of the Chinese population is particularly poor and professional cleaning procedures are hardly offered or demanded, the high prevalence of gingival bleeding and calculus in Chinese adults is coherent. What is unexpected is the small proportion of the population presenting with periodontal destruction (CPI-grades 3 and 4), whereas, in Germany, greater proportions of the population are exhibiting periodontal destruction in spite of generally good oral hygiene habits and professional support in the form of regular check-ups and cleaning measures.

These extremely unfavourable results for Germany: more missing teeth per person, higher rates of total edentulousness in seniors and a much higher level of periodontal destruction in adults, are difficult to understand, if one takes into account that in China:

- oral health awareness on the part of the population is almost non-existent, a huge deficit in terms of knowledge about dental diseases and how to avoid them exists,
- fluoride intake is vastly insufficient,
- community-based preventive programmes for children and adolescents are not very widespread,
- dental care services are very limited, particularly in rural areas,
- dental diseases are largely not treated and
- only a small minority has insurance against dental diseases.

Under these circumstances one would have expected Chinese adults to have many more missing teeth per person, higher rates of total edentulousness in seniors and significantly more pathological pockets than adults in Germany, an industrialized country, whose oral health standards rank – after Sweden and Australia – among the best in high-income countries (Bauer *et al.*, 2009).

Table 2 Maximal CPI-grades (in %) for different age groups in China (Cn) 1995/1996 and Germany (D) 2005

Years	CPI 1		CPI 2		CPI 3		CPI 4	
	(gingival bleeding)		(calculus)		(shallow pocketing of 4–5 mm)		(deep pockets of ≥ 6 mm)	
	Cn	D	Cn	D	Cn	D	Cn	D
12	38.0	70.0	14.0	29.2	–	–	–	–
15	34.9	51.7	33.0	33.4	0.2	12.6	–	0.8
18	31.0	–	47.6	–	0.7	–	0.1	–
35–44	23.3	11.8	70.9	14.4	12.8	52.7	2.1	20.5
65–74	13.9	4.0	63.6	6.8	18.4	48.0	3.8	39.8

Source: Wang *et al.*, 2002; Micheelis and Schiffner, 2006.

Explanations for surprising differences

What might be the reasons for these surprising findings? Owing to the fact that, broadly speaking, China possesses a very poor dental infrastructure, it is an extremely interesting country in which to observe in a “great field-experiment” how the most frequent dental diseases affect oral health over time if they are not influenced by dental treatment strategies. In this context, two questions arise. Firstly, why do the Chinese exhibit widespread caries and gingivitis prevalence but only in less severe forms until they reach an advanced age although for the most part these diseases are not treated? Secondly, how can it be explained that German adults, living in a high-income country with a sophisticated and well-functioning dental care system, whose oral health and efficiency results progressed considerably over the past 30 years, have significantly more tooth mortality per person than Chinese adults, living in a low to middle-income country?

A number of global investigations of oral health document epidemiological differences between developing and industrialized countries (Baelum *et al.*, 2007; Petersen, 2008) but on the whole no discussion is being conducted on the reasons for unexpected findings. The explanatory model developed by WHO within the framework of the International Collaborative Study of Oral Health Outcomes (ICS II), which is based on a system approach where external environmental conditions, the dental care system and the personal characteristics of the population influence oral health attitudes (Anderson and Davidson, 1997), cannot explain the specific discrepancies which exist

between China and Germany. Furthermore, the study conducted by Baelum *et al.* (2007) fails to provide reasonable clues for the surprising differences in the numbers of missing teeth per person and total edentulousness rates in Chinese and German adults and seniors.

To answer the first question, we must keep in mind the conventional wisdom of dentists in industrialized countries. They usually argue that untreated caries and periodontitis generally lead to irreparable tooth damage and, in the long run, to tooth loss. The findings from China seem to contradict this belief. In spite of caries progression in adulthood (Luan *et al.*, 2000), the Chinese example confirms that untreated caries and periodontitis often lead neither to tooth loss nor, necessarily, to total edentulousness in higher age groups. The underlying reasons for this fact continue to puzzle the experts.

The first consideration is that the theoretical background to this conviction might be wrong. Indeed, new research is questioning the chain of events – caries, more caries, gingivitis, periodontitis, tooth loss – and shows that caries and periodontal diseases are not one-way processes. Many carious lesions come to a natural arrest (Elderton, 2003) and gingivitis, which is more prevalent in developing countries (as is the case in China), often does not progress to severe forms of periodontitis and later to tooth loss (Baelum *et al.*, 2007). However, these new insights are only valid under the premise of good oral hygiene habits and/or preventive professional help. Precisely these premises, however, are definitely not fulfilled in China.

Another possible cause could be the link between diet and dental diseases. Current knowledge of this

relationship is shown in Table 3. Of particular relevance for China are sugar consumption per person, fluoride intake, quality of oral hygiene and intake of antioxidant nutrients (e.g. green tea). As undernutrition only affects 10% of the Chinese population (FAO, 2009) this possible causal factor can be neglected.

If yearly sugar consumption lies below 10 kg per person, the caries level is very low (Sheiham, 1991). As the Chinese consumed an average of 9 kg sugar/person/year in 2005 (WHO, 2009), the result is a low level of caries. This might partly explain the less severe forms of caries and periodontitis in China. On the other hand, fluoride intake per person is very low and oral hygiene extremely poor. These negative effects might be

compensated for or eclipsed by the high consumption of unsweetened green tea, containing antioxidant ingredients (catechins) (American Academy of Periodontology, 2009). In fact, China is the biggest producer and consumer of green tea. Studies point out that the frequent consumption of unsweetened green tea seems to support antibacterial activity against caries (Hamilton-Miller, 2001) and periodontitis (Kushiyama *et al.*, 2009). The degree to which these positive and negative factors influence the low levels of caries and periodontal disease and the low rates of missing teeth in adults is still unknown. In this context, research is needed to find convincing answers, all the more because this question also concerns many other developing countries.

Table 3 Summary of strength of evidence linking diet to dental diseases

Linking diet	Evidence	Decreased risk	No relationship	Increased risk
... to dental caries	Convincing	Fluoride exposure (local and systematic)	Starch intake (rice, potatoes, bread; excluding cakes, biscuits snacks with added sugar)	Amount of free sugars
	Probable	Hard cheese, sugar-free chewing gum	Whole fresh fruit	–
	Possible	Xylitol, milk, dietary fibre	–	Undernutrition
	Insufficient	Whole fresh fruit	–	Dried fruits
... to dental erosion	Probable	–	–	Soft drinks and fruit juices
	Possible	Hard cheese, fluoride	–	–
... to enamel defects	Insufficient	–	–	Whole fresh fruit
	Convincing	Vitamin D	–	Excess fluoride
... to periodontal disease	Probable	–	–	Hypocalcaemia
	Convincing	Good oral hygiene	–	Vitamin C deficit
	Possible	–	–	Undernutrition
	Insufficient	Antioxidant nutrients	Vitamin E supplementation	Sucrose

Source: WHO/FAO, 2003.

A further possible reason for low caries and periodontitis levels, and the very few missing teeth per person in the Chinese adult population, could be that the Chinese possess a certain genetic disposition that is responsible for their relative resistance to dental diseases and the latter's most serious expression – “tooth loss”. However, as wealthier populations in Chinese regions such as Hong Kong and Chinese-dominated countries (Singapore) have remarkably more missing teeth per person and higher tooth loss rates, the proba-

bility of existing genetic factors seems to be low. Were these factors to exist, oral health in Hong Kong and Singapore would not be significantly worse than in Mainland China (Saekel, 2010).

Having initially investigated the questions arising from the Chinese perspective, let us now take a look at the discrepancies from the German perspective. What reasonable causes can be found for the much higher numbers of missing teeth per person in German adults and a rate of total edentulousness in German seniors that is twice as

high as that found in China? In the first instance, there is, once again, the connection between nutrition and oral health. On average, Germans have a much higher yearly sugar consumption in 2005 than the Chinese: 38 kg per person (WHO, 2009a) compared with 9 kg in China. If the yearly sugar consumption lies over 15 kg per person, caries activity increases with rising sugar intake (WHO/FAO, 2003).

In high-income countries, however, the relationship between sugar intake and the level of caries is only a tenuous one (Woodward and Walker, 1994; Walker, 2000) or sugar consumption is widely neutralized by sufficient fluoride intake (Burt and Pai, 2001). As the fluoride intake of German adults is sufficiently high – the used toothpaste is to well over 90% fluoridated (Staehle, 2004) and the market share of fluoridated table salt amounted to 70% in 2007 (IfK, 2008) – it is likely to neutralize the high German sugar intake to a great extent.

Additionally, the German diet, which is relatively fat and rich in calories, interspersed with frequent sweet and/or salty snacks between meals, fails to explain the discrepancies because some ingredients of the diet have protecting effects (*e.g.* fat) and for others the cariogenic or anticariogenic effect is unclear (Staehle and Strippel, 2004). In addition, the great majority of the German population regularly practice good oral hygiene so that possible negative overall effects on oral health should be small. Around 75% of children, adolescents, adults and 61% of senior citizens clean their teeth twice a day. Some also use sugar-free chewing gums and a small minority (particularly adults) use dental floss. In addition, 76% of children, 66% of adolescents, 76% of adults and 72% of seniors visit the dentist regularly for check-ups at least once a year (Micheelis and Schiffner, 2006). Consequently, the higher sugar intake and less healthy dietary habits in Germany are likely to be almost completely neutralized by sufficient fluoride intake, good oral hygiene practices and the regular dental visits for check-ups undertaken by the majority of the population.

Another reason for differences in periodontal status and tooth mortality could be diverging smoking habits. However, as the number of cigarettes smoked in 2007 per person, per annum, is much higher in China (1 648) than in Germany

(1 125) (Wikipedia, 2010) this consideration also fails as a possible explanation.

Having examined possible influencing factors such as genetic causes, dietary habits, oral hygiene practices, fluoride intake and smoking habits, the dentists' treatment philosophies remain as the only explanatory factor. Is Elderton's conclusion, based on considerable research over decades, that "it cannot be assumed that dentistry, as widely practised, is necessarily good for the teeth" (Elderton, 2003), confirmed by the present state of German dentistry? Many signs point in this direction. Although oral health and dental care in Germany have made the progress described above, the predominant dental treatment strategies are by no means sufficiently preventive, nor are they sufficiently oriented towards tooth preservation. What is more, the quality of care in the case of restorations is not as good as it should be (Bauer *et al.*, 2009). As the comparison of oral health of the Chinese and German population clearly indicates, the preventive approach is still in its infancy. In a recent scientific debate in Germany over the correct dental treatment strategy in certain defined cases, the periodontologist, Kocher, and the prosthodontist, Biffar, jointly came to the conclusion, that the less restorations that are performed, the more likely patients are to retain more natural teeth throughout their lifetime (Anonymous, 2009). This result is in line with findings from studies in German dental practices, where many periodontally damaged teeth were extracted at a rather early stage (Splieth *et al.*, 2002), and only one-third of teeth needing endodontic treatment were actually treated. This leads to the conclusion that many teeth, which could be preserved from an endodontic perspective, are being extracted, without any attempt at treatment (von Hammerstein-Loxten, 2001). The German findings are also in line with international findings from other high-income countries (Shapiro, 1994; Broadbent *et al.*, 2006; Mombelli, 2006; Baelum *et al.*, 2007).

This conclusion is indirectly substantiated by the results of a recent German study that investigated the influence of a preventive practice approach on the oral health of patients. The study revealed that oral health of adult patients is significantly better after long-term preventive care (>15 years) than the oral health of the average

adult population. The mean number of missing teeth in over 65-year-olds in these two German practices was 9.3 and 8.0 (Bastendorf and Laurisch, 2009). Compared with the current German average for 65 to 74-year-olds, of 14.1 (2005), this is an improvement, but it exceeds the Chinese results for seniors only slightly (9.9 MT). These findings from two renowned prevention-oriented German practices are disappointing and emphasize the necessity to examine the efficacy and efficiency of the predominant dental strategies in Germany, in general.

As the forming and remaining biofilm on tooth surfaces is the main etiological factor behind caries and periodontal disease, measures to counteract bacterial plaque are of primary importance (Axelsson *et al.*, 2004). Consequently, the generally prevailing standard invasive treatments, such as restorations and scaling, do not constitute effective ways of managing dental caries and periodontal disease (Elderton, 2003). An evidence-based preventive concept of quality dental care, which puts the interest of the patient first, has to emphasize the assessment of carious and periodontal lesions with the objective of allowing the natural arrest of the disease process. This concept must be supported, at the same time, by specific preventive measures.

These new insights require far-reaching changes of many of the predominant dental strategies deployed by the majority of German dentists. For example, if a patient asks his dentist whether he needs treatment, the dentist should not answer "Yes, two fillings" but should, instead, reply "As you have two carious lesions, we have to alter the nature of the chemical process going on in your mouth in order to bring the lesions to arrest" (Elderton, 2003). Within such a concept, existing restorations are not replaced just because of marginal breakdown for they often can be repaired and thus allowed to continue function satisfactorily (Elderton, 1993). Non-surgical management of caries in general practices is necessary and achievable and improves oral health; therefore, it should be the norm (Evans, 2009).

The avoidance of restorative treatment, when appropriate, should be considered as a prime preventive measure. The universal adoption of a preventive, evidence-based approach to treatment decisions is seen as the most important factor both

in reducing tooth mortality and in reducing the restorative burden for society (Elderton, 2003). A case study that follows such an approach to managing dental diseases is described by Staehle (2010), who has also elaborated the minimal-invasive tooth preserving treatment techniques for this approach (Staehle, 1999). The complete concept is practised at the University Clinic Heidelberg. However, until now, such approaches are not the norm in Germany. In this connection, it would be relevant to note that Germany has one of the highest dentist to population ratios in the world (2007: 1 : 1 247). The vast majority of interventions are carried out in highly equipped solo practices, with only a few salaried dentists (KZBV 2008) operating on a fee-for-service remuneration basis. As a result, overtreatment in terms of invasive and restorative measures is frequent, as is undertreatment in the area of preventive care. The extraordinarily high Care Index for adults (35–44: 96% and 65–74: 95%, Micheelis and Schiffner, 2006) illustrates this fact, indicating that almost every carious lesion is being treated, irrespective of whether the lesion is active or inactive. More than one-third of all fillings per person, insured with the statutory health insurance, are placed in the absence of caries-related indications (Bauer *et al.*, 2009).

A study on oral health of 50 to 60-year-old Germans confirms this finding, showing that regular dental attendance correlates strongly with DMFT scores that are 4.7 points higher, while there is no correlation with DT scores (Hahn *et al.*, 1999). The authors interpret this as a clear sign that DMFT scores are not a suitable indicator of caries prevalence, especially in care systems where restorative treatments are easily available. In high-income countries, the overall DMFT index is more an indication of the attitudes of dentists towards restorative care than of the existence and severity of caries prevalence (Hahn *et al.*, 1999).

Furthermore, dental education in many ways does not correspond to the priority to be granted, by law, to prevention and tooth preservation in the social dental care system. In addition, the dental fee schedule in the statutory health care system – since it is a fee-for-service scale – is not based on prevention and medical indication. The consequence is that many dentists perform more services than

are necessary and often give preference to restorative measures because they are more profitable.

Only if the majority of dentists were to follow a genuinely preventive approach,

- where dentists convince their patients that daily plaque control is the decisive factor in determining oral health (Axelsson *et al.*, 2004, Elderton, 2003) and

- where preventive and minimal-invasive measures for the preservation of permanent teeth are the focus as opposed to the complete replacement of missing teeth (Kern, 2003),

could the surprising discrepancies between China and Germany – in terms of tooth mortality – ultimately vanish.

In their large-scale test spanning several decades in which – according to the age cohort – only 0.4 to 1.8 teeth per person were lost over a 30-year period, Axelsson *et al.* (2004) were able to prove the tremendous success of a consistently preventive approach to oral health. As these advances in oral health were achieved in a private dental practice, their results cannot be readily transferred into social dental care structures such as those that exist in Germany. However, the Jönköping study, which is a representative study of a Swedish city of 130 000 inhabitants, reveals that similar effects on the oral health of populations are also achievable by means of enforced preventive care in social dental care structures. From the age of 40 and up to the age of 70 only 5.8 teeth per person were lost on average (0.2 MT per year) in Jönköping. Under the age of 60, no total edentulousness was observed (Hugoson *et al.*, 2005). The same study, done thirty years before (1973) showed that, between the ages of 40 and 70, an average of 9.9 teeth per person had been missing. With regard to lost teeth per person, the situation in Sweden in 1973 exactly mirrored the present day situation in China. These figures mean that over a period of 30 years of improved preventive social dental care in Jönköping, it was possible to nearly halve the mean number of missing teeth per person between the ages of 40 and 70 years (9.9 MT in 1973 versus 5.8 MT in 2003).

There is no obvious reason why Germany's social dental care providers, in adopting a stricter preventive and evidence-based approach that primarily counteracts bacterial plaque, should not be

able to reduce the incidence of new carious lesions and prolong the life of existing restorations while achieving equally low average numbers of missing teeth per person in adults and seniors as in Jönköping. In summary, it can be concluded that the predominantly restorative and invasive dental strategies applied in Germany are responsible for the surprisingly higher tooth mortality rates when compared with China.

Through the comparison between China and Germany, and the discussion on possible explanations for these astonishing differences, it was possible to determine necessary changes in German dental care strategies. It would not have been possible to arrive at these findings with such clarity if comparisons between Germany and other high-income countries had been used.

China's chances and choices

As a country with a caries and gingivitis prevalence that is widespread but not severe, China is in the comfortable position of being able to pick out the best therapeutic and system approaches from among those embraced by certain industrialized countries. By modifying these experiences, China can adopt proven caries management and treatment measures, and dental care structures, without accepting the negative aspects of their experiences. It would be very negligent for Chinese authorities not to carefully consider the international experience gleaned by countries that have sophisticated and functioning dental care systems but which do not always get the results society wants. On the other hand, the biggest mistake would be to ignore self-developing, unregulated dental structures because, once badly designed supply facilities exist, it is twice or three times as difficult to change such a structure. In this regard, Chinese newspapers are right in demanding that it is "time for dental care" (China Daily, 2007).

What are the choices at China's disposal? The first option would be for China to introduce a widely unregulated dental system that evolves in line with the interests of the professional dental providers. This would inevitably be a chair-side approach favouring restorative procedures and leading to supply structures that care only for

people who can afford to pay the requested fees-for-service. In such a system, large parts of the population would remain unserved and under-served and the bulk of treatment will focus on profitable invasive measures. These circumstances would be similar to the ones obtaining in general medicine in the period 1980–2003, with all their shortcomings.

The second option would be a government-induced preventive chair-side system. Certainly, this approach would serve better the interests of the population and – in the long run – would lead to improved oral health. The decisive disadvantage of such an approach, however, would be that, here too, only limited sectors of the population would benefit from the system because, again, many people will not be able to afford the requested fees or will lack the necessary oral health awareness – thus preventing them from seeking professional preventive help. If the Government were to decide to pay the fees for the needy, the system would produce enormous costs. Even affluent Western societies have difficulties financing such individualized preventive chair-side systems. For a country like China, whose population is not used

to regular dental attendance and where people still believe that “a tooth ache is not a disease” (Zhang and Ling, 2004), the benefit-cost analysis of such a system – from society's viewpoint – would yield a negative result.

A third option would be to create a state-of-the-art dental care system, which combines the latest knowledge of evidence-based preventive and tooth-preserving dentistry, with dental care structures that put the patient's interest in the forefront and is, to a large extent, community-based so that it reaches large sectors of the population. As daily plaque control is vital in determining oral health, the main objective of this system would be to enable individuals to practice good daily oral hygiene with the aid of community-based approaches and to promote self-care. When necessary, professional preventive assistance could be provided by trained prophylaxis personal, employed in integrated, comprehensive care clinics and working under the supervision of a dentist. Lesions that require curative care can be treated using minimal-invasive measures performed by dentists. The advantages of population-based preventive procedures are shown in Table 4.

Table 4 Benefit-cost relations of prophylactic measures in Germany at the end of the last century

Prophylactic measure	Benefit – cost relationship
Domestic use of fluoridated table salt	>70.0
Group prophylaxis (4-12 years)	5.1
Fissure sealants of permanent molars	2.3
Group prophylaxis and fissure sealants	5.4
Risk-oriented intensive prophylaxis as group prophylaxis	2.9
Risk-oriented intensive prophylaxis in dental practice	1.2
Individual prophylaxis (12-18 years) in dental practice	>1.1
Risk-oriented adult prophylaxis in dental practice	2.1
Preventive treatment approach	>5.0

Source: Saekel, 2003.

The ratios were calculated on the basis of German figures. A benefit-cost-ratio > 1 means that a measure is efficient. The higher the ratio, the more efficient is the preventive procedure. A benefit-cost ratio < 1 would indicate that the saved therapy costs (benefit) are lower than the cost of the prophylactic measures. All of the preventive measures shown have positive ratios and are therefore profitable. However, the ratios clearly illustrate

the significantly higher benefit-cost relationship of group- and population-based measures compared with individual prophylaxis performed in solo dental practices. The prevention-oriented dental approach has a benefit-cost factor of over five, which means that one Euro spent in preventive treatment generates an oral health benefit of five Euros. Apart from vaccinations, no other health sector has a greater efficiency than oral (group)

prophylaxis and prevention.

All three alternatives start from different premises as far as Government activities, manpower and financial resources are concerned. The need for regulations on the part of the Government is lowest in the first model, of medium intensity in the second model and of high intensity in the third model. The need for dentists is highest in the first model, lower in the second one, because many preventive measures can be carried out by prophylactic personal whereas the third model requires comparatively few dentists and more educated prophylaxis personal. The German experience, in particular, proves that financial resources for the first model are by far higher than for the second. However, the third model has the lowest requirements in terms of financial resources.

In low and middle-income countries, perceived oral health problems are mainly related to pain and discomfort (Mosha and Scheutz, 1993). This is also true for China (Du *et al.*, 2000). Existing oral health problems cannot be resolved because of a shortage of dental manpower. Although it is rather difficult to accurately determine the dentist to population ratio in China nowadays – with figures varying depending on the source between 1 : 10 000 (WHO, 2009b), 1 : 24 000 (Tse, 2005), 1 : 40 000 (Yeweng *et al.* 2002) – most scientists diagnose a severe shortage of oral health care providers in China. Furthermore, most dental providers have their clinic/practice in cities, whereas the majority of the population lives in rural areas. Only Baker and Zhou disagree and stress the fact that the number of dentists is increasing faster than the population while demand is decreasing. Policy-makers should therefore be cautious about further increasing the number of dentists (Baker and Zhou, 2001). Indeed, it must be noted that, between 1978 and 2004, the number of dental schools rose from six to 47 and undergraduate enrollment increased from 200 to 2 500 (Ling and Fu, 2007).

When there is a shortage of dental providers, the normal strategy is to train more dentists. However, this reaction would be fallacious. At best, it would facilitate access to service for well-off citizens in urban areas and prolong lack of service for the greater part of the population – the rural inhabitants. At worst, it could lead to training for the benefit of others because educated dentists might

emigrate in order to find better-paid positions abroad (Baelum *et al.*, 2007). In cases where a country succeeded in increasing its dentist to population ratio and dentists stayed in their home country, as happened in Syria and the Philippines, the Care Index of the child and adult population remained unchanged, at a low level, or rose only moderately from 17% to 33% (Beirut *et al.*, 2004). The reason why increased numbers of dentists had only marginal effects on the Care Index of the population was the inability of most individuals to afford restorative procedures. Consequently, the conventional Western approach to dental service provision, with highly equipped solo practices, is not only unaffordable for large sectors of the population but, at the same time, fully neglects the principles of modern research findings, according to which minimal intervention and prevention are, indeed, state-of-the art dentistry (Baelum *et al.*, 2007).

As oral health knowledge in China is poor, people generally do not practise habits that are conducive to oral health. Furthermore, supportive environments as well as national and regional oral health promotion programmes are rare, and oral health awareness is almost unknown. As a result, the perceived oral health problems of the Chinese population cannot be met by an approach according to which treatment needs are normatively defined by dentists and, to a large extent, an outdated type of restorative dental care is provided. The Chinese situation therefore requires a completely different oral health care strategy (Baelum *et al.*, 2007).

In order to avoid negative experiences of the high-income countries, particularly with regard to significantly higher tooth mortality in adults, a simple emulation of Western dental approaches cannot be recommended. Such emulation might result in deteriorating oral health over a long period of time, during which the Chinese population would have to undergo a phase of “mass dental extermination” (Bouma *et al.*, 1987; Baelum *et al.*, 2007). The development of oral health in Hong Kong and Singapore, where tooth mortality in adults and seniors is much more frequent (Saekel, 2010), confirms this assessment. Table 5 also illustrates how realistic this assessment is with regard to industrialized Western countries. In

many of these affluent societies, rather high numbers of missing teeth per person can already be observed in middle-aged adults (Finland, Ireland,

Great Britain) and extremely elevated rates of edentulousness are to be found in seniors (Finland, Ireland, Norway, Great Britain).

Table 5 Missing teeth per person and rates of total edentulousness in adults (35-44) and seniors (65-74) in selected high-income countries at the beginning of this century

	Amount of missing teeth (absolute)		Total edentulousness (in %)	
	35-44*	65-74*	35-44*	65-74*
Denmark	3.9	12.0	3.9	27.0
Finland	14.0	–	3.6	41.0
France	–	16.9	–	16.3
Ireland	6.8	–	4.1	48.3
Norway	–	13.5	–	40.0
Austria	2.2	18.1	–	14.9
Switzerland	1.4	10.6	–	>11.5
Great Britain	5.3	14.7	1.0	46.0
Australia	2.1	11.9	0.5	20.3

* Age classes. Source: Bauer *et al.*, 2009.

Conclusions and recommendations

A dental care system, in which dentists define normatively individual treatment needs by indicators such as DMFT and CPI alone, generally leads to:

- considerably overestimated treatment needs,
- frequent iatrogenic damage to dental dentition and periodontal conditions and
- ultimately to ineffective, invasive restorative treatment, at the expense of control and preventive strategies.

Such a system cannot be recommended for China.

The objective for a socially-oriented dental care system in China should be “to provide such a level of care that enables people to retain a natural functional dentition that enables a person to eat, speak and socialize without discomfort, pain or embarrassment throughout life” (Baelum *et al.*, 2007). Highest priority must be given to the preservation of natural teeth and not to the complete replacement of missing teeth.

Germany's experience, and international comparisons of the efficacy and efficiency of different dental care systems in developed nations, reveal that the fundamental decision in creating a dental system which serves the social needs of the population, and ensures good-quality dental care, lies in

selecting the right approach to dentistry – which is to be taught at universities and implemented by dental providers in their daily routine (Bauer *et al.*, 2009). If young children and adolescents grow up in an environment where preventive attitudes are practised from birth, where the young obtain free preventive and curative care until adulthood, it is of secondary importance – at least in high-income countries – whether this takes place in a publicly financed, contribution-financed or privately financed dental care system. In low or medium-income countries, however, the manner in which the dental care system is financed matters a great deal. Under these circumstances, an entirely privately financed system has to be excluded in the case of China.

The decision to give priority to a preventive therapeutic concept should be accompanied by a population-based approach because it has far greater public relevance and its financial requirements are considerably lower than those of an individualized approach. In contrast to an individualized approach that favours professionally applied fluoride and would have only minimal public impact, a population-based approach advocates the regular use of fluoridated toothpaste, which supposedly accounts for 50% of the caries decline in industrialized countries (Bratthall *et al.*, 1996), and recommends the use of fluoridated table salt. These measures are very inexpensive and

reach everyone. Similarly important are countrywide public programs to build oral health awareness, to spread knowledge regarding the causes and the prevention of oral diseases, to improve regular oral hygiene as well as to introduce systematic group prophylaxis aimed at infants, children and adolescents up to adulthood. Depending on the local situation, the population approach should be complemented by a high-risk approach at or below the community level, targeted to subpopulations with a particularly high caries risk (e.g. kindergartens and schools in remote areas, extreme impoverished groups or regions with especially unfavourable conditions).

People who require professional dental services need to be sure that dental providers are implementing a strictly preventive and minimal-invasive concept. Instead of invasive operative treatments, such as restorations and scaling, emphasis should be placed upon the assessment of each carious and periodontal lesion. Dentists should try to bring the ongoing caries and periodontal disease process to a natural arrest by offering specific appropriate measures (Elderton, 2003). Before arriving at a diagnosis, they should differentiate between active and inactive and cavitated and non-cavitated lesions. Non-cavitated, active lesions can be controlled and arrested using non-operative measures such as plaque control and fluoride (Nyvad *et al.*, 1999; Baelum *et al.*, 2006). Such a treatment concept no longer solves biological problems by means of mechanistic, technical solutions (Baelum, 2008). Existing restorations should not always be replaced because of a moderate degree of marginal breakdown. The avoidance of restorative measures should be seen as a primary preventive intervention. Whenever possible, the tooth substance conserving approaches such as repair, refurbishing or “explorative” cavity preparation should be chosen, instead of the replacement of restorations (Mjör and Gordon, 2002; Mjör, 2005).

Only by means of such a universal, preventive and evidence-based professional treatment approach can unnecessary and often iatrogenic invasive restorations be avoided and the repeat circle of permanent restorative dentistry minimized (Elderton, 2003). It is imperative that the low and middle-income countries, in particular, avoid the mistakes made in many high-income societies.

China still has a chance to opt in favour of a population-based, common risk approach because ambulatory solo practice structures are still practically non-existent. In implementing this approach, comparatively fewer dentists and more prophylaxis personal will be needed to perform measures such as applying sealants at an early stage, removing subgingival calculus and reinforcing proximal cleaning (Crossner and Unell, 1996).

If China embraces such a preventive and population-based approach, it has the opportunity to develop one of the most advanced preventive dental care systems in the world. Simultaneously, China would be able, while steadily improving its standard of living and thereby changing its dietary styles, to avoid the deterioration of its population's oral health. Indeed, by adopting a preventive and broadly based approach, the country could achieve good oral health in the deciduous teeth of infants and pre-school children while maintaining and ameliorating its relatively positive oral health results in adolescents and adults. Such a system would need much fewer financial resources than most of the dental care systems found in the industrialized world. This will be particularly so, if well-functioning school dental services are implemented.

However, this approach will require clear long-term goals, corresponding Government regulations and supervising structures, as well as the support of all participants. In particular, dental education must be in line with these ideas, which is currently not yet the case in China despite recent changes in the curriculum of the country's dental schools (Ling and Fu, 2007). The introduction of such a system needs time and can only be implemented on a step-by-step basis. Switzerland, for example, needed 40 years to achieve a 90% decline in caries among 12-year-olds. Germany – a successor with regard to systematic group prophylaxis for the young generation – achieved the same goal in half the time (Bauer *et al.*, 2009). The great achievements recorded in the oral health of the entire population of Jönköping (Sweden) were achieved only after 30 years of target-oriented preventive work. Therefore, a time span of at least 20 years has to be envisaged for the creation of a broadly based, successful, prophylactic and preventive environment with appropriate dental structures in

China.

To facilitate this task, policy should first concentrate on the young generation, and should direct its activities at them, as the basis of oral health is established and proper oral hygiene habits are rehearsed during the first 18 years of life. Policymakers and university teachers should always be ready to correct certain developments if the outcomes are not consistent with the superior goals.

In addition to the implementation of preventive dental care in a community-based system, it is also important for the treatment catalogue and the remuneration scheme of the social dental health insurance to offer the right type of incentives. According to Germany's experiences, this means, in the case of China, that the treatment catalogue should contain the newest evidence-based preventive measures and conservative treatments. Ideally, and if funds allow, these treatments should be provided without co-payment. Crowns and prosthetic procedures should not be included in the dental health insurance's treatment catalogue in order to avoid overtreatment and to avoid giving dentists false incentives.

As the oral status of the Chinese population is characterised by high DT scores but low caries and periodontal disease levels, as well as low missing teeth per person, this proposal is in line with existing oral treatment needs. In a low or medium-income country, such a treatment catalogue gives the strongest possible incentive to dentists and individuals to practise prevention and tooth preservation, as well as proper oral hygiene at home. Only in cases of serious disease, when prosthetic care is absolutely necessary (e.g. oral cancer), should dental health insurance remunerate the expenses for dentures in part or in full. An established catalogue of such diseases exists in Switzerland. For all other forms of prosthetic care, individuals could have the option of taking out private health insurance, if they really think it might be necessary at some point in time.

In addition, the remuneration system for the dental care providers who serve patients covered by social dental health insurance, should offer the same incentives. This means that the schedule should be largely based on capitation because capitation encourages prevention (Lennon *et al.*,

1990) and averts overtreatment. Only a few fee-for-serve items, for example for minimal-invasive fillings the quality of which must be good, should be envisaged.

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