

Getting the message across to periodontitis patients: the role of personalised biofeedback

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Maintenance of high levels of oral hygiene through home care regimes remains the mainstay of successful periodontal therapy and maintenance. However, many patients fail to achieve adequate home care and treatment fails or disease recurs, despite well designed supportive care programmes. The standards of plaque control required for successful management are frequently higher than those attained by the consulting clinician, and this level of expectation is frequently underestimated by dental care professionals. Patients need considerable motivation to engage in what is a considerable daily commitment, and re-motivation on a regular basis is key for longer-term success. This review discusses how clinicians can improve the impact of their oral health messages to patients using personalised biofeedback techniques and novel technologies in order to effect behaviour change in those patients.

Key words: Biofeedback, near patient testing, oral hygiene, risk prediction, disease scoring, self efficacy

Setting the context

Inflammatory periodontitis is one of the most prevalent human diseases¹ and a major cause of adult tooth loss². Severe disease affects 8% of UK adults and more than 85% of individuals over 65 years exhibit periodontal destruction³. Prevalence statistics are similar in other parts of Europe, Asia and the USA. Periodontal therapies whether publically or privately funded are extremely costly to health care providers, and in the UK constituted 50% of all courses of dental treatment in 2002. These costs continue to rise globally as the population of the developed world ages and retain their teeth for longer. In addition to the substantial negative impact of periodontitis on oral health, there is also mounting evidence that periodontitis has systemic consequences and that it is a risk factor for peripheral macrovascular disease and diabetes. Epidemiologic studies largely support an association between periodontitis and atherosclerotic vascular disease⁴, independently of smoking status, and it has been shown that there is a bi-directional relationship between periodontal inflammation and diabetic control⁵. Chronic periodontitis (CP) occurs in predisposed individuals with aberrant inflammatory/

immune responses to the microbial plaque that accumulates at the gingival margin⁶. The underpinning event appears to be an ineffective host response, involving hyper-inflammation that fails to remove the causative pathogens. Excessive or prolonged release of neutrophil (PMNL) proteolytic enzymes, pro-inflammatory mediators and oxygen radicals is responsible for the majority of host-tissue destruction in CP⁷. If the plaque biofilm is not mechanically removed in susceptible patients the epithelial attachment to the tooth migrates apically, forming a periodontal pocket. Sub-epithelial inflammation becomes severe tipping the homeostatic balance in favour of PMNL enzymes and reactive oxygen species (ROS), causing loss of periodontal ligament, bone and ultimately the tooth⁷.

To achieve successful clinical periodontal outcomes, the standards of individual mechanical plaque removal need to be extremely high and failure to achieve and maintain this results in long-term treatment failure⁸. Indeed, Turner⁹ demonstrated that improvements in clinical outcomes are achievable with improved patient-based plaque control alone. Optimal results require a willingness by individual patients to invest considerable time in achieving such high standards of oral hygiene, an

awareness of what is required, and the ability (in terms of dexterity and knowledge of their oral anatomy) to perform quite complex technical procedures. Changing patient behaviour requires compliance with dental/medical advice¹⁰ and in periodontitis patients this requires the implementation of rigorous and consistent oral hygiene practices including brushing, flossing, tongue cleansing and use of specific mini-interdental brushes to effect interproximal plaque removal.

This review will discuss various models of psychological intervention aimed at achieving behaviour change, with specific emphasis on oral hygiene. It will discuss the limitations of current approaches used within the clinical setting to motivate oral hygiene behaviour change and illustrate the potential for novel biofeedback techniques to augment our existing armamentarium, in motivating patients to long-term improvements in self-efficacy and ultimately self-care.

Definitions

Some definitions are necessary to explain aspects of terminology used in this review:

Self Efficacy - An individual's estimate or personal judgment of his or her own ability to succeed in reaching a designated level of performance that has an influence over events that affect their lives, e.g., quitting smoking, losing weight or achieving a certain level of plaque control. Such beliefs produce effects through four processes:

- Cognitive processes
- Motivational processes
- Affective processes
- Selection processes.

Cognitive processes are thought processes that involve the acquisition, processing and use of information.

Motivational processes are those that stimulate someone into action. The level of motivation is reflected by a person's choice of action, the intensity of action and how well and long they sustain the action.

Affective processes are those processes that control emotional status and which elicit emotional reactions.

Selection processes are decisions people make about types of activity or environments they are willing to enter into, based on their perception of coping and which can shape their behaviour and the direction of their personal development.

Biofeedback is a component of medical care that involves measuring a patient's quantifiable bodily functions (e.g. blood pressure, heart rate) or indeed biomarkers of a health/disease relevant outcomes (e.g. levels of

plaque on teeth, nicotine levels in saliva) and conveying that information to the patient in real-time.

Near Patient Testing also referred to as 'point of care testing' refers to the use of a medical device designed to quantify (fully or semi-quantification) a health/disease relevant measure at the bed- or chair-side, thus facilitating immediate biofeedback of results to the patient, rather than awaiting results from a distant laboratory-based analysis.

Compliance is defined as the extent to which a person's behaviour (in terms of performing plaque removal, following dietary advice etc.) coincides with medical advice¹¹. The term has become unpopular in behavioural circles as it implies an authoritarian prescriptive approach to behaviour change that does not engage a patient's views and concerns.

Adherence describes active and collaborative involvement of patients in professionally recommended medical advice¹¹. The term 'concordance' is also used to encompass a philosophy of partnership between clinicians and patients.

Models of healthcare

In order to understand the role of biofeedback in patient-centred care pathways, it is important to first consider basic models of healthcare delivery. A number of models exist across the developed world, but the majority remain based on medical or surgical models that are clinician driven. The 'repair model' has pervaded dental training and practice since the beginning of the last century, despite the convincing work of Axelsson⁸ which demonstrated that common dental diseases like caries and periodontitis are preventable, provided a risk based approach to prevention is adopted at a patient level¹². Despite this, prevention at a population level remains generic in nature, rather than focusing resources on the individuals that have greatest need. Practitioners still focus upon identifying current disease and *fixing it when it breaks* rather than identifying those patients most at risk of developing disease in the future and engaging patients in individualised preventative care programmes. Ironically, periodontal diseases lend themselves to several different healthcare models. The biological basis of periodontology is substantial, as is reflected in the wide diversity of periodontal research much of which focuses upon disease aetiology and pathogenesis rather than surgical intervention. The evidence base for both putative and true risk factors for periodontitis has reached a level where alternative models for periodontal care can now be implemented. One such model is the 'Wellness model', which is a patient driven, rather than a clinician driven model. Patients are comprehensively assessed when they are well, (i.e. prior to the development of

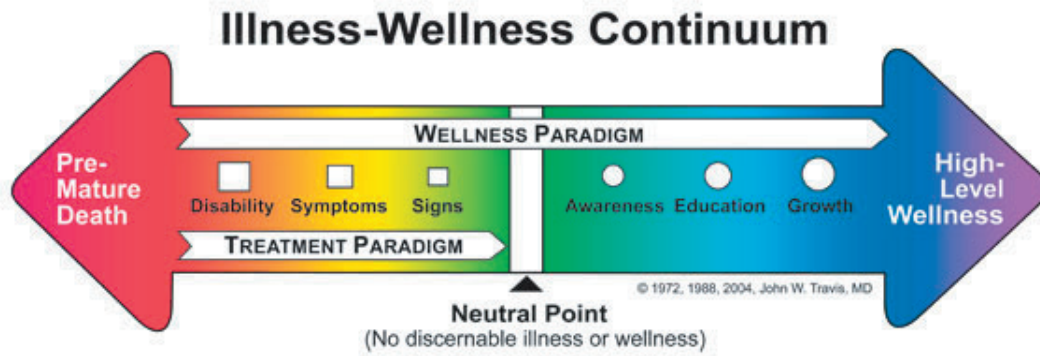


Figure 1. Illness-Wellness Continuum

disease) and their risk of developing oral diseases is quantified using accepted clinical measures. The patient is then provided with evidence-based and personalised information using objective risk prediction models to help them take greater responsibility for maintaining their own 'wellness' and prevent disease developing in the future. Risk scores can be calculated and communicated to individual patients in a simple and visual manner and used to determine individual care plans based upon future need rather than current disease status.

Many different models of wellness have been proposed, one early example being that of John Travis, developed in 1972 as a 'wellness continuum' to illustrate the relationship between treatment and wellness. He defined 12 dimensions of wellness with the Wellness Energy System (Figure 1).

A further model, developed by Donald B. Ardell¹³ incorporated an inclusive classification of wellness with self-responsibility at its core and with satellites that included nutritional awareness, physical fitness, meaning and purpose, relationship dynamics, and emotional intelligence. Such a model encompasses the importance of lifestyle factors in preventing chronic diseases (Figure 2 – developed further in 1998).

Indeed, recent studies have demonstrated inverse associations between plasma measures of nutritional status¹⁴, obesity¹⁵ and stress¹⁶ and periodontitis prevalence, illustrating how periodontitis, as a chronic disease, sits comfortably within a broader healthcare model of wellness.

The need to implement behaviour change

The consensus view within Europe is that gingivitis is a pre-requisite for the development of periodontitis¹⁷. The plaque biofilm is the primary aetiological agent in the development of gingivitis¹⁸ and also periodontitis¹⁹ and therefore it is logical that primary prevention strategies for periodontitis focus upon efficient plaque removal. The latter is also a fundamentally important component of periodontal therapy and supportive care, in particular the removal of plaque from interproximal



Figure 2. Inclusive classification of wellness (from Ardell 1998)

regions²⁰. However, assessing adherence to oral hygiene is not straightforward as plaque indices or scores (dichotomous measures of presence or absence) only provide a measure of short-term adherence to plaque control regimes (many patients brush before seeing their dental surgeon or hygienist). Bleeding upon probing the gingival margin is a better indicator of longer-term adherence with plaque control regimes, but individual patients' inflammatory responses vary according to their 'risk profile' for periodontitis and evidence indicates that the bacteria themselves only account for about 20% of the variance of periodontitis²¹, the remainder being governed by the host response to them.

Adherence to healthcare advice also varies with some estimates reporting figures as disparate as 15% and 93%¹⁰. Factors that predict high levels of adherence include:

- Presence of acute or unpleasant symptoms
- Immediately beneficial effects from the intervention
- Absence of adverse effects from the intervention
- Minimal change in lifestyle.

None of the above apply to periodontitis or the successful implementation of improved oral hygiene regimes and it is therefore unsurprising that medium-term adherence rates in chronic periodontitis patients are reported to be below 50%²²⁻²⁴. Assessing adherence can be achieved using various strategies; the most commonly employed are listed in *Table 1*, which is adapted from Christenson²⁵.

Whilst there is little evidence to support the contention that flossing improves periodontal outcomes, there is evidence that it is effective in reducing interproximal plaque and calculus formation^{26,27}. However, adherence to recommended flossing protocols reduces as soon as instruction and supervision have come to an end²⁸. So there is a clear need to implement behaviour change as a vital component of successful periodontal therapy and maintenance, but a strategy that employs education and motivation of patients as the only approach, fails to achieve this²⁹. Obtaining compliance remains the key challenge for oral health educators³⁰.

Current motivational strategies within the surgery

There is a lack of evidence from randomised controlled clinical trials to support or refute the efficacy of current clinical strategies used in general dental practice. Most motivational strategies employed within dental surgeries to improve oral hygiene practices fail to consider the psychology of behaviour change. Most practitioners will simply advise their patients that they have periodontal disease and that it may result in tooth loss, therefore they need to clean their teeth more effectively. Patients are then often shown oral hygiene techniques on models that represent a mirror image of their mouths and which challenge their cognitive ability to translate those practices into their own mouths. The stepwise approach illustrated below may help to achieve a higher level of understanding and motivation in a traditional practice setting, albeit anecdotally. It is based upon the traditional ‘tell’, ‘show’, ‘do’ method of teaching:

‘Tell’ - educate patients about their disease - periodontitis patients need to understand that periodontitis is not universal and they are different to the majority of the population. Advising patients they are one of 8% of UK sufferer’s of significant disease³ will help with this process. Patients must believe that they will develop disease even if their oral hygiene practices are average for their peers, in this way they will not feel they have dirty mouths, but at the same time they will appreciate that the standard of oral hygiene they need to achieve is in the top 8% of the population (or 2% if they have aggressive disease).

Introducing the concept of ‘risk’ and ‘risk factors’, and the fact that the reason they are susceptible is because their immune system is over-reacting to the microbial plaque that accumulates at the gingival margin (and damaging their own tissues), may help them understand the nature of their susceptibility. Another useful strategy is to use the analogy of diabetes patients; just as diabetes patients need to be careful about eating habits and need to monitor their blood glucose levels to avoid longer-term diabetic complications, so periodontitis patients need to be careful about tooth cleaning regimes and their need to monitor their plaque levels to avoid longer-term tooth loss. Moreover, advising patients that their oral hygiene levels need to be higher than those of the dental surgeon him/herself often cements the message that expectations will be extremely high. It is also vital however to ensure that patients realise such interventions do work and will improve the likelihood of tooth retention, even if they are of high risk status³¹.

‘Show’ - patients how the disease presents, what it looks like and what their role is in managing their disease - The use of radiographs to demonstrate landmarks for normal bone levels, where bone has been lost, and the location of the tooth apex, is often helpful to enable patients to visualise their disease experience and also helps personalise the educational message for them. Similarly, demonstrating where plaque is in their mouths by disclosing and instructing in the correct oral hygiene practices to employ to remove it, should be performed on the patient’s

Table 1 Assessing adherence to recommended behaviour change advice.

Method of Assessment	Example
Subjective reporting	Patient self report (e.g. smoking habit, 24-hour dietary recall)
Biological measures	Blood or saliva levels of a biomarker e.g. salivary cotinine in smoker’s (Surescreen – GFC Diagnostics, Bicester UK: saliva cotinine assay – see later)
Indirect measures	Assessing wear of toothbrush with time, residual toothpaste in tube, use of disease calculators (e.g. PreViser – PreViser.co.uk - see later)
Direct measures	Plaque levels or bleeding on probing, measurement of brushing behaviour using tooth brush tracking and visualisation technology (e.g. Oralinsights® – see later)
Clinical outcomes	Resolution of disease, inflammation, pocketing etc.

own teeth using a mirror so they may observe. Positive encouragement and reinforcement are essential and the adaptation of the type of brush or its action (in the case of electric brushes) to personal patient circumstances is key to success.

Do' - It is important that patients perform the recommended oral hygiene practices themselves in front of the adviser, so the clinician is clear what the patient is capable of achieving immediately after direct instruction. Avoidance of floss wherever possible and the use of mini-interproximal brushes tends to facilitate ease of interproximal cleaning.

It is important to recognise that despite the above, traditional interventions are limited in their ability to achieve long-term behaviour change³².

The theory of behaviour change

The definition of behaviour change is either to change an existing behaviour or introduce a new (currently non-existent) behaviour. The distinction is important as different advice may need to be given for different circumstances³³. The existing behaviour may be to increase or reduce a specific behaviour, or to change the timing or technique of a behaviour. For example, tooth brushing, getting patients to change technique or increase the number of times they brush daily³⁴. A non-existent behaviour is usually a new behaviour, which is introduced to the patient, for example flossing.

The assumption that attitudes and beliefs are major determinants of behaviour is shared by a number of models from which prediction about health behaviour can be made. Examples of these models are:

- The health belief model
- The protection motivation theory
- The theory of reasoned action.

The Health Belief Model

This model was originally developed by social psychologists in the US in an attempt to understand why people failed to make use of disease prevention or screening tests for early detection of diseases³⁵. The model was later developed to examine patients' responses to symptoms and their levels of compliance. The model encompassed two key beliefs, *perceived susceptibility* to the disease (a person's subjective perception of the risk of contracting the disease) and *perceived severity* (a person's subjective evaluation of the impact the disease or consequences of the illness) and two distinct sets of beliefs, *perceived benefits* (the subjective evaluation of the effectiveness of various actions available in reducing the threat) and *perceived barriers* (which describe a person's anticipated negative aspects of a particular behaviour) (Figure 3). According to this model, the combined levels of susceptibility and severity increase motivation to act, whereas perceptions of benefits (fewer barriers) provide the preferred path of action.

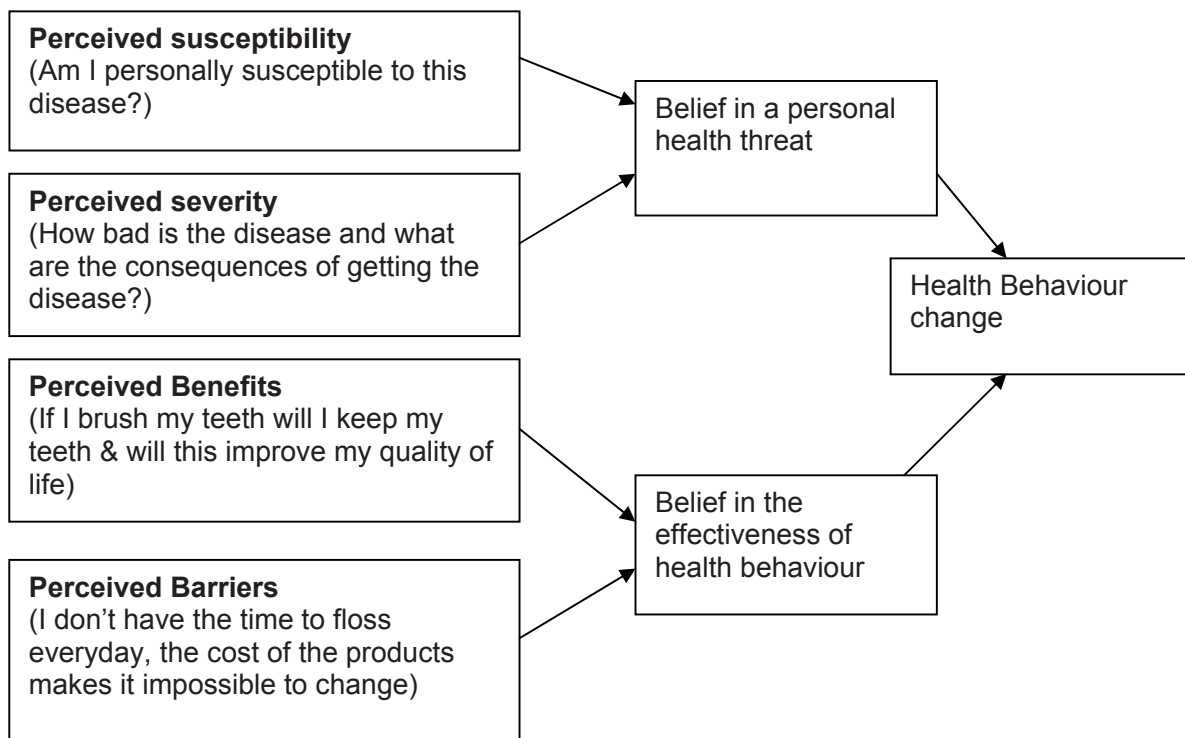


Figure 3. The health belief model³⁶

A potential weakness of this model is that several important determinants of health are not included. For example, the model does not consider potentially positive aspects of health-impairing behaviour patterns (e.g. enjoyment of smoking) or that many health behaviours are popular for reasons totally unrelated to health (e.g. weight control is usually motivated by wanting to look good and not for health reasons)³⁸. The model also fails to include self-efficacy or perceived control as factors influencing health. If people think they are unable to succeed in health related behaviour, e.g. keeping to a diet, they are unlikely to do so. The model also assumes that beliefs in a personal health threat and in the effectiveness of health behaviour will directly influence behaviour³⁸.

Protection motivation theory

Another model developed by Rogers called the protection motivation theory (PMT) attempted to provide a theoretical framework which could help explain empirical data from previous studies³⁷. According to the theory, protection motivation (e.g. engagement in some kind of health protective behaviour)³⁷ depends on three factors:

- The perceived severity
- The perceived probability of the event occurring or of susceptibility
- The efficacy of the recommended response in averting the event³⁸.

According to the model, the response of a smoker to a stop-smoking campaign, which emphasises the link between smoking and lung cancer, would be:

- How bad is it to have lung cancer?
- How likely is it that I will get lung cancer?
- How much would stopping smoking reduce my risk of getting lung cancer?³⁸

The model assumes that the three factors combine to determine the intensity of protection motivation. The model was revised in 1983, to include further variables. The most important variable to be added was self-efficacy. The concept of self-efficacy refers to a person's belief that he or she is able to cope with the behaviour change. People may be motivated to stop drinking or smoking, but if they believe they would be too weak or too addicted to do so, they are unlikely to succeed. The revised model also includes barriers and rewards to change, and it assumes motivation to protect oneself from danger is a positive function that will result in change.

The theory of reasoned action

This theory predicts behavioural intention and assumes that behaviour is a function of the intention to perform that behaviour. A behavioural intention is determined by

the person's attitude towards that behaviour. Subjective norms combine two components, normative belief and motivation to comply. Normative beliefs are our beliefs about how people who are considered important to us expect us to behave. According to this model, the effectiveness of changing a person's behaviour depends on success in influencing the individual's intention to engage in the specific behaviour. Since intentions are assumed to be the determinants of behaviour, a change in behaviour should occur. However, despite this association the translation of intentions to actual behaviour change do not always take place. *Figure 4* illustrates this model.

Health Locus of Control

The term Locus of Control was introduced to describe a relatively stable set of beliefs held by a person about the perceived causes of events and situations. Whereas personal control beliefs are exclusively concerned with a person's perceived ability to do something, the Locus of Control construct is equally concerned with the perceived influences of external factors, such as chance or fate³⁹.

This theory proposes that behaviour is a function of; the extent to which the individual believes the behaviour will lead to a particular reinforcement and, the extent to which the reinforcement is valued. Rotter also believed that social learning theory could be applied on a more general level and that a distinction could be made between internals, those who believe events are a consequence of their own actions, and externals, those who feel events are unrelated to their own actions and steered by external factors instead⁴⁰. The Social learning theory (SLT)³³ has been used extensively to change behaviour in education and chronic ill health in children³³. SLT argues that we learn by modelling behaviour from others through observation and more effectively through language. Individuals are more likely to adopt a modelled behaviour if:

- It results in outcomes which they value (e.g. wanting to retain their teeth)
- It is similar to that observed from an individual of admired status (they have built up trust in the dentist)
- The behaviour has a functional value (the value could relate to them remaining dentate).

Therefore, SLT suggests that when working with patients the practitioner needs to:

- Understand their values – what the outcomes of the treatment will be and how it will affect them
- Be able to relate to their needs rather than be paternal
- Identify those who model the 'good' behaviour
- Embed the behaviour within the family context so that the modelling and learning can be continued for the whole family.

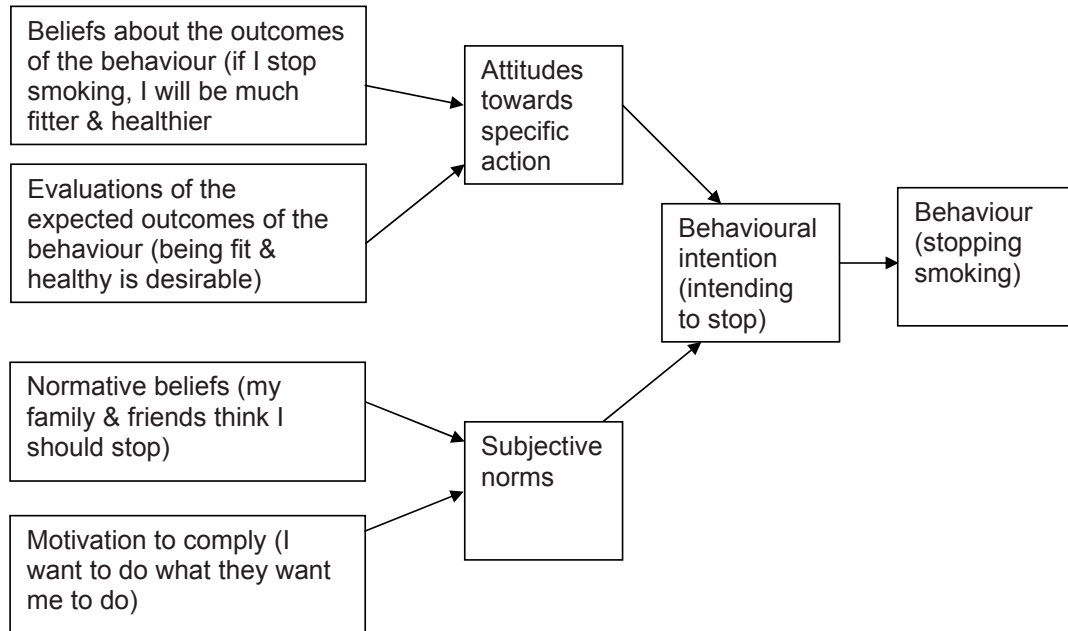


Figure 4. The theory of reasoned action³⁸.

How the information is presented to the patient is also important. Patients can be overwhelmed by too much information presented either verbally or in written format. Cognitive psychology shows us that in our conscious mind we hold 7 ± 2 pieces of information at any one time.

The reasons why health education programmes are unsuccessful^{34, 41}

Behaviour change usually requires additional interventions other than the conveying of a healthy message. Specific skills training e.g. tooth brushing technique or flossing may be necessary. This approach offers a direct impact upon behaviour if combined with knowledge-based messages. Messages need to be tailored to the target audience to address social, cultural and environmental barriers to successful health education outcomes. Bringing about lasting and effective changes in health behaviours is not about being prescriptive; it is more about encouraging participation and empowering patients to make any necessary changes in their own lives. The role of the health professional is to identify which patients are ready to change, and to provide them with the appropriate help and support to enable them to do so. Freeman presented two important procedures to help the health care professional understand behaviour change in patients⁴². These were:

- Motivational interviewing
- The Theory of Change.

Motivational interviewing encourages patients to take control over their health and over potential change,

by encouraging them to speak, and by doing so enables them to identify their oral health needs. The patient needs to be able to identify the issues that may affect their attempt to change. The health care professional should be able to assess whether the patient is ready to change. Readiness to change is a vital part of the behaviour change process, using a simple scale (not ready, unsure and ready) can help practitioners tailor the health message to individual patients. The motivational interviewing techniques, described by Freeman⁴², together with the readiness to change should enable patients to develop their own health priorities. Even if the patient is not ready to change, the motivational interview is tailored to the individual and the health professional must wait until the patient is ready. If the time is right for change, then a personalised preventive regime can be developed⁴².

DiClemente⁴³ and Prochaska developed the 'stages of change model'. The model is divided into six different stages of behaviour change (Figure 5). These are pre-contemplation, contemplation, preparation, action, maintenance and relapse. The stages reflect and hence provide a means of assessing progress from unawareness, through motivation to compliance. The stages are based upon measures of readiness to change which include the degree of ambivalence, the resolution of conflict, as well as the establishment and maintenance of the health behaviours. Thus progress through the stages is slow and torturous with many false starts and relapses. People with chronic dental problems cannot jump from pre-contemplation to maintenance. Their behaviour change is a journey, which may not be a smooth one, patients may move back and forward through the stages⁴⁴.

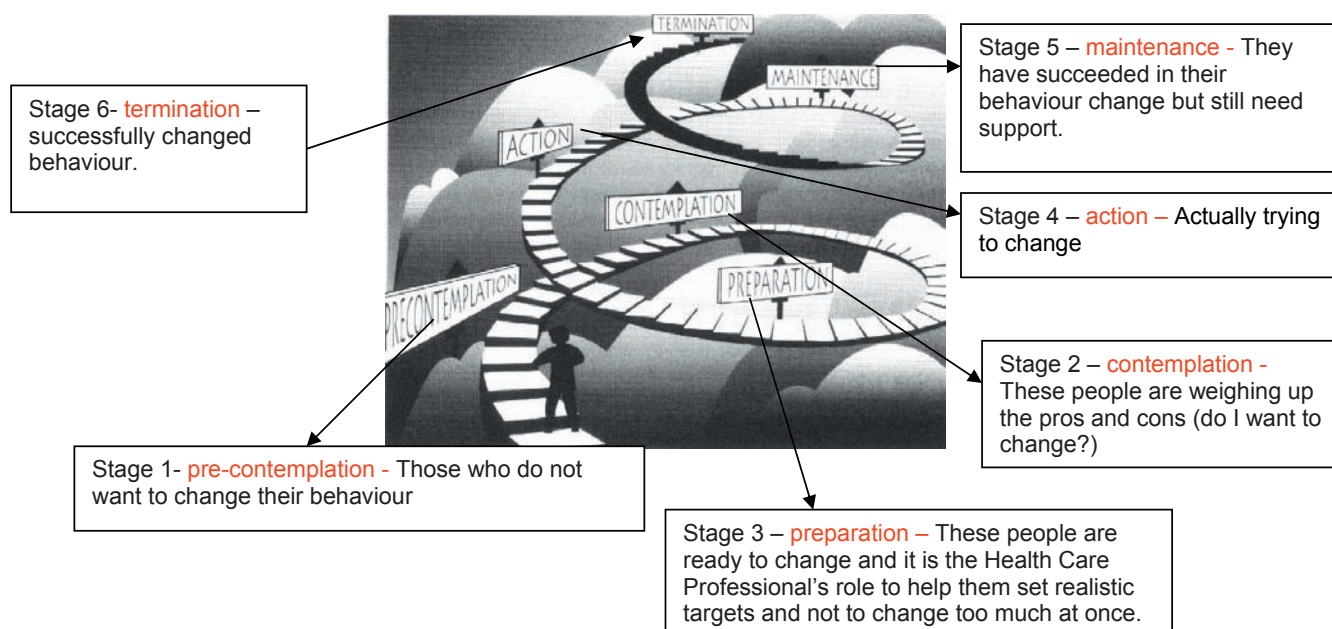


Figure 5. Stages of Change

How can dentists help?

Firstly, patients need to respect the practitioner who delivers the information. The methods used for delivery of health information can directly affect the clarity of the message and the resulting behaviour change. The patient should value the outcome. Cognitions of patients can be key to the uptake or not of behavioural change interventions, but further research is required in this area.

The strategy must incorporate some means of providing information other than in an advice-giving format. The information should not be given like a prescription for some dreadful medicine; it must be presented so patients feel that it is important to them and can take ownership of it. Health professionals must be able to assess the patient's readiness to change as this is the key to behaviour change.

Bringing about lasting and effective changes in health behaviours is about encouraging patients to identify and express their own dental health needs, exploring their own attitudes and values as well as empowering them to make any necessary changes in their own lives. The dental team plays an important role in trying to motivate patients. Understanding emotional difficulty patients may face in the dental surgery and providing a level of empathy may lead to a positive treatment outcome and could encourage patients to attend regularly. It is important to remain sensitive to patients' concerns. A friendly confident manner exhibited by the dental team is likely to be reinforcing for many patients, but not all. The dental team also needs to appreciate that change is a slow and gradual process from unawareness through motivation to compliance. The most important aspect

of behaviour change is that the patient must want to change their behaviour.

Solutions to achieving longer-term behaviour change?

The remainder of this review will focus upon achieving oral hygiene behaviour change through:

- Employment of psychological intervention strategies
- Novel forms of biofeedback that are available within the dental surgery.

Psychological interventions

Based upon the evidence that health relevant behaviours are determined by cognitions, such as prospective beliefs of risk, benefit, expectations and goals, Schüz *et al.* examined the efficacy of social cognitive theory (SCT) upon successful adherence to dental flossing²⁹. SCT assumes that the motivation to implement a health behaviour change relies upon:

- Risk perceptions - thus risk prediction can be an important motivational tool (see PreViser - below)
- Self efficacy - belief in one's ability to brush effectively is a key motivator (see Oralinsights® - below)
- Outcome expectations – belief that the intervention will improve outcomes and/or reduce periodontal risk.

The study of 157 non-dental university students demonstrated that the only significant predictor of flossing change was 'planning' the implementation of the flossing regime by using 'if-then' action plans e.g.

planning that if one is unable to floss in the evening, then placing the floss by the toothbrush will ensure it happens in the morning. The authors expressed the view that “*providing patients with information about their personal risk, the benefits of dental flossing and the ease of its performance can enhance motivation to act, but this alone may not be enough for actual behaviour change*”. This work was supported by a further study by Sniehotta and co-workers²⁹ who demonstrated that a brief (1.16 minute) intervention based upon planning when, how and where to floss, significantly affected flossing at two-week and two-month follow up assessments. This is the first evidence for the efficacy of ‘if-then’ plans in facilitating changes in self-care behaviours³² also applying to interdental cleaning.

A recent systematic review of psychological interventions used to improve adherence to oral hygiene instructions in adults with periodontal diseases⁴⁴, did not include a meta-analysis of published studies because unfortunately the available studies that fit the designated criteria were insufficient in number or quality (n=4; 344 participants). However, it did provide tentative evidence that psychological interventions resulted in improvements in plaque scores by comparison with non-intervention control groups.

Contemporary approaches to biofeedback

There are a variety of biofeedback strategies that aim to personalise the health care message for individual patients and some exciting innovations have been developed over the last 5 years. Biofeedback technologies such as those discussed below, provide personalised feedback to patients using their own biological or behavioural measures and avoid the need to wait for complex laboratory-based testing. This section will briefly discuss three example systems, which aim to intervene at dif-

ferent stages in the clinical care pathway (*Figure 6*) and which utilise innovative technologies to achieve their goals. They are:

- Smokescreen® - a near patient test for measuring salivary cotinine as a biomarker of exposure to tobacco smoke
- PreViser’s Oral Health Information Suite™ - a novel risk and disease prediction system for periodontitis, caries and oral cancer
- Oralinsights® - a breakthrough toothbrush tracking and visualisation technology for interactive oral hygiene instruction and patient motivation.

Smokescreen - near patient salivary cotinine assay

Smokescreen is a technology developed to address smoking as a key risk factor for incident and progressive periodontitis and one in which a dose response exists between smoking habit and severity of periodontitis⁴⁵.

Figure 7 illustrates the technology, which employs a syringe to collect a mixed saliva sample. The latter is then inserted into a plastic receptacle and in doing so the syringe tip breaks a glass seal that contains chemicals which react with any cotinine present within the sealed apparatus to induce a colourimetric reaction. The strength of colour change is directly proportional to amount of cotinine in the patient’s saliva (pale yellow being low levels and darker brown indicating higher levels). The test takes under 10 minutes and a simple colour chart is used to provide patients with immediate feedback about the amount of cotinine in their saliva. Barnfather *et al.*⁴⁶ conducted a randomised, blinded, controlled trial in primary care dental practice to determine if there was any benefit in smoking quit and/or reduction rates by adding such direct biofeedback to a brief

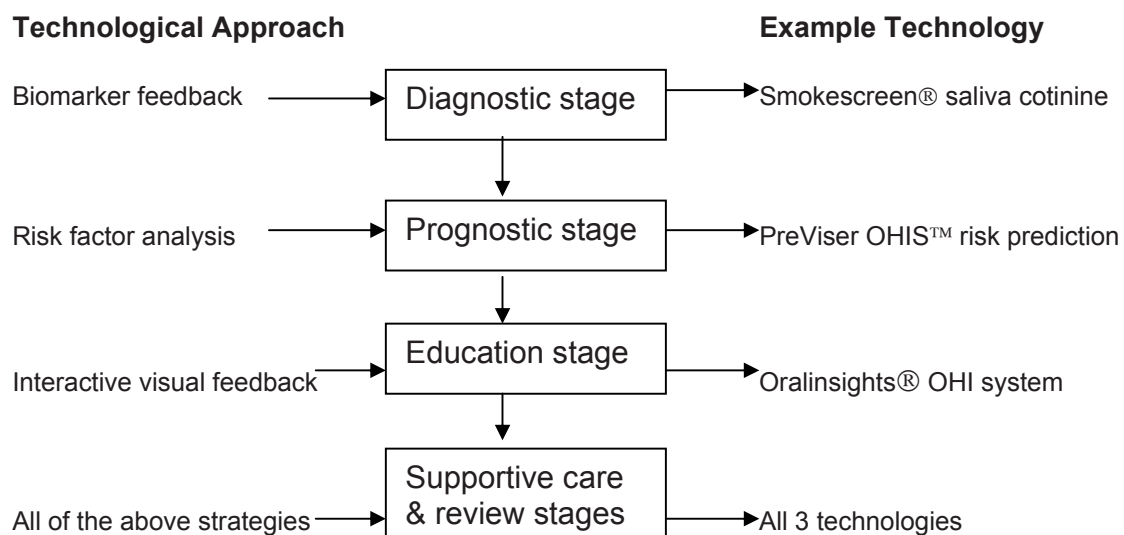


Figure 6. Novel biofeedback technologies within a periodontal care pathway

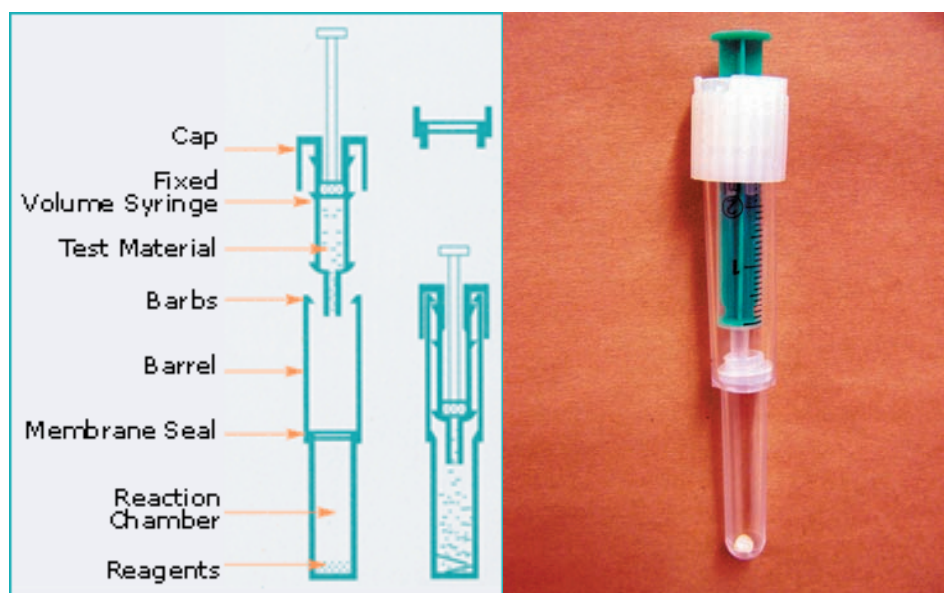


Figure 7. Smokescreen® salivary cotinine assay device

Periodontal (Gum Disease) Risk and Disease Assessment

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7D6C0446-F186-4E9C-ABDC-32A3DB2E380C

Risk of Gum Disease: 3



Risk predicts your future disease state. Your risk is determined by risk factors, which are distinct from the signs and symptoms of disease. Preventing disease requires treatment that reduces your risk factors. With routine dental care, tooth loss is 10 times more likely for an individual who has very high (5) risk compared to an individual who has low (2) risk. However, when risk is used to guide the selection of special treatment, tooth loss can be reduced 50% to 700%.
Your risk score of 3 is reflected against the chart to the left.

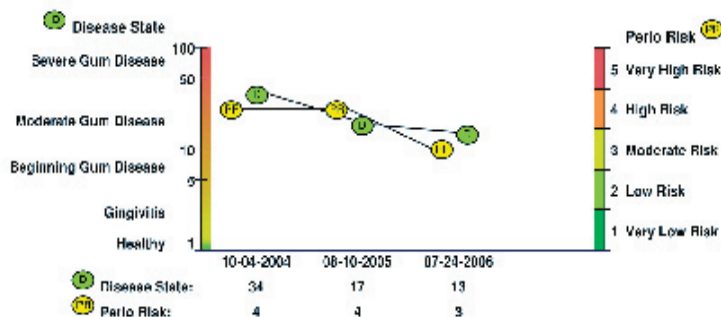
Disease State: 13

Localized mild and moderate periodontitis

Your disease state reflects the amount of damage caused by gum disease. As the disease state worsens, treatment increases in amount, complexity and cost. Tooth loss and the failure rate of repairs are greater for individuals with higher disease state scores. Treatment can repair the damage caused by disease, but tends not to help much in preventing new disease. Disease prevention requires treatment that reduces your risk factors. The best treatment incorporates both repair (where needed) and prevention.



What Changed? The information below shows the progression of your risk scores:



Active Intervention You May Need

Generally most effective May be effective Less likely to be effective

Figure 8. PreViser Oral Health Information Suite

smoking cessation intervention involving 100 patients. They demonstrated a significantly higher quit rate in the biofeedback group (23% cases *vs* 7% controls) and an overall decrease in tobacco use (68% cases *vs* 28% controls) and concluded that quit rates in a primary dental care setting could be reduced by 17% using such a personalised biofeedback approach.

PreViser – Oral Health Information Suite (OHIS)

The OHIS is a computer-based algorithm developed to incorporate a web-based risk and disease calculator for immediate patient feedback. It incorporates risk calculation algorithms for periodontitis, caries and oral cancer and the periodontitis calculator has been validated in a 15-year longitudinal clinical study⁴⁷.

Basic data on demographic, medical, behavioural and clinical parameters, collected during routine dental history and examination procedures, is entered into a computer and transmitted to a mainframe server. The risk and disease scores are immediately returned in a visual print out (*Figure 8*) that can be used for patient education, motivation and monitoring of risk factor and disease management with time. Risk is represented on a simple scale of 1-5 and disease on a scale of 1-100. Each time data is entered at sequential visits during therapy, a graph is plotted of patient progress. This approach to risk calculation and feedback forms a key component of SCT psychology (see previously).

In a study of 523 veterans⁴⁷, risk scores were shown to be strong predictors of bone and tooth loss. Patients in the highest risk group (group 5) at baseline examination had a 22.7-fold increased risk of loss of teeth that were periodontally involved at a baseline, 15-years after that examination, relative to those in a low risk group

(group 2). By year 15, 82.7% of patients in risk group 5 had lost 1 or more teeth, compared with 20% in risk group 2.

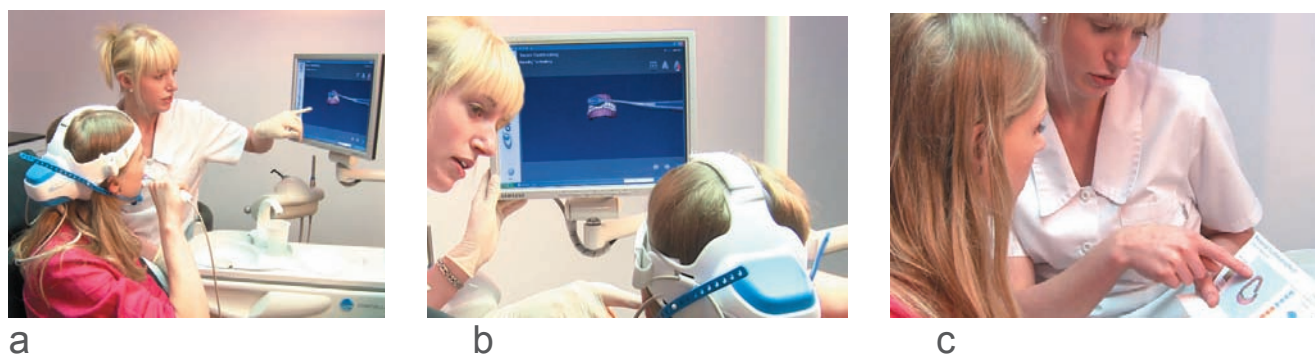
Oralinsights® interactive OHI system

Oralinsights is a portable, interactive OHI system developed by Unilever which can be easily integrated into a dental surgery for use in a hygienist session (*Figure 9*). The system allows a dental professional and patient to view the patient's tooth brushing behaviour on screen, in real-time 3D and provide motivational feedback to improve tooth brushing behaviour.

In an Oralinsights session the patient wears a headset with sensors and a simple measurement is taken to generate unique virtual models of their dentition. Whilst the patient brushes, the position, orientation and motion of the toothbrush relative to each tooth is tracked, recorded and subsequently analysed by the system. Total time spent tooth brushing and time the brush was in contact with each tooth surface is used to visualise 'hot spot' areas that are least brushed.

Motivational feedback is subsequently given to the patient in the form of an interactive OHI session facilitated by real-time visualisation. The hotspot area is highlighted on the screen with red 'virtual plaque' which is gradually removed as the patient brushes with a correct brushing technique. At the end of the session a personal tooth brushing report is generated for the patient to take home for continued motivation and oral hygiene improvement.

Use of Oralinsights has been shown to be successful in changing tooth brushing behaviour resulting in reduction of plaque levels and this effect has been sustained for up to one year⁴⁸.



Tooth brushing instruction using Oralinsights:

- a - patient wearing headset with sensors to detect toothbrush position relative to jaws
- b - interactive OHI with real-time visualisation of tooth brushing in 3-D on screen
- c - reviewing the personal OH report card

Figure 9. Oralinsights® interactive OHI

The role of the dental team

The dental team is in a unique position compared to other health care professions to affect behaviour changes in key sections of the population to whom they have unique access. Dental patients generally attend without symptoms and on a regular basis, and follow-up procedures have always been an important part of dental practice; healthy people are more likely to visit their dentist or hygienist than their doctor. Dentists and the dental team are trained to interview, assess, motivate, educate and provide support and counselling to patients. For example, patients with periodontal disease may visit the dentist every three months for a basic procedure and at these appointments the dental team can provide help and support to reinforce changed behaviour.

Summary and conclusions

This review has considered the evidence base for psychological interventions and personalised biofeedback in motivating patients to successfully implement health behaviour changes aimed at improving their oral hygiene. It contends that education and motivation alone are insufficient to achieve longer-term changes in oral hygiene behaviour and that planning the behaviour change is essential to improve success rates. Novel methods of providing biofeedback also appear to offer a key strategy within the Social Cognitive Theory model, which also incorporates a patient's understanding of their risk for disease development, the consequences and outcomes of the disease, as well as the benefits of treatment. As periodontitis remains a significant burden on health care providers and economies, and the ageing population retain their teeth for longer, it is time that preventative strategies were finally and fully embraced within the general dental services, by adopting wellness models of care delivery rather than the traditional repair models. The technologies are already available to help patients take greater responsibility for their own oral care, but the dental practice community must be prepared to change behaviour and practice, just as it expects behaviour change from its patients.

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Iain Chapple would like to declare that he acts as a consultant for Unilever PLC and also PreViser.co.uk

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