Dentistry is being shaped by the Internet and Social Media. Can Teeth Whitening be made safer and more affordable?

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ABSTRACT
The Internet has shaped our lives and will continue to influence how we live. Social media sites such as Facebook, Twitter and Instagram are widely used by the public every day, and our computer screens are constantly being bombarded with images of the “perfect body”. However, along with a slim, toned figure, a major factor of whether a person is considered attractive or not is whether they have a dazzling white smile. Due to this extra pressure, many people are undergoing teeth whitening, either by a professional, qualified dentist, or they are carrying out different procedures on their own teeth at home in an attempt to improve the appearance of their teeth. In this project I will explain how and why many people are experiencing adverse effects on the health of their teeth by exposing them to whiteners, and will suggest a research-based website that could be designed to prevent people from unwittingly using potentially harmful chemicals on their teeth and also provide a discussion forum for ideas and feedback.

INTRODUCTION
There are two categories of Teeth Whitening; non-vital and vital. The non-vital procedure is carried out on a tooth that has had root canal treatment, which causes the tooth to become stained on the inside. Currently Teeth Whitening is offered on the NHS, but only in cases where there is a valid medical reason, such as “to lighten teeth that have discoloured because the nerve has died”. Having undergone root canal treatment, patients then receive a form of whitening provided by the NHS to recover the natural colour on that particular tooth. To overcome the internal darkness that the root canal has caused, the dentist places a whitening agent inside the tooth prior to filling over it.

On the other hand, vital processes are used to improve the appearance of all the teeth, and are mainly used for cosmetic purposes. The latest and most common vital procedure is Laser Teeth Whitening (Figure 1) which is by far the most expensive, upwards of £99.00 just for a single one hour treatment. It is carried out by qualified dentists and involves a Hydrogen Peroxide based gel-like solution being coated onto the patient's teeth. Then the surface of the teeth is exposed to a strong, specialized light or laser activates the gel, causing it to release oxygen ions and lift the stains from the teeth in the process. Although this method has gained extensive popularity among aesthetically conscious people as it does result in visibly whiter teeth, there are drawbacks to this whitening method.

Although the product shouldn’t come into contact with the nerve endings or the gums, it can cause discomfort, sensitivity, and even pain if the process is carried out unprofessionally. The pain in the majority of the cases is temporary and subsides spontaneously but some people complain of the pain worsening after the procedure. There have been many press stories about patients who have received inadequate treatment and therefore suffer excruciating pain and sensitivity after the procedure. Many of these were due to the person carrying out the whitening process being unqualified, despite the 1984 Dentists Act which states only trained
dentists can perform dental procedures. However whilst Laser Teeth Whitening may be expensive, it is still popular among the public as it provides instantaneous whitening and there is no time consuming follow up procedure - it is completed in a single sitting appointment only.

Almost all Teeth Whitening treatments involve the use of Hydrogen Peroxide. Although there are some products that claim not to contain Hydrogen Peroxide, many of these will contain a substitute chemical, Carbamide Peroxide. Carbamide Peroxide, although it may also be an effective whitening agent, contains Hydrogen Peroxide at a ratio of 1:3. When it reacts with the saliva in the mouth, it produces Hydrogen Peroxide, which will have the same overall effect as pure Hydrogen Peroxide. Hydrogen Peroxide is effective because as it penetrates the porous enamel, it releases oxygen which then reacts with the discoloured material on the teeth, chemically changing it, making it detach from the tooth's surface.

The majority of Teeth Whitening treatments on the market today contain Hydrogen Peroxide despite the number of negative side affects associated with this chemical on the teeth and gums. The most common problem is that the patient often suffers from very sensitive, painful teeth during and even after the whitening process. Although patients are warned about the possibility of suffering discomfort before the treatment commences, the intensity of the pain and its duration varies from person to person. If the concentration of Hydrogen Peroxide is too strong, it can also burn the soft tissue or even cause irreversible gum recession, exposing the root of the tooth and causing sensitivity (Figure 2). Another risk is that Hydrogen peroxide products reduce the hardness of the enamel as well as what is called the elastic modulus or stiffness, (a measure of the ability of the tooth surface to "bounce back" in response to applied force), so the tooth becomes more brittle and liable to break.

The Chief Executive of the General Dental Council (GDC) revealed in an interview with the BBC that "over the last few years we have received hundreds of complaints from the public and dental professionals about poor tooth whitening".

Because of the risks associated with the use of Hydrogen Peroxide, the Irish Medical Board brought in a new legislation in October 2012, stating that limits must be placed on the percentage of Hydrogen Peroxide present in cosmetic products. For products available at pharmacies or over-the-counter for DIY use by the general, untrained public, this limit was 0.1%, whereas products used only by experienced dental practitioners can have up to 6%. These limits are sensible as it has now been verified that Hydrogen Peroxide can have multiple side effects on the human body. High concentration of Hydrogen Peroxide or elongated exposure to the chemical can cause irritation to the oral cavity, especially the gums,
tongue and roof of the mouth. Furthermore, if the patient should swallow the Hydrogen Peroxide it can damage the internal membrane of the oesophagus, causing pain and sensitivity whenever food or drink is consumed.

Many people resort to using DIY Whitening kits to improve the appearance of their discoloured teeth because it’s vastly cheaper than having them professionally done. As such, there is a large market for dental products promising to whiten the shade of the buyer’s teeth easily from the comfort of their own homes. These kits contain a weaker whitening agent than the compounds available to the dentist, however even these kit compounds are not completely safe and by treating themselves at home, the individual is taking risks with their own oral health. Their teeth may appear to be shades whiter and brighter, but there are some hidden consequences the budget conscious consumer may not have considered.

i) The weaker whitening content of the home kit means it takes longer to achieve the desired shade of whiteness than the procedure carried out by professionals.

ii) The individual is tempted to use the home kit more often than instructions advise or for longer periods or more extensively (overlapping gums).

iii) If the products used to bleach the teeth are too acidic, then the enamel can be softened and even start to dissolve, causing sensitivity and discomfort to the user, ultimately shortening the life of the tooth.

iv) By whitening their own teeth, they may be covering up early indicators of decay. In turn, this will lead to worse oral problems in the future as stained teeth are often one of the primary signs of decay, or possibly even an abscess. Home whitening disguises these signals and hides potential problems from the dentist’s eye at their next regular dental appointment. It is therefore most sensible that Teeth Whitening is carried out by a qualified dentist as they would be able to recognise and treat the initial signs of decay accordingly before problems escalate before the whitening.


Whitening Strips (Figure 3) are the probably most popular home whitening kit among the general public for a number of reasons. Firstly, they are easily accessed by anyone as most are sold over the counter, meaning buying them can be incorporated into a person's weekly shop, as opposed to the individual having to designate time to consult with their dentist about whitening treatment. Secondly, they are considerably cheaper than the procedures carried out by qualified dentists, (approximately £5.00 to £50.00 as opposed to over £99.00) and thirdly, they are simple to use with a result visible within half an hour.
Small pieces of polyethylene are used to create the Whitening Strips as it is a flexible plastic that can be moulded easily to the tooth's surface (Figure 4). Each strip is coated with a gel made from either Hydrogen Peroxide or Carbamide Peroxide which reacts with the saliva in the mouth, causing it to be oxidised to form peroxide and urea. Urea is an acid which acts to break apart the bonds within the stains on the surface of the teeth, whilst the peroxide acts as the whitening agent.

However, some problematic outcomes have been identified with the use of Whitening Strips. Some users have reported that whilst using Whitening Strips, they suffered from gum irritation, tooth pain, and sensitivity. Although these symptoms may be overcome with the use of pain killers in the short term, the application of these strips can hide a more serious underlying issue. The irritation may also be a result of the product being applied incorrectly. Since the process is not being carried out by trained dentists, it is the responsibility of the individual to ensure that the product guidelines are rigorously stuck to. If applied incorrectly or simply ineptly and pushed into the gums, extreme sensitivity and soreness may result. Using the strips too often or for too long can also damage the enamel and lead to underlying tissue damage below the gums.

If individuals have discovered that these strips work then they are more inclined to use them again and again without realising the damage they are doing to their teeth. Excessive use of teeth whitening products results in the enamel breaking down and areas of de-calcification forming on the surface, which leads to increased porosity of the teeth (Figure 5). Both of these consequences cause the dentine of the teeth to become exposed, or in worse cases, the pulp chamber containing the nerves and blood vessels, which results in the teeth becoming extremely sensitive and ultimately short lived.

All of the above teeth whitening procedures use the same agent that is contained in the products used to bleach hair. Using too much peroxide on the hair can cause irreversible
damage, just as it can with the teeth. When used on hair, it results in multiple stress points along the strands, as well as weakening at the scalp and drying and breaking the hair itself. Similarly, when Teeth Whitening products are overused, the surfaces of teeth and the surrounding gums can be weakened and broken down by the Hydrogen Peroxide.

Some DIY kits claim not to use Hydrogen Peroxide. Instead they contain Chlorine Dioxide, the same acid that is used to disinfect swimming pools. This chemical whitens the teeth by etching the surface of the tooth, which, in turn, destroys the protective enamel, therefore causing the teeth to become very sensitive as the under layers are exposed. In many cases these changes are permanent, and in extreme cases may lead to the loss of the teeth. Not only does Chlorine Dioxide damage the enamel of the teeth, the acid can also burn the gums, further increasing the risk of losing teeth. Similarly, other products use Sodium Bicarbonate. As another abrasive, this too can strip the enamel from the teeth, leaving permanent damage.

DISCUSSION
Throughout the last decade the Internet has become the most effective and efficient method of spreading information. The Internet offers many obscure remedies to whiten the teeth, however, although these may be effective, many of these will have other hidden outcomes on the health of the teeth that the user may not know about. Although there are many websites designated to informing the reader about the weird and wonderful teeth whitening agents that various authors have discovered, most of the time there is no mention as to what effects the sample may have on the health of the teeth or the rest of the body.

Some of the remedies suggested are techniques such as rinsing the mouth with apple cider vinegar, or lemon or orange juice. Although they may have the power to whiten the teeth, being acidic they also have the power to erode the enamel on the teeth, causing teeth to become worn down, sensitive, transparent, and discoloured as the dentin is exposed. Similarly, whitening with apples or strawberries has been revealed as an effective home-remedy, however these to contain naturally occurring acids, malic acid found in apples and ascorbic acid found in strawberries, which also cause enamel erosion.

![Figure 6](http://www.oralb.com/products/vitality-precision-clean)

Although regularly brushing the teeth thoroughly with toothpaste may be seen as the obvious teeth whitening solution, this in itself brings about some potential dental difficulties. Unquestionably, a person who regularly brushes their teeth with have whiter,
brighter teeth than someone who only brushes occasionally as they are frequently removing the plaque and tartar that will have built up since they last brushed. According to The Daily Mail, the best teeth whitening product is the Oral B Vitality White and Clean Rechargeable Toothbrush (Figure 6), which can be purchased from £30.00. The manufacturer of this toothbrush stated that this device is unique as it ‘features a rubber polishing cup to help remove stains and whiten teeth’.

Electric toothbrushes are recommended by most dentists as they are more efficient and effective at removing plaque, and are especially beneficial for patients with limited manual dexterity. However, brushing is an abrasive action, so brushing too hard or too often can not only cause irreversible gum recession, exposing the roots and creating tooth mobility and sensitivity, but can also wear down the enamel, causing the dentin to be exposed. As dentin has a yellowish brown tint, this contributes to discolouring the overall appearance of the teeth.

Although enamel is the hardest structure in the human body needing, as it does, to protect teeth and maintain the integrity of the bite, even enamel is vulnerable to abrasion by certain products, even to over-vigorous brushing. So it is important to figure out ways to reduce damage to this vitally protective part of the tooth whilst allowing it to appear shiny, white and healthy as we all wish to see.

There are many types of toothpaste available from supermarkets that claim to contain miracle ingredients to whiten the teeth. These contain abrasives that remove stains on the enamel and make the teeth appear whiter and cleaner, however the actual colour of the teeth is not altered. They also all contain a very low percentage of Hydrogen Peroxide, but not enough that is going to cause adverse effects on the health of the teeth. Sodium bicarbonate may also be a secret ingredient of toothpastes and mouthwashes because of its whitening power and plaque removal effect, however, this may greatly wear down the enamel, which can then lead onto sensitivity of the teeth and potentially pain to temperature changes.

Individuals attain different habits throughout their lives which could contribute to the staining of the teeth. Naturally, the easiest way to whiten the teeth is simply not to expose them to chemicals that might stain them in the first place. Food and drinks such as coffee, tea, red wine, berries and food colourings are known to discolor the teeth if they are consumed too often. Tobacco products have also been proved to have harmful effects on the teeth, including periodontal disease and oral cancer, both of which stain the teeth an unappealing yellow-brown colour (Figure 7). Many people expose their teeth to acidic chemicals daily, which wear down the enamel and expose the dentin below, causing sensitivity and discolouration (Figure 8). These can be simple everyday ingredients in cooking, such as lemons, olives, and cranberries. For the same reason, carbonated drinks, and sports drinks which contain phosphoric acid and organic acids, should be avoided.
Evidence for techniques to whiten the teeth has been found that dates back for hundreds of years, right back to the Middle Ages. Documents have been found that reveal that the herb elecampane (Inula helenium) was scrubbed onto the teeth, and sage leaves were ground up into a powder and mixed in with salt to create a paste which was also rubbed onto the teeth's surface. Sage, along with rosemary and mallows, was suggested to help alleviate gangrene and soreness of the mouth. Having been tested in labs, these remedies have been proven to not only whiten the teeth, but also remove tartar, prevent decay, and strengthen gums.

CONCLUSION
Some of the techniques suggested by people on the Internet have been proven to whiten teeth effectively and safely. For this reason, a website should be designed that informs the reader of methods that have been clinically proven to whiten the teeth, and any known after-effects that these methods may incur. If an individual thinks they have discovered a substance that they believe to have the power to whiten the teeth, then they are able to write their observations in a comments box on the website. These messages are instantly sent to a research team, who could chemically test the substance for its whitening ability and any possible side effects it may have on the teeth and oral cavity. Any methods that have been proved to be effective and otherwise harmless can then be published on the website for the readers to view and try themselves, and report back. This way the relatively small cohort from the clinical trials can be exponentially extended, thereby growing the research on that method. This may expose further effects or helpful tips. If the technique has any minor consequences, they must be mentioned in the article as and when they are discovered as it important that the individual who may choose to try that method completely understands the risk they may be putting themselves and their teeth under and to what degree. In this way, readers can discover new quirky methods that have been clinically tested and proven to whiten the teeth, but at the same time be warned if there are any hidden side effects of using the acquired technique. As these methods would have been ultimately discovered by people from the general public, it is highly likely these teeth whitening agents would be cheap, everyday household products that are easily accessible to everyone.
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