

## **Research Assessment Exercise 2020**

### **Impact Case Study**

**University:** The University of Hong Kong (HKU)

**Unit of Assessment (UoA):** Clinical Dentistry (UoA 4)

**Title of case study: Managing tooth decay in preschool children through prevention and caries arrest treatment with silver diamine fluoride solution**

#### **1. Summary of the impact**

Our research conducted since 2001 has been pivotal in developing the use of silver diamine fluoride (SDF) solution to manage tooth decay in children. Our excellent results led to the establishment of an oral health programme that served more than 170,000 preschool children in Hong Kong in 2010 to 2019. The direct health impact includes approximately 24,000 decayed primary teeth treated with SDF a year, with over 70% of the decay becoming inactive. Our research has also influenced dental services overseas with a clinical guideline on SDF use developed by the American Academy of Pediatric Dentistry in 2017 with considerable global reach.

#### **2. Underpinning research**

Although tooth decay (dental caries) is largely preventable, it is still a major public health issue among preschool children in Hong Kong and overseas. Access to dental treatment is a problem for preschool children in most places around the world due to various reasons, including accessibility and affordability of dental services and compliance with care among the very young children. Untreated tooth decay can lead to pain and infection, and affect children's oral health related quality of life. This calls for a new strategy to manage tooth decay.

In the early 2000s, Prof. Edward Lo (full-time teacher, 1988-now) and Prof. Chun-Hung Chu (full-time teacher, 2007-now) of HKU's Faculty of Dentistry pioneered research on the use of SDF to manage dental caries in young children. Over the years, a series of clinical trials on preschool children was conducted [1-4]. In the randomized controlled trials, SDF solution was painted onto the active carious (decayed) lesions in the primary teeth of the study children in the test group once every 6 or 12 months. In these clinical trials, besides having a placebo control group in the early studies, the comparison group in the later studies usually received other forms of fluoride treatment, such as brushing with fluoride toothpaste, topical application of sodium fluoride varnish and high fluoride-release glass ionomer cement. At the follow-up clinical examinations by dentists who were not informed of the participants' group assignment, it was found that most (usually 60-80%) of the SDF-treated lesions had become inactive, i.e. the soft carious dental tissues had turned hard and decay had not progressed. Moreover, it was found that SDF can prevent the development of new tooth decay in sound teeth. This non-invasive treatment was proved to be an effective alternative to the traditional restorative approach (drill and fill) in managing tooth decay in young children, and was more effective than other fluoride delivery options. Furthermore, our clinical trials showed that topical application of SDF is safe for use in children aged 3 to 5 years [5].

The research team has also conducted many laboratory studies to discover the mechanisms by

which SDF works, including its effects on dental plaque bacteria, inhibition of collagenase and remineralization of dental tissues, to allow us to understand the mechanisms of action of this product why it is more effective than other approaches [6].

On the topic of management of tooth decay using SDF, HKU's research ranks top in the world in terms of both quantity and quality. A total of 13 papers on original clinical trials conducted by the Dental Faculty were published in 2001-2019, mostly in the Journal of Dental Research (the top dental journal in term of impact factor ranking). In the past 8 years, we had obtained five major external competitive research grants, including from the Research Grants Council of Hong Kong, totaling approximately HK\$40 million. Prestigious research awards obtained include the IADR Colgate Research in Prevention Award in 2014 and the IADR Cariology Research Group Science Award in 2016.

### **3. References to the research**

1. Zhi QH, Lo ECM, Lin HC. Randomized clinical trial on effectiveness of silver diamine fluoride and glass ionomer in arresting dentine caries in preschool children. *Journal of Dentistry* 2012; 40: 962-967.
2. Fung MHT, Duangthip D, Wong MCM, Lo ECM, Chu CH. Randomized clinical trial of 12% and 38% silver diamine fluoride treatment. *Journal of Dental Research* 2018; 97:171-178.
3. Duangthip D, Wong MCM, Chu CH, Lo ECM. Caries arrest by topical fluorides in preschool children: 30-month results. *Journal of Dentistry* 2018; 70:74-79.
4. Gao SS, Zhao IS, Hiraishi N, Duangthip D, Mei ML, Lo ECM, Chu CH. Clinical trials of silver diamine fluoride in arresting caries among children: a systematic review. *JDR Clinical and Translational Research*. 2016; 1:201-210.
5. Duangthip D, Fung MHT, Wong MCM, Chu CH, Lo ECM. Adverse effects of silver diamine fluoride treatment in preschool children. *Journal of Dental Research* 2018; 97:395-401.
6. Mei ML, Lo ECM, Chu CH. Arresting dentine caries with silver diamine fluoride: what's behind it? *Journal of Dental Research* 2018; 97: 751-758.

## **4. Details of the impact**

### **Direct impact on oral health of preschool children in Hong Kong**

The latest oral health survey conducted by the Hong Kong SAR government in 2011 found that half of the 5-year-old children had dental caries. Moreover, over 90% of the decayed primary teeth were untreated. Access to dental care services is a problem for preschool children in Hong Kong because there is no public nor subsidized dental care service for them.

The use of SDF to manage tooth decay, both through the prevention of new decay and arresting (inactivating) active decay, has been incorporated into a large scale oral health promotion programme organized by the Faculty of Dentistry HKU in collaboration with various non-governmental organizations (NGOs). The oral health programme served over 100 kindergartens in Hong Kong a year in 2010 to 2019. This programme received financial support from the Hong Kong government, charity foundations and individual donors. In total, 171,000 preschool children received clinical service in 2010 to 2019 (approximately 19,000 children a year). Among them, 55,000 children with tooth decay and parental consent received SDF treatment (approximately 6,100 children a year). About 218,000 decayed primary teeth were treated (24,000 teeth per year). This programme has attracted local mass media attention and the reports in newspapers and televisions have raised social awareness of the importance of good oral health and dental care for preschool children in Hong Kong [Source #1 to #3].

Results of the clinical examinations show that the success rate of SDF treatment in arresting dental caries in the above-mentioned oral health programme was high, over 70% [Ref #2]. It is estimated that 4,270 children per year were saved from suffering toothache and infection (6,100 children with tooth decay treated by SDF x 70% success rate). In addition, it is calculated that in each year the caries process in 16,800 decayed primary teeth was arrested (24,000 SDF-treated decayed teeth x 70% success rate). These teeth would exfoliate naturally without causing any major oral health problems. If these decayed teeth were treated by the conventional restorative approach (placement of dental fillings), the treatment cost would be HK\$ 8.4 million (\$500 per filling x 16,800 teeth).

The most recent development of this oral health programme is a large donation of close to HK\$56 million from the Hong Kong Jockey Club Charities Trust to the University of Hong Kong to incrementally expand the outreach dental service using SDF for dental caries control to cover all kindergarten children in Hong Kong (approximately 180,000 children in 1,000 kindergartens). This is a 3-year project and has been implemented since September 2019. It can be anticipated that a significant impact on the oral health of preschool children in Hong Kong will be achieved.

### **SDF treatment for management of tooth decay has been recognised locally and internationally**

The Faculty's clinical and laboratory research work on management of tooth decay using SDF was published in more than 40 articles in international scientific journals. HKU's research work on the use of SDF for caries management has drawn the attention of the dental profession internationally, including announcement in the website of the FDI (the largest international dental organization representing the national dental associations of over 100 countries) [Source #4]. Because our clinical research has shown that SDF is safe for use and highly effective in arresting tooth decay and that it can be applied in both clinical and community settings, it has become particularly useful for treating tooth decay in young children with limited access to dental care. Teaching on how to use SDF has recently been introduced into the undergraduate and postgraduate dental programmes in many dental schools in different countries such as Thailand and the USA [Source #5].

The clinical studies and systematic review conducted by the HKU researchers showed that SDF is a breakthrough dental agent in this century due to its safety, acceptance by most children and parents, simplicity in application, and efficiency and effectiveness in preventing and arresting (inactivating) tooth decay [Ref #4 and #5]. This led to the development of an evidence-based clinical guideline on the use of SDF to manage cavitated caries lesions in primary teeth in young children by the American Academy of Pediatric Dentistry in 2017 [Source #6]. The main basis of this new guideline is the findings of the clinical research conducted by HKU researchers as reported in a systematic review [Ref #4]. The use of SDF is also recently promoted by the American Dental Association for the dentists in the U.S.A. [Source #7] and by the Association of State and Territorial Dental Directors of the U.S.A. [Source #8] and the American Academy of Pediatrics [Source #9].

## 5. Sources to corroborate the impact

- 1) News and documentary broadcasted in a local television channel (i-cable) - Title: 預防幼兒蛀牙的新方法 (New way to prevent tooth decay in young children). Program: Document on Health. Release date: 2 August 2015.
- 2) News and documentary broadcasted in a local television channel (TVB Jade) - Title: 港大證明 1 種溶液可止蛀牙 獲美採用 (Silver diamine fluoride was proved to be effective in stopping cavities by the University of Hong Kong and is approved for used in the US). Program: News Broadcast. Release date: 31 October 2016.
- 3) News article in a local newspaper (Headline Daily) – Title: 港幼童每五人兩蛀牙 - 比率較美日等地偏高 (Every two out of five young children in Hong Kong have tooth decay – prevalence higher than US and Japan) Publication date: 27 July 2015.
- 4) World Dental Federations: News: Mechanisms of silver diamine fluoride on arresting caries: a literature review. 5 March 2019. accessed date 30 Oct 2019.  
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- 5) Ngoc CN, Mehta R, Donovan TE, Ferreira Z, Andrea G. Teaching silver diamine fluoride in U.S. dental schools' predoctoral curricula. Journal of Dental Education 2018; 82(12): 1305-1309. DOI:10.21815/JDE.018.141
- 6) American Academy of Pediatric Dentistry. Use of silver diamine fluoride for dental caries management in children and adolescents, including those with special health care needs. [Crystal et al. Pediatric Dentistry 2017;39(5):e135-145.] accessed date 30 Oct 2019.  
[http://www.aapd.org/media/Policies\\_Guidelines/G\\_SDF.pdf](http://www.aapd.org/media/Policies_Guidelines/G_SDF.pdf)
- 7) American Dental Association, Center for Evidence-Based Dentistry. Nonrestorative treatments for carious lesions clinical practice guideline (2018). [Slayton et al. Journal of the American Dental Association 2018;149(10):837-849] accessed date 30 Oct 2019.  
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- 8). Association of State and Territorial Dental Directors. Silver Diamine Fluoride (SDF) Fact Sheet. March 2017. Amended July 2017. accessed date 30 Oct 2019.  
<https://www.astdd.org/www/docs/sdf-fact-sheet-09-07-2017.pdf>
- 9) American Academy of Pediatrics. AAP News. Silver diamine fluoride arrests untreated dental caries but has drawbacks. accessed date 30 Oct 2019.  
<https://www.aappublications.org/news/2016/08/05/SilverDiamine080516>