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Te Whatu Ora

GUIDANCE ON

THE USE OF SILVER DIAMINE FLUORIDE

IN AOTEAROA NEW ZEALAND

May 2025

Guidance on

THE USE OF SILVER DIAMINE FLUORIDE IN AOTEAROA NEW ZEALAND

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Ma te huruhuru te
manu ka rere,
ma te niho ora ka
ora te tangata

With feathers
the bird will fly,
with good oral health,
the person will thrive

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ABOUT THE GUIDANCE DOCUMENT

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PURPOSE

To support Aotearoa New Zealand-registered oral health practitioners' decision-making in the appropriate clinical use of SDF.

THE NEED FOR A GUIDANCE DOCUMENT

In September 2024, SDF was approved by Medsafe as a medicine to manage dental caries and dentine hypersensitivity. To support the safety of patients and practitioners, the oral health sector identified a need for a document to guide practitioners on its use, as a stand-alone information source and to supplement the New Zealand Guidelines for the Use of Fluorides[1].

To ensure oral health practitioners continue to practice competently and safely in accordance with the Dental Council New Zealand's scope of practice competencies, Standards Framework and recertification programme, practitioners must ensure that they are competent in the application and use of a new product. For medicines, this means understanding the pharmacology, indications, contra-indications, dosages, application technique and other factors associated with its use, to determine the appropriateness of the medicine's use, and explain the benefits and risks to the patient as part of obtaining the patient's and/or caregiver's informed consent on the treatment plan.

SCOPE

Silver diamine fluoride (not product-specific) composition; action; efficacy; benefits and disadvantages; safety; clinical application; and informed consent process.

TARGET AUDIENCE

This document is primarily intended for dental and oral health practitioners in Aotearoa New Zealand who can use SDF. It is likely that it will also be used by health service provider organisations and funders, patients, and parents or caregivers.

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DOCUMENT DEVELOPMENT PROCESS

The New Zealand Oral Health Clinical Advisory Network Executive agreed to provide a clinical guidance document on SDF. Subsequently, a guidance group was formed, comprising representatives from a range of oral health practitioner disciplines and key oral health professional groups in Aotearoa New Zealand. Those members and the organisations they represented were:

Ellen Clark, NZ Dental Association

Margaret-Rae Clark, Te Rōpu Niho Ora and Te Ao Mārama Aotearoa Māori Dental Association

Kathy Fuge, Community Oral Health Service

Tina Godbert, Te Rōpu Niho Ora

Heuiwon (Chris) Han, NZ Oral Health Association

Sene Ioane, Pasifika Dental Association

Pauline Koopu, OHCAN

May Mei, University of Otago

Olivia Murdoch, Special Care/Hospital Dental Service

Lester Settle, OHCAN

Bethy Turton, Boston University

Leeann Waaka, Te Ao Mārama Aotearoa Māori Dental Association

Moira Smith, OHCAN Chair

Jane Dunbier, OHCAN secretariat

Working groups were formed to draft clinical guidance in the application of SDF, and to review the literature on the efficacy of SDF and patient/caregiver acceptance, and to develop informed consent information. The informed consent information form was user-tested with over 20 patients/caregivers from a range of population groups and amended based on their feedback. Drafts of the guidance document were circulated to the guidance group members for feedback, as a group and individually as needed, and amended accordingly.

The SDF Guidance Group and OHCAN would like to acknowledge the following people:

Dr Robyn Haisman-Welsh, who reviewed and assisted in collating the working groups' documents, conducted additional literature searches and contributed to the drafting of this document.

Dr Juliet Gray, who provided feedback throughout the drafting process.

Dr Arun Natarajan, **Dr Callum Durward** and **Emeritus Professor Murray Thomson** for providing peer review.

Ngā mihi nui **Tawhiri Gilbert** (Ngāti Raukawa ki te tonga, Ngāti Kahungunu ki te Wairoa) for translating the informed consent document in te reo Māori.

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PREAMBLE

Globally, dental caries is the most prevalent chronic disease, in all age groups;[2] it has considerable consequences for individuals' and families' wellbeing, health and quality of life, and is costly for patients and their family, health systems and society.

New Zealanders' oral health has considerably improved over time, with almost all the population now retaining one or more of their natural teeth.[3] Nevertheless, approximately one in three people have untreated coronal caries,[3, 4] dental caries is one of the leading causes of preventable hospital admissions for our children[5] and a small, but not unsubstantial, proportion of young adults present to hospital emergency departments with infections of dental origin, some of which are life-threatening.[6, 7] Among our care-dependent older people, over half have untreated coronal caries and one in three have untreated root caries.[4]

Of greater concern are the significant and persistent disparities in dental caries experience in Aotearoa New Zealand, with Māori, Pacific peoples, people with disability, people dependent on others for their oral care, and those on fixed and low incomes, or living in rural areas, being disproportionately affected.[3, 4] Such ethnic, socioeconomic and geographic disparities are predominantly a consequence of inequities in the social determinants of oral health, particularly the ability to access affordable oral health care services in a timely manner, if at all. In Aotearoa New Zealand, over half of people over 15y visit an oral health practitioner only when they have a problem, or not at all, citing cost as a key barrier to seeking care.[8]

The long-awaited arrival of SDF in Aotearoa New Zealand presents oral health practitioners with another option to include in a patient's dental caries management plan – to treat and prevent dental caries, relieve pain and discomfort, improve quality of life and/or avoid the need to undergo higher-risk and more challenging means of managing their oral care. More importantly, it has considerable potential to overcome many of the barriers people face when seeking oral health care, thereby improving oral health for all in Aotearoa New Zealand.

Dr Moira Smith BDS PGDipSci DPH PhD
Chair, New Zealand Oral Health Clinical Advisory Network

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THIS DOCUMENT IS ENDORSED BY THE FOLLOWING ORGANISATIONS

TE AO MĀRAMA
Aotearoa Māori Dental Association

'Hei Oranga Niho mō te Iwi Māori', Te Ao Mārama supports initiatives that enhance oral health equity for our people. This guidance document on the use of Silver Diamine Fluoride aligns with our commitment to accessible, evidence-based, and culturally responsive care. Te Ao Mārama Aotearoa Māori Dental Association endorses this kaupapa toward better outcomes for whānau Māori.

PASIFIKA DENTAL ASSOCIATION

The Pasifika Dental Association endorses this guidance document on the use of Silver Diamine Fluoride (SDF). The Pasifika Dental Association recognises the significant role SDF plays in improving oral health outcomes, particularly in our Pasifika communities, where access to dental care can be a challenge.

SPDNZ
SPECIALIST PAEDIATRIC DENTISTS NZ

The Specialist Paediatric Dentists of New Zealand (SPDNZ) is a professional not-for-profit organisation comprising dental specialists committed to advancing the oral health of tamariki and rangatahi in Aotearoa New Zealand. SPDNZ supports the inclusion of as part of an evidence-based, ongoing caries management approach tailored to individual patient needs. SPDNZ is pleased to endorse this document, which provides evidence-based, practical guidance for all oral health practitioners. SPDNZ also encourages oral health practitioners to engage with the growing body of literature on silver diamine fluoride, particularly its role in promoting oral health equity within the local context.

New Zealand Dental Assoc.

New Zealand Oral Health Association
Te Ohu Pūniho Ora o Aotearoa

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EVIDENCE INFORMING THIS DOCUMENT

Sources

This document is informed by evidence (up to November 2024) from international authorities and professional oral health associations' guidance and guidelines, and the academic literature, including systematic reviews and some primary studies, and is based on contemporary international best practice.

Volume and quality

Almost all systematic reviews informing this document have identified a low volume of mostly low-moderate quality evidence, largely owing to methodological limitations. It should be noted that the evidence base on the efficacy of SDF on arresting caries in permanent teeth and preventing new carious lesions in primary and permanent teeth is particularly limited. For root caries prevention and arrest, the evidence base is small, but considered high quality.[14]

Authors of systematic reviews have consistently called for the need for more and/or high-quality randomised controlled trials to provide certainty on the efficacy of SDF for teeth and surfaces of any type. For example, authors of a 2024 Cochrane Review on the efficacy of SDF concluded that *"Although we found 29[f] studies [RCTs; 12,020 children and 1,016 older adults[g]], most evidence was from individual (or few) studies, which were very small"* and *"All studies included high risks of bias, and some findings were imprecise (e.g. because of small sample sizes)"*.[15]

The WHO Expert Committee on Selection and Use of Essential Medicines, when reviewing the Application for SDF as an essential medicine, determined the overall quality of the evidence (for efficacy and other factors) for the medicine as high.

The efficacy and other outcomes of SDF treatment in children and adults are emerging areas of research (few publications can be found in the literature before 2000[10]), warranting further investigation.

Given the evolving evidence base for SDF efficacy, it is strongly recommended that practitioners consult the contemporary literature to ensure that they remain current and competent in their use of SDF.

For a summary of systematic reviews of clinical comparisons, from 2009-2024, see Appendix 1).

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HISTORY OF SDF USE IN DENTISTRY

Silver diamine fluoride (SDF) was first developed and approved for clinical use as a dental therapeutic agent in Japan during the 1960s.[9, 10]

In 2016, SDF was recognised by the US Food and Drug Administration as a breakthrough therapy for caries arrest in children and adults, indicating its potential to address an unmet medical need (as identified at the time).[11, 12]

In 2021, SDF (38%w/v) was included in WHO's Model List of Essential Medicines[a] 22nd List (2021) and Model List of Essential Medicines for Children 8th List (2021),[13] indicating its potential to meet the priority health needs of a population.

SDF is used in several countries of relevance to Aotearoa New Zealand.[9] For example, in the US, UK and Australia, SDF is approved for use to manage dentine hypersensitivity, and is used 'off-label' (that is, for purposes outside the registered indications) for the treatment of dental caries. In other countries, national licensing is limited to SDF use for root caries and desensitisation. In 2017, Health Canada approved SDF (as a natural health product[b]) as an anti-caries agent for use in patients aged 3+years[c].

In Aotearoa New Zealand, on 3 September 2024, Medsafe approved[d] a SDF product[e] as a medicine for the arrest and prevention of dental caries treatment of dentine hypersensitivity.

[a] Essential medicines are those that satisfy the priority health care needs of a population. They are selected with due regard to disease prevalence and public health relevance, evidence of efficacy and safety and comparative cost-effectiveness. They are intended to be available in functioning health systems at all times, in appropriate dosage forms, of assured quality and at prices individuals and health systems can afford. WHO Model List of Essential Medicines - 22nd list, 2021

[b] Products assessed by Health Canada and found to be safe, effective and of high quality under their recommended conditions of use. https://www.canada.ca/en/health-canada/services/drugs-health-products/natural-non-prescription/applications-submissions/product-licensing/licensed-natural-health-products-database.html

[c] https://health-products.canada.ca/lnhpd-bdpsnh/info?licence=80075746

[d] Provisionally for two years from 3 September 2024. https://gazette.govt.nz/notice/id/2024-go4442

[e] Topamine

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WHAT IS SDF?

- A colourless or blue-tinted liquid alkaline (pH 10-13) solution, containing high concentrations of fluoride and silver with an amine link.
- Commonly used with a fluoride concentration of 38%w/v.
- One drop (25µL) of SDF solution is sufficient to treat up to five teeth with dental caries.[16]

WHAT IS SDF USED FOR IN DENTAL CARE?

- Arresting and preventing dental caries.
  - SDF is a safe and effective, topically-applied, minimally-invasive treatment option (for children and adults) to arrest and prevent dental caries in primary and permanent teeth, and to arrest and prevent root caries in permanent teeth.
  - Arrested caries are those areas of tooth decay that have stopped progressing and are inactive. Arrested caries lesions typically appear darkly stained (dark brown or black), may have a shiny or glossy surface, and feel smooth and hard when probed with a ball-ended instrument. When monitored with a standardised index, these lesions will also be observed to have remained stable in size.

  NOTE: when using SDF, hardness of tooth surfaces on probing is an indication that a lesion is arrested; the black colour of the lesion alone is not an acceptable method to judge lesion arrest.[17]
- Desensitising hypersensitive teeth.
- Reducing tooth hypersensitivity in patients with molar-incisor hypomineralisation (MIH), affected molars, at all levels of severity, and as an adjunct to overall management of the condition.[18-20]
- Other applications of SDF have been reported, such as detecting carious tissue during excavation and managing infected root canals. Some of these 'other' uses involve risk and there is little evidence to inform such uses.

NOTE: In Aotearoa New Zealand, SDF has not been approved by Medsafe for 'Other' uses. As such, this document does not endorse their use or include information on them. Use of SDF for these purposes will be considered by Medsafe as 'off-label' (that is, for purposes outside the registered indications). Practitioners should be aware of their responsibilities to patients when prescribing off-label use of medicines. See Medsafe's website for information on off-label use of medicines https://www.medsafe.govt.nz/profs/RIss/unapp.asp

WHO CAN USE SDF?

Dental and oral health practitioners registered with the Dental Council of New Zealand, within their scope of practice (Appendix 2).

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HOW DOES SDF WORK?

SDF has four main mechanisms of action:

- inhibiting bacterial growth and biofilm formation;
- promoting remineralisation and counteracting demineralisation;
- inactivating proteolytic activity and preventing collagen degradation; and
- occluding dentinal tubules and promoting tertiary dentine formation.

Overall, SDF modifies bacterial actions on, and augments remineralisation of, the hard tooth surfaces.[21]

- **The various components of SDF function as follows:**
  - silver functions as an antimicrobial, as an enzyme inhibitor, and the residual layer of silver (predominantly silver phosphate) inhibits the growth and metabolism of cariogenic bacteria in the dental biofilm.
  - fluoride facilitates the chemical process of oxidising the silver component and promotes the remineralization of tooth structures.
  - silver and fluoride ions penetrate approximately 25 microns into enamel and up to 2.1 mm into dentine[11]
  - ammonia stabilises the solution.

- **SDF's mechanism of action is not firmly understood, and research is ongoing.[20] It is thought that:**
  - the silver and fluoride work synergistically (rather than additive) to prevent dental caries and to arrest it when formed. This is particularly relevant for dentine lesions, which involves a process of collagen matrix degradation; by contrast, enamel lesions are a consequence of net demineralisation.[21, 22]
  - following application, a highly mineralised surface rich in calcium fluoride and silver phosphate forms on carious lesions, arresting the carious process.[19]
  - the high pH (alkaline) environment inhibits bacterial metabolism.
  - the black staining that appears following SDF application is attributable to the formation of the silver compound.[23]

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BENEFITS OF SDF USE IN DENTAL CARE

SDF has multiple benefits, including its efficacy in treatment, ease of application, and in providing wider benefits for individuals, whānau and the health system.

- SDF provides practitioners with another option for managing dental caries in children and adults when:
  - cooperation for restorative care is limited or lacking;
  - high efficacy is required;
  - other restorative dental care is not available; or
  - aesthetics is not a primary concern (for example, non-visible carious premolars and molars).
- SDF is a patient-centred, minimally-invasive, and pain-free dental treatment that can be delivered in a timely manner.
- SDF can be combined with other preventive, therapeutic, and restorative options in providing risk-based, patient-centred comprehensive care.
- For rural and remote populations, locations that have few or no oral health care workforce or have difficulty recruiting and retaining oral health practitioners, and for people who have difficulty physically accessing dental care, SDF enables access to an effective therapeutic agent.
- SDF does not generate aerosols and has a low risk of cross-infection.[10, 24]

CORONAL CARIES ARREST AND PREVENTION – EVIDENCE OF EFFICACY

Overall conclusions from the literature

Efficacy in treating dental caries is a key benefit of SDF.

Most clinical trials investigating SDF efficacy in treating dental caries have been in child populations and predominantly in involved primary teeth.

There is more empirical evidence on caries arrest than prevention.

- As noted above, study authors have consistently raised the insufficiency of evidence for drawing firm conclusions on SDF for caries prevention in primary teeth or for caries prevention and arrest in permanent teeth.[14, 15] Nevertheless, it is considered that the effect of SDF in caries prevention and arrest on coronal surfaces of permanent teeth will be similar to that seen in primary teeth.[17]
- Conclusions of a recent Cochrane Review were more conservative than previous systematic reviews, finding that, when compared to placebo or no treatment, SDF may help in dental caries arrest in the primary dentition (low certainty evidence) and in the permanent dentition (evidence is very uncertain), and may help prevent new caries in the primary dentition or on the coronal surfaces of the permanent dentition (evidence is very uncertain).[15]

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Aligning with current literature, Crystal and Niederman[20] concluded, *"Taken together, the underlying clinical trials and systematic reviews indicate that SDF arrests caries in primary teeth and root caries in elders, and may prevent formation of new caries".*

An overview follows of the current evidence base on SDF efficacy of arrest followed by that of prevention of dentine coronal caries in primary and permanent teeth (as relevant).

Caries arrest

- 38% w/v fluoride SDF solution is more effective in arresting caries in primary teeth than other concentrations (5%, 12% and 30%).[21, 25]
- Systematic reviews have consistently supported SDF's effectiveness for arresting coronal caries in the primary dentition, over typical comparators (NaF varnish, Atraumatic Restorative Treatment and placebo).[14, 26]
- For coronal caries arrest in the primary dentition, the prevented fraction[h] has been found to be 55%-96% (based on one systematic review with two studies), with dental caries arrest rates reported of 65-91% (based on four systematic reviews with six studies).[14]
- The overall percentage of active dentinal caries lesions arrested in preschool children has been found to be as high as 81%[14] [also cited by WHO[26]].
- Of six systematic reviews published since 2022, three concluded SDF to be effective in arresting carious lesions in primary teeth.[28-30]
- Anterior teeth may have higher rates of arrest than posterior teeth.[20]
- The wide range in caries arrest rates in primary teeth reported in the current literature suggests that a proportion of lesions receiving SDF treatment will not become arrested.[15]
- Large lesions, occlusal lesions and those with visible plaque have a lower chance of arrest than small, proximal or clean lesions.[20]

Caries prevention

- For coronal caries prevention in the primary dentition, the prevented fraction was 70-78% (two systematic reviews with two studies) and for first permanent molars, the prevented fraction was 64% (one systematic review with one study).[14]
- Of six systematic reviews published since 2022[i], two concluded SDF to be effective in arresting and preventing caries in primary and/or permanent teeth.[31, 32]

[h] The proportion of a disease outcome or mortality that has been averted or prevented due to the presence of a protective factor.[27]

[i] See also 15 and 29

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Evidence of efficacy of SDF on arresting and/or preventing of coronal caries over other treatments.

There is a lack of consensus in the literature on SDF's superiority in efficacy in arresting and/or preventing caries over other means of doing so.

SDF application may be more effective than other caries management options alone, including sodium fluoride varnish, oral hygiene instruction, motivational interviews and/or placebos, in arresting carious lesions and inhibiting new dentinal lesions.

SDF should be considered a treatment option in a patient's overall caries management plan tthat also includes twice-daily toothbrushing with a fluoride toothpaste, and in which appropriate dietary recommendations and consequent modifications have been made.

An overview of the current evidence on SDF efficacy over other management options in arresting and/or preventing dentine coronal caries in primary and permanent teeth, by source, follows.

- Seifo et al.[14] concluded in their umbrella review *"that SDF outperformed the comparators regardless of the outcome measure"* (all systematic reviews included in the umbrella review focussed mainly on the primary dentition).
- Mungur et al.[32] concluded that SDF provided higher preventive fractions in permanent teeth of children than other topical applications such as sodium fluoride varnish.
- Worthington et al.[15] noted that comparisons of their review with other systematic reviews are not meaningful owing largely to differing sources of evidence and different study methods. While they agreed with professional body recommendations on the likely greater effectiveness of SDF than no treatment in caries, they did not find high-certainty evidence to support the guidance statements of the ADA[12], BSPD Patient Information Leaflet,[33] or the AAPD policy statement[34] that SDF was preferable to fluoride varnish.

International authorities and professional oral health associations have summarised the evidence as follows.

- WHO advised that SDF is significantly more effective than placebo, no treatment, or fluoride vanish.[35]
- University of California San Francisco (UCSF)[16] noted biannual application out-performed all minimally-invasive options, including the atraumatic restorative technique, and is more effective in preventing new carious lesions, except for dental sealants. In addition, most all other management options are more expensive and require monitoring.
- The AAPD[34] advised that SDF is more effective than fluoride varnish for arresting dentinal caries.

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ROOT CARIES ARREST AND PREVENTION – EVIDENCE OF EFFICACY

Root caries arrest

Systematic reviews substantiate SDF's efficacy for arrest and prevention of new root caries lesions.[26]

- Annual SDF application appears to arrest root caries by 90% (at 30-month follow-up).[35]
- The prevented fraction for root caries arrest is between 100% and 725% higher than a placebo treatment.[14]

Root caries prevention

- The prevented fraction for root caries prevention is between 25% and 71% higher than a placebo treatment.[14]
- A systematic review and meta-analysis on the management of root caries in dependent older people found significantly lower in mean new active root caries lesions post-intervention with SDF than in controls, at both 24 months and 30-36 months, highlighting the significant protective impact of SDF on root surfaces in older adults.[36]
- Worthington et al.[15] found moderate-certainty evidence that SDF likely prevents new root caries than placebo or no treatment. For SDF versus fluoride varnish, the authors were unsure about the effect on crown and root surfaces of permanent teeth.

BENEFITS ASSOCIATED WITH CARIES ARREST

- Arrested carious lesions do not cause further pain and infection.
- SDF can be used as soon as a carious lesion is clinically diagnosed.
- SDF treatment can preserve tooth structure and prevent tooth loss.
  - It can enable teeth that are difficult to restore or unable to be restored to have active caries arrested, and be retained in the mouth, rather than being extracted.
- By avoiding tooth extraction, SDF treatment may help to maintain the space in the primary/mixed dentition.
- SDF treatment may avoid restorations or dental extractions in patients who would find this difficult to cope with medically or psychologically.
- SDF treatment can assist in avoiding or delaying dental treatment under general anaesthesia or sedation.
  - By arresting carious lesions and controlling subsequent pain and infection, SDF can help buy time, and avoid or delay the need for dental treatment under sedation or general anaesthesia. This is particularly relevant for young children, reducing the risks of sedation or general anaesthesia, and avoiding the development of fear and anxiety associated with dental treatment.
  - An Australian study found that the use of SDF reduced by 88% the rate of preventable dental hospitalisations among Victorian children referred for dental general anaesthesia in hospital.[37]

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- SDF treatment can improve quality-of-life, through reduced pain and infection from dental caries, and reduced school or work absences.[26, 38]
- SDF is cost-effective and affordable, for both patients and the health system. It is considered an effective and less costly caries management option in populations with a high risk of caries.[28]
  - In Aotearoa NZ, SDF costs $0.64/drop (including GST).[j] One drop can treat up to 5 teeth.
  - Application is time-saving and considerably effective.
  - Cost-effectiveness should also consider:
    - savings in practitioner time in applying SDF.
    - SDF's considerable clinical effectiveness (especially likely when compared to other caries management options).
    - savings made from preventing more complex treatment and patient management procedures, especially general anaesthesia and other forms of sedation.[39-42]
  - An Australian study demonstrated the cost-savings from diverting dental general anaesthesia in children when implementing a SDF protocol.[39]

Reducing dentine hypersensitivity[k]

- Two systematic reviews on the effectiveness of SDF in reducing dentine hypersensitivity found that it was effective in adults; however, both concluded that more well-designed clinical studies are needed.[43, 44]

Controlling sensitivity in molar-incisor hypomineralisation (MIH)

- SDF controls hypersensitivity in teeth affected by MIH, at all levels of severity.[18]
- The AAPD[45] and a systematic review on treatment approaches to MIH[28] cited an RCT[46] that found similar short-term effectiveness of SDF and SMART sealants (see page 31) in arresting enamel caries and reducing hypersensitivity in hypomineralised molars. At three years, the same RCT found that both treatments were effective in reducing hypersensitivity, with SMART demonstrating better protection against dental caries over time.[47]
- SDF is well suited to assist with control of hypersensitivity for
  - patients when performing oral self-care at home and as an adjunct to overall management of the condition.
  - managing behaviour during restoration placement in MIH-affected posterior teeth with hypersensitivity.
  - interim/stabilising use in combination with GIC restorations when stabilising moderate to severe MIH lesions until definitive treatment planning can be made.

[j] At time of publication.

[k] Note: SDF will not stain healthy tooth structure. SDF will not stain mature and non-carious dentine, but will stain white spot lesions, immature and hypomineralised enamel and areas of active caries.

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WHO COULD BENEFIT FROM SDF TREATMENT?

- Patients of all ages, across the life span.
- Patients with high or extreme[I] caries risk, who have active carious lesions in anterior and posterior teeth, including patients with severe early childhood caries and those with xerostomia.
- Patients undergoing radiation therapy for head or neck cancers.
- Patients presenting with cavitated carious lesions who cannot tolerate local anaesthesia or conventional dental restorative treatment owing to their specific condition, special needs or their high risk of systemic infection arising from untreated dental caries. Such patients could include:
  - pre-cooperative children whose behavioural/medical conditions limit invasive treatment;
  - children and those with special care needs for whom there is a need to delay/buy more time for definitive treatment at a later stage as cooperation or health condition allows or with sedation or general anaesthesia, when there is likely to be a delay in providing definitive treatment at a later stage, or avoidance of treatment altogether;
  - people who are medically-compromised, immunocompromised, too frail to be treated conventionally, and those with severe cognitive or physical disabilities, or dental phobias; or
  - when sedation or general anaesthesia is not desirable, considered safe, or available.
- Patients with multiple cavitated carious lesions that may not be able to be treated conventionally in one visit.
- Patients whose dentition must be stabilised before it can be restored over time.
- Patients with difficult-to-treat dental caries owing to challenges in tooth access, isolation, and restorative preparation. Examples include recurrent caries at a crown margin, root caries in a furcation, or the occlusal surface of a partially-erupted third molar.
- People without access to or who have difficulty accessing dental care for any reason, including physical disability, people living in rural and remote locations, or without access to local dental services, and those who frequently miss appointments.
- Patients with dentinal hypersensitivity or MIH.

[I] "Patients with salivary dysfunction, usually secondary to cancer treatment, Sjogren syndrome, polypharmacy, aging, or methamphetamine abuse. For these patients, frequent prevention visits and traditional restorations fail to stop disease progression. Similar disease recurrence occurs in severe early childhood caries."[16]

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TOOTH-LEVEL CRITERIA IN SDF TREATMENT

- For dental caries management, teeth with
  - no clinical signs of pulpal inflammation or reports of unsolicited/spontaneous pain (direct application of SDF on vital pulp causes damage to pulp tissue and necrosis[48]).
  - asymptomatic cavitated carious lesions that are not encroaching on the pulp. If possible, radiographs should be taken to assess depth of caries lesions.
  - cavitated carious lesions on any surface, if they can be accessed to apply SDF (orthodontic separators may be used to help gain access to proximal lesions, if patient cooperation allows).
- For dentinal hypersensitivity management, teeth with
  - non-carious cervical lesions giving sensitivity.
  - MIH (to reduce hypersensitivity).
- SDF can be considered for use in non-restorative or minimally-invasive cavity management, where:
  - there is inadequate tooth tissue remaining for a restorative solution or there are non-restorable dentinal lesions, and symptoms/clinical presentation suggest a vital pulp.
  - there are asymptomatic cavitated dentine carious lesions in primary teeth.
  - lesions that are shaped so that they are smooth and able to be easily cleaned, aiding patient's home hygiene care.
  - there are multiple carious lesions that require extended treatment visits.
  - there are sensitive tooth surfaces, including those with MIH.

IS SDF SAFE?

- SDF is safe when used appropriately (dosage and application criteria) and according to the manufacturer's instructions.
  - A review of harms, toxicity and safety supported the application for SDF's inclusion as a medicine in WHO's List of Essential Medicines for dental caries and recommended it as safe in both child and adult populations.[26]
  - No severe harms or adverse health outcomes or adverse events, such as toxicity or allergic reactions, have been reported following the application of SDF.[14]
  - In published clinical trials with over 4,000 young children globally, exposure to manufacturer's recommended amounts of SDF had not resulted in any reported deaths or systemic adverse effects.[18]
  - Large safety margin calculations and pharmacokinetic modelling of silver deposition in children confirm that SDF application in children is safe, the amount of fluoride applied to carious teeth is well below any known toxic dose, and serum fluoride and silver levels after SDF application are lower than toxic concentration.[49]
  - Repeated applications of SDF are safe. SDF is typically applied twice-yearly, but can be reapplied every 3, 6 or 12 months, depending on patients' individual needs.[12]

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- Age-appropriate dose forms and strengths for administration to infants and children are not required.
  - Application doses are the same across all age groups. Calculations indicate that the amount of SDF applied to carious teeth is well below any known toxic dose.[26]
  - The maximum dose is 260 µL (equates to eight drops) per treatment visit.[11] This dose limit has been developed by the FDA drug panel for the phase III, multicentre, randomised, placebo-controlled superiority trial run by the University of Michigan, New York University, and University of Iowa[m] to assure safety based on the weight of a small 12-month-old child.
  - The relative safety margin of using an entire drop on a 10kg child (aged approximately 12 months old) is 400-fold.[16]

  Note: one drop of SDF can treat up to five teeth.

- Exposure to fluoride through the application of SDF is low.
  - One drop of SDF contains a much lower fluoride content than one drop of sodium fluoride varnish.[50]
  - There appears to be no risk of dental fluorosis from biannual application of SDF in children[26] or in the long-term.[16]
- SDF can be safely applied to carious lesions in teeth that do not have signs or symptoms of pulpal involvement. When applied appropriately, no adverse pulpal response or severe pulpal damage or reactions have been reported.

Safety of SDF + NaF varnish

- If practitioners choose to apply NaF varnish following SDF treatment, they need to be aware that the fluoride doses are additive.
  - The maximum dose of 260 µL (eight drops) SDF contains 11.6 mg fluoride,[11] which is similar to the 11.3 mg dose in a standard 0.5 mg packet of fluoride varnish. Individual product dose limits are based on safety for a 10kg child.
  - It is unlikely that clinicians will encounter a clinical situation that would require even half of the above stated maximum doses of SDF or fluoride varnish in very young children.[11]
  - Combining the full doses is safe for adults and for children over 20 kg.
  - For children who are less than 20kg, combined dose limits can be adjusted according to weight using a total dose of 1.13mg/kg fluoride (for example, four drops of SDF and the smallest (0.25mL) packets for fluoride varnish).[11]

[m] Fontana M. Effectiveness of silver diamine fluoride (SDF) in arresting cavitated caries lesions. ClinicalTrials.gov. xUS National Library of Medicine. 2018. NCT03649659. https://clinicaltrials.gov/ct2/show/NCT03649659.

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WHEN SHOULD SDF NOT BE USED?

Patient-level

- SDF is contraindicated in patients with allergy to silver, fluoride or ammonia. Note the importance of distinguishing between allergy to nickel and other trace metals rather than actual silver allergy, which is rare.[16]
- Relative contraindications include patients with stomatitis, ulceration, significant ulcerative (desquamatous) gingivitis or mucositis. Increased absorption and pain would be expected with contact.[16]
- Patients with high aesthetic requirements.

NOTE: No international guidelines or guidance preclude the use of SDF in pregnant or breastfeeding women.[n] Nevertheless, practitioners should exercise caution when treating them.

Tooth-level

- SDF should not be placed on exposed pulps; direct application causes pulp necrosis.[48]
- SDF is contraindicated in teeth with:
  - clinical signs or symptoms of pulp involvement, including irreversible pulpitis, or dental abscess/fistula;
  - radiographic signs of pulpal involvement, or peri-radicular pathology;
  - infection or pain from the dental pulp; or
  - active lesions that do not arrest following SDF treatment (Note: reapplication is recommended in lesions that do not arrest first time).

NOTE: Refer to the manufacturer's information sheet for product-specific contraindications.

[n] Only when SDF is used with KI; see Appendix 3

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DISADVANTAGES & UNDESIRABLE AESTHETIC OUTCOMES OF SDF TREATMENT

No major adverse effects of clinical/medical relevance of SDF treatment have been reported.

SDF stains the treated and arrested carious lesion black

- The dark staining is a sign of caries arrest and is permanent unless restored.
- This undesirable aesthetic outcome is a widely acknowledged disadvantage of SDF treatment.

Clinical caution: SDF can stain demineralised and/or immature enamel.

To avoid inadvertent staining of teeth, caution should be taken when applying SDF on teeth adjacent to teeth (particularly anterior) that may have non-cavitated (white-spot) lesions, hypomineralised enamel and/or immature enamel (such as in newly erupted teeth, see Figure 1). Patients and/or caregivers should be informed prior to applying SDF that such staining may inadvertently occur, given that such situations may not be clinically detectable.

Figure 1 SDF can stain erupting enamel. SDF was applied to the upper incisors while they were still erupting. The exposed enamel at the time of treatment was immature and porous. A considerable amount of silver penetrated into the enamel and oxidised, with that becoming apparent.

SDF will not stain:

- mature and non-carious dentine.
- mature and sound enamel, unless there is any superficial defect, such as hypomineralisation or carious/demineralised or immature enamel, where the porosities allow silver ions to penetrate.[12, 43, 51]

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SDF acceptibility to patients

- The dark staining may not be acceptable to patients and/or caregivers, and it may present a barrier to treatment acceptance, for example, young children or those with root caries in visible sites.
- School-aged children and parents, and adult patients, have expressed hesitancy about the dark staining, especially in anterior teeth.
- Consideration must be given to the subsequent ethical aspects of SDF treatment; that is, the potential for stigmatisation and peer-victimisation of children, along with negative judgements of parents of children with stained teeth.[38, 52, 53]
- For some patients and/or caregivers, SDF's benefits may outweigh any aesthetic limitations.[52]
- Few international studies (and none in Aotearoa New Zealand) have investigated the acceptance and social impacts of SDF treatment among Indigenous peoples.°
  - In Canada, acceptance of SDF among Indigenous communities was contingent on thorough communication and culturally-sensitive approaches. Study authors emphasised that practitioners take a cautious and informative approach when using SDF among Indigenous communities.[55]
- A review and network meta-analysis[38] found that OHRQoL was not appreciably more affected by SDF treatment for dental caries than other standard care interventions, and concerns over staining of dental decay and oral mucosa by SDF do not seem to affect OHRQoL. The impact of the baseline severity of disease treated by SDF on OHRQoL is currently unknown.
- Overall, Worthington et al.[15] reported *"the impact of SDF staining of teeth was poorly reported and the evidence for adverse effects is very uncertain. Additional well-conducted studies are needed. These should measure the impact of staining and be analysed to take account of clustering issues within participants."*

Addressing aesthetic concerns and improving uptake of SDF treatment

- In addition to aesthetic concerns, acceptance of SDF treatment is also contingent upon patients and/or caregivers trusting professional advice and having access to information. Informing patients about the benefits of SDF treatment – especially its advantages over extractions or higher-risk alternative treatments, such as sedation/general anaesthesia – is key to addressing patient and/or caregivers' concerns and increasing SDF acceptance.[52, 53]
- Patients appear to place high importance on receiving information about SDF's safety, long-term effects, and the level of evidence about SDF effectiveness.[52]
- Acceptability also appears contingent on tooth location. Acceptability is higher for treatment of posterior teeth than anterior teeth or in teeth in less visible areas of the mouth.[52, 53]

° It should be noted that, anecdotally, similar concerns to those about SDF and stigma have been raised by some parents and practitioners in Aotearoa New Zealand about children's teeth treated with stainless steel crowns, particularly among Māori and Pasifika. In an Aotearoa New Zealand study exploring the views of Pacific parents of pre-school children on oral health care.[54]

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- To improve acceptability:
  - Patients and/or caregivers could be offered the option to have SDF applied only to posterior teeth with carious lesions.[53, 56] It is not yet known whether SDF's effect on OHRQoL differ between anterior and posterior applications.[38]
  - Carious anterior teeth could be managed using NaF varnish and/or discing, along with home care preventive oral hygiene measures and dietary improvements.
  - The treated and arrested cavitated lesions can be restored later with tooth-coloured materials, when dental caries is controlled and a patient's circumstances allow.
  - Restoration with a tooth-coloured material may not completely allay patients' aesthetic concerns, but, it can substantially improve aesthetics and (in turn) the acceptability of SDF treatment; in one RCT, the acceptability rate was 56% in the SDF-only group and 79% in the SMART group.[57]
- Caregivers' acceptance of SDF appears to be greater when the child is uncooperative for (or anxious about) restorative treatment and local anaesthesia, and where the alternative is treatment under sedation or general anaesthesia.[52, 53]

Other disadvantages

- SDF can discolour tooth-coloured fillings.
  - Polishing fillings can help remove this stain, but it may stay visible at the restoration margin.
- SDF can irritate gingival and mucosal surfaces, if compliance with application protocols is not sufficient.
  - This typically resolves within 48 hours of application.
- SDF can temporarily stain gingiva, mucosa and skin if it inadvertently touches these surfaces.
  - This typically resolves in 2-14 days.
- A very limited number of reports in the literature note that SDF has a transient metallic/bitter taste.
  - Applying NaF varnish after the SDF can help to reduce this problem.
- SDF is not always successful and may not work fast enough to prevent pulpal damage from dentinal caries.

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INFORMED CONSENT

It is important to obtain the patient's and/or caregiver's informed consent before treating teeth with SDF.

In keeping with the concept of informed consent, all non-surgical and restorative treatment options and their potential side-effects (such as darkened tooth surfaces treated with SDF) should be offered and explained to patients and/or their caregivers, as should potential staining of skin and clothes, and the need for reapplication for disease control. They should be offered the opportunity to ask questions.

It is the practitioner's responsibility to ensure that the discussion and its outcome have been documented in the patient's notes.

If practitioners are not sure that a patient and/or their caregiver understands the information provided, they should not proceed, or they should arrange for someone to provide further support or interpretation.

A patient information sheet and informed consent form, including a version in te reo, are in Appendix 4.

CASE SELECTION, DETERMINING TREATMENT INTENTION

- SDF treatment should be considered part of a comprehensive caries management plan, rather than only as 'one and done' treatment.
- When considering SDF as a treatment option, practitioners should take into account tooth and person-level factors, and the wider social factors that determine dental caries experience and that influence caries management.
- Prior to commencing SDF treatment, patients and/or caregivers should be appropriately informed of the benefits and risks of SDF treatment, and alternative treatment options, and their consent gained and documented.

Given the range of benefits and indications for SDF use, practitioners should consider what it is they are aiming to achieve for the patient when offering it as a treatment option.
That is, is it:

- **Preventive -** to prevent further progression of early or incipient lesions, or to prevent dental caries development on susceptible surfaces.
- **Stabilising -** to slow or stop caries progression if delays in conventional restorative treatment are anticipated. For example, until a child matures enough to tolerate invasive treatments or an individual's health improves.
- **Definitive -** as a final procedure, where no further treatment may be required. For example, as part of a palliative care plan, when the tooth to be treated is in a location that is difficult to restore or close to exfoliation, or where the arrested lesion does not require restoration.

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CLINICAL APPLICATION PROCEDURE FOR SDF

Prior to application, provide the patient with protective glasses, and coverings to reduce the risk of staining clothes if the solution is accidentally spilt. SDF permanently stains clothes and surfaces.

- If possible and clinically appropriate, take radiographs to assess depth of caries lesion(s) and identify any periapical pathology.
- Remove gross debris from cavitation to improve SDF's contact with denatured dentine.
- Excavation of carious dentine prior to SDF application is not necessary. It may be considered for aesthetic purposes; it may reduce the proportion of arrested caries lesions that become black.
- Caution should be taken to avoid staining the lips and skin.
  A protective coating, such as Vaseline or cocoa butter may be carefully applied to the lips and skin around the mouth to prevent SDF staining the soft tissues.
- Isolate treatment areas with cotton rolls or other isolation methods.
- Place a drop of the solution in a dappen dish.
  It is important to immediately replace the cap on the SDF bottle.
- Dry the lesion with gentle flow of compressed air or a cotton pellet.
- SDF is best applied with a microbrush (that is, not a cotton pellet). Careful application with a microbrush should be adequate to prevent intraoral and extraoral soft tissue exposure. Bend the microbrush and dip it into the SDF, and dab it on the side of the dappen dish to remove excess liquid before application.
- Apply SDF directly to the affected tooth surface.
- Wait for up to 3 minutes (ideally) – but for at least 1 minute – to ensure absorption, while keeping the tooth isolated to prevent inadvertent staining or irritation of adjacent oral tissues.
- Remove any excess SDF by lightly blotting with gauze or a cotton pellet, or apply a gentle flow of compressed air until the tooth is dry (to minimise systemic absorption).
  - If only shorter times are achievable (for example, very young or difficult to manage patients), monitor arrest progress carefully at subsequent visits and evaluate for reapplication.
- Caution should be taken to avoid inadvertent staining of teeth when applying SDF on adjacent teeth (particularly anterior) that may have non-cavitated (white-spot) lesions (that is, lesions that are sub-clinical) or hypomineralised enamel and/or newly-erupted teeth with immature enamel. Patients and/or caregivers should be informed prior to applying SDF that such staining may inadvertently occur, given that such situations may not be clinically detectable.

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Interproximal technique

SDF can be applied interproximally to treat lesions on tooth surfaces between teeth or difficult-to-reach to reach areas, as follows.[11]

- Dry the contact point and surrounding tooth surfaces with air and/or cotton pellet and then either
  - using a microbrush, saturate the embrasures (labial, lingual/palatal, occlusal) with SDF.

OR

  - place dry superfloss in the contact area and apply SDF on the labial/lingual and occlusal surfaces. Do not move the floss for at least 1 minute.
- In both methods, ensure that the surrounding soft tissue is protected (for example, by using a gloved finger) from contact from SDF or it travelling along the floss.

Application to pits and fissures in teeth adjacent to teeth being treated

When treating posterior primary teeth, consider applying SDF as a preventive measure to the pits and fissures in the adjacent molar teeth.

Optional application of sodium fluoride varnish

- International guidelines note the option of applying sodium fluoride varnish over the SDF,[11, 18, 59] although there is no evidence that this will improve outcomes.
  - Sodium fluoride varnish helps to keep the SDF in contact with the treated tooth surface for longer, reduces the risk of inadvertent staining on other teeth and masks the bitter taste of the SDF. Do not complete this step if a restoration is to be placed the same day.
- When covering SDF-treated carious lesions with fluoride varnish, the fluoride dose is additive.

Post-application instructions

- Instruct the patient (and caregiver if relevant) to not eat or drink for one hour, if possible.
- SDF should be considered a treatment option in a patient's overall caries management plan, which include twice-daily toothbrushing with a fluoride toothpaste and in which appropriate dietary modifications have been made.
  - Reinforce the requirement for the patient and/or caregiver to maintain good oral hygiene by brushing twice daily with at least 1000ppm F toothpaste and keeping sweet foods and drinks to a minimum, ideally at meal-times where possible. Suggest choosing plain milk and water over other drinks.[p]

Note: Research investigating several SDF solutions for stability after opening suggested that SDF solutions be used within 60 days of opening, having found that fluoride and silver concentrations decreased substantially after that period of time.[59]

[p] https://info.health.nz/keeping-healthy/activity-diet/teeth-gums/tooth-decay

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FOLLOW-UP/RECALL: EVALUATING CARIES ARREST AND THE NEED FOR REAPPLICATION OF SDF

- Ideally, patients should be followed-up within two to four weeks of the first SDF treatment, to evaluate the need for reapplication.
- Reapplication of SDF may be indicated if the treated carious lesion does not appear arrested (dark and hard). Hardness of tooth surfaces on probing is an indication that a lesion is arrested; the black colour of the lesion alone is not an acceptable method to judge lesion arrest.[17]
- For patients of any age, practitioners should use their clinical judgment to determine frequency of application, based on the patient's caries risk, level of oral hygiene and capacity to perform oral self-care, fluoride exposure, needs, and the wider factors influencing their health (social determinants of health).[20]
- Bi-annual reapplication increases the caries arrest rate, in contrast to a single application[18], and is recommended to reach a high preventive effect (80% preventive fraction).[26]
- Additional SDF can be applied at recall appointments as needed, based on the colour and hardness of the lesion or evidence of lesion progression. Reapplication is safe.
- For older adults who are capable of oral self-care, annual application of SDF seems to be effective for arrest and prevention of root caries. Multiple applications may benefit a more dependent and at-risk older population.[20]

Restoration of teeth following SDF treatment

- Caries lesions can be restored with glass ionomer cement (GIC) or resin composite materials immediately after application of SDF (that is, same-day) or at a later appointment to
  - recover form and function of a cavitated tooth.
  - improve cleansability and prevent food impaction.
  - improve aesthetics.
- SDF treatment does not appear to reduce adhesion of glass ionomer restorations. Research suggests that it should be possible to bond resin composite materials to dentine previously treated with SDF. [60, 61]
- Where SDF is placed on the same day as the restoration, studies suggest rinsing the lesion after the application of SDF and before adhesive procedures (GIC or resin adhesive systems) are performed.[62]
- Where resin bonding is to be achieved, it is recommended to separate the etching step from the priming and bonding steps.[63]
- GIC is the preferred restorative material owing to its long-term release of fluoride, which supports remineralisation and reduces the acidogenicity of the biofilm, and its antibacterial action.

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Silver-modified Atraumatic Restorative Technique (SMART)

- SMART is *"a modified application of the atraumatic restorative treatment (ART) philosophy, that allows the flexibility to use SDF – with or without cleaning the margins using rotary or other minimally invasive methods – before placing a restoration".*[11]
- SMART is a relatively new procedure and evidence on it is still emerging. Longer-term studies are required to determine longevity and effectiveness, and to inform best practice.

NOTE: a wide range of suggested techniques and procedures are described in the literature. The evidence on the outcomes of some procedures, such as those with little or no cavity preparation, is limited.

- Typically, SMART is minimally invasive, may not require analgesia or cavity preparation, and may have a shorter treatment duration. It can preserve tooth tissue and is potentially time and cost-saving.
- SMART may be particularly beneficial for anxious and/or paediatric patients, patients with MIH-affected permanent molars, and those at high risk of caries.
- SMART may be beneficial for patients/caregivers with aesthetic concerns

NOTE: Stained tooth structures may show around the margins of the restoration or through restorations , depending on the thickness and opacity of the restorative material. Selectively removing caries and/or preparing clean margins may limit the staining to the internal part of the cavity and reduce darkening at the restoration margin. Consider using opaquers under the restoration material.[11]

- SMART may be as successful as alternative/conventional techniques, such as vital pulp therapies (indirect pulp treatments or mineral trioxide aggregate (MTA) pulpotomies), in managing large carious lesions in primary teeth.[64]
- Current evidence suggests that SMART does not cause harm, and there are no reports of it worsening clinical outcomes. Evidence suggests that SMART outcomes are more favourable than when only ART or only SDF are used.[65]
- Light-curing will darken the SDF treated area and (in turn) the restoration.

SMART may be completed in (i) a single visit or (ii) in two stages, with GIC (typically) placement at an appointment subsequent to SDF treatment.

Same-day SMART may be beneficial for patients who

- may have difficulty returning for a second appointment; or
- require sedation for dental treatment.

Two-stage SMART benefits

- Waiting 2-4 weeks to restore the SDF-treated tooth will allow time for further hardening of the dentine and for any free silver to dissipate, reducing staining or discolouring of both GIC and composite resin restorations.

For further information and suggested procedures see, for example, Aldosari et al.,[57] Young et al.[11] and Hegde et al.[66]

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Guidance on the Use of Silver Diamine Fluoride in Aotearoa New Zealand

APPENDICES

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APPENDIX 1

Summary of clinical comparisons: systematic reviews

Clinical scenario	Comparison	Findings	References
Prevention of new lesions in primary teeth	SDF vs Fluoride Varnish	SDF prevents the progression of incipient lesions, but there is yet to be sufficient evidence for the prevention of new lesions, especially in primary molars.	Inchingolo et al., 2024 Muntean et al. 2024
Prevention of new lesions in pit and fissures on permanent teeth	SDF vs Sealants	Some evidence of SDF's preventive benefit in preventing cavitated lesions in first permanent molars. Sealants remain the gold standard with more predictable preventive outcomes.	Ruff et al., 2023 Liu et al., 2014 Braga et al., 2009
Prevention of new lesions on root surfaces among older adults	SDF vs High fluoride (5000ppm Toothpaste), Chlorhexidine, or Fluoride Varnish	Annually applied 38% SDF solution combined with oral health education is most likely to be the most effective in preventing dental root caries. SDF has a preventive effect better than a placebo and is as effective as Chlorhexidine mouth rinse or Fluoride Varnish	Zhang et al. 2020 Oliveira et al., 2018
Root surfaces sensitivity	SDF vs Potassium Nitrate	SDF is more effective than Potassium Nitrate for reduction in root hypersensitivity Evidence to support SDF for treatment of hypersensitive dentine on root surfaces.	Chan et al., 2023 Hendre et al., 2017 Chan et al., 2024
Arrest of cavitated carious lesions on primary teeth	SDF vs Fluoride Varnish	With appropriate protocols, both SDF and Fluoride Varnish can arrest caries lesions in primary teeth. However, SDF is more effective than Fluoride Varnish at arresting cavitated carious lesions in primary teeth. The arrest of carious lesions in the primary dentition with SDF or Fluoride Varnish of preschool children is lower than arrest rates seen in older children.	Seifo et al., 2019 Almawh et al., 2021 Mabangkhru et al., 2020 Duangthip et al., 2018
	SDF vs Atraumatic Restorative Technique Restorations	Both techniques will arrest the progression of carious lesions with comparable effectiveness. Both techniques are equally acceptable to patients and families. Atraumatic restorative technique restorations take much longer to place and are less cost-effective.	Abdellatif et al. 2021

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Summary of clinical comparisons; systematic reviews *Continued*

Clinical scenario	Comparison	Findings	References
Arrest of cavitated carious lesions on root surfaces	SDF vs Fluoride Varnish SDF vs High fluoride toothpaste	Annual applications of 38% SDF is the most effective treatment for root caries in older adults.	Castelo et al., 2021 Kumar et. al., 2018
Arrest of coronal caries lesions in permanent dentition	SDF vs conventional restorative treatment	While SDF would likely to successfully and predictably arrest coronal caries lesions in permanent dentition, insufficient clinical evidence has been generated to compare SDF treatments with others regarding arresting caries progression. SDF treatments can also not be compared to conventional restorative techniques, which not only address the caries progression but also restore teeth to function. Silver Modified Atraumatic Restorative Techniques (SMART) have some favourable early reports for the treatment of coronal carious lesions in permanent teeth.	Seifo et al., 2019 Mungur et al., 2023 Ahmed et al., 2022 Mohammed et al., 2022

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APPENDIX 2

Dental Council
Te Kaunihera Tiaki Niho

Dental Council position on the regulatory requirements on application of Silver diamine fluoride

3 March 2025

The topical application of Silver diamine fluoride (SDF) to teeth can be an effective treatment for dental caries, prevention of dental caries and dentinal hypersensitivity.

The Dental Council considers:

1. The *management of any disorder or condition/disease of the oral cavity and associated facial structures* that involves surgical or operative procedures below the gingival margin or the surface of the skin, mucous membranes or teeth is a restricted activity, that can only be performed by a registered oral health practitioner.

2. The topical application of SDF to manage a carious lesion is considered management of a disease and is a restricted activity, that can only be performed by an appropriately registered oral health practitioner.

3. The topical application of SDF by unregistered persons is not permitted.

The following table details the regulatory requirements:

Management of dental caries using Silver diamine fluoride		
Role	**Application of SDF**	**Medicine legal requirements**
Oral health therapist Patient <18 years	Can apply as per scope of practice	Not applicable – exempted under Schedule 1 of Medicines Regulations
Patient >18 years • Adult restorative care exclusion on scope of practice	Can apply under instruction of a: • Dentist/dental specialist • Oral health therapist adult restorative exclusion on their scope of practice • Dental therapist registered with adult care	
Patient >18 years • No Adult restorative care exclusion on scope of practice	Can apply as per scope of practice	

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Dental therapist Patient <18 years	Can apply as per scope of practice	
Patient >18 years • No Adult care scope of practice	Can apply under instruction of a: • Dentist/dental specialist • Oral health therapist adult restorative exclusion on their scope of practice • Dental therapist registered with adult care	
Patient >18 years • Adult care scope of practice	Can apply as per scope of practice	
Dental hygienist	Not permitted	Not applicable

Prevention of dental caries using Silver diamine fluoride		
Role	**Application of SDF**	**Medicine legal requirements**
Oral health therapist	Can apply as per scope of practice	Not applicable – exempted under Schedule 1 of Medicines Regulations
Dental therapist Patient <18 years	Can apply as per scope of practice	
Patient >18 years • No Adult care scope of practice	Can apply under instruction of a: • Dentist/dental specialist • Oral health therapist adult restorative exclusion on their scope of practice • Dental therapist registered with adult care	
Patient >18 years • Adult care scope of practice	Can apply as per scope of practice	
Dental hygienist	Can apply as per scope of practice	

Dentinal hypersensitivity		
Role	**Application of SDF**	**Medicine legal requirements**
Registered oral health practitioner	Can apply as per scope of practice	Not applicable – exempted under Schedule 1 of Medicines Regulations

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APPENDIX 3 SDF APPLICATION FOLLOWED BY POTASSIUM IODIDE

Internationally, products that include a second step of applying potassium iodide (KI) following SDF application are available and used.

The purpose of the KI step is to partially mitigate the black staining from the application of SDF and (in turn) alleviate patients' concerns about aesthetics and improve their acceptance of SDF treatment.

At the time of the publication of this guidance document, products that include KI were not approved for use in Aotearoa New Zealand. Nevertheless, given that the use of KI will likely come to the attention of practitioners, this appendix on its use and efficacy when used with SDF is provided for practitioners' information. Most international authorities and professional oral health associations' guidance and guidelines, and some systematic reviews listed in References provide further information on SDF + KI.

How does KI work?

- It acts by preventing the formation of silver oxide.
- It reduces the black staining by reacting with excess silver ions and precipitating yellow silver iodide, an effect influenced by the amount of KI applied.
- The effect is temporary, possibly owing to the high photosensitivity of the silver iodide produced. Even when KI is used, if the carious lesion is left exposed to light, there is staining.

Effectiveness in reducing staining

- The UCSF protocol states *"In our clinical experience, a saturated solution of KI helps but does not dramatically effect stain; arrested lesions normally darken. Most stain remains at the dentin-enamel or cementum-enamel junction"*[16]. This conclusion is consistent with those of more recent systematic reviews on the effect of the combined use of SDF and KI on tooth staining and discolouration.[67, 68]
- At the time of writing, the evidence on the efficacy of SDF + KI to reduce staining is inconclusive, it *"failing to show meaningful and statistical advantage... in the management of SDF-associated tooth staining"*.[68]
- The authors of the two reviews cited in the previous points noted the limited available evidence on SDF + KI, the methodological limitations of the studies, and the need for more well-designed studies to obtain a more robust evidence base.

Effectiveness of SDF and SDF + KI in disrupting the plaque biofilm microbiome

- Limited evidence on the anti-cariogenic activity of SDF + KI indicates no significant difference in activity between SDF alone and SDF + KI.[67]

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Affect of KI on arrest rates

- The use of KI has been associated with lower arrest rates among children, reducing the efficacy of SDF treatments.[69]

Safety of SDF + KI

In addition to the person-level contraindications for SDF (page 23), international recommendations advise that KI is contraindicated in the following patients:[16, 59]

- Women who are pregnant or during the first six months of breastfeeding.[q]
- Patients undergoing thyroid gland therapy.
- Patients on thyroid medication.
- Patients with a known allergy to potassium or iodine.

[q] Owing to concerns of overloading the developing thyroid with iodine. It is recommended that women of childbearing age have a pre-treatment pregnancy test.[16, 59]

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APPENDIX 4 INFORMED CONSENT FORM

INFORMED CONSENT FOR SILVER DIAMINE FLUORIDE (SDF) TREATMENT

You or a member of your whānau are being offered a treatment to stop an area of tooth decay (cavity) getting worse or to treat a sensitive tooth.

Please ask any questions if you need more information.

What is Silver Diamine Fluoride (SDF)?

SDF is a liquid that is applied to stop tooth decay and sensitivity. The silver ingredient works to kill or slow the bacteria that causes tooth decay, and the fluoride strengthens the part of the tooth that is decayed. Ammonia is added to stabilise the solution. SDF also works by blocking up the part of the tooth that causes it to be sensitive to hot and cold food and drink.

SDF has been safely used in multiple countries for many years.

SDF will not repair or replace a broken tooth to its original shape or the way it originally looked. You or your whānau may still require other dental treatments, including fillings, crowns or root canal treatment, to save the tooth.

Benefits of SDF treatment

- Treatment is simple and painless. No injections (numbing) or drilling is required.
- It can be very effective in stopping tooth decay.
- The treated tooth should not cause any further pain or infection.
- Many teeth can be treated in a single visit.
- It can help buy time for people who are very young, fearful, or who may need to be sedated or have a general anaesthetic for traditional dental treatment.

How is it applied?

Treatment is simple and painless. No injections (numbing) or drilling is required. After treatment, the tooth should not cause any further pain or infection.

To help stop any SDF getting on other parts of the mouth, the teeth are isolated with cotton rolls. Vaseline or cocoa butter may also be put on your lips. Any food debris that may be stuck in the cavity is gently removed, the tooth is dried, and a very small drop of SDF is put onto the part of the tooth with the decay for 1-3 minutes. Any excess SDF is then soaked up with a small cotton wool ball. Sometimes SDF can be applied to the fissures (grooves) of teeth next to those being treated to help stop a cavity developing. If possible, do not eat or drink for one hour after the treatment.

We may see you again in about 4 weeks' time to check if the SDF treatment has worked. At your next regular appointment, we will also check to see if you need SDF applied again. If you are having SDF treatment to stop decay, studies show that, for most people, applying SDF twice a year gives better results than applying it once a year.

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Although SDF treatment has a high success rate, sometimes it doesn't work. If your first treatment is not successful, you may need another SDF treatment, or a filling or crown, root canal treatment, or extraction.

To help protect your teeth from further decay, we recommend brushing teeth twice a day with fluoride toothpaste, especially last thing at night, with no food or drink afterwards, and limit the number of times you or your child have sweet foods and drinks, especially between meals. Plain water and milk are best for teeth.

You should not be treated with SDF if:

- You are allergic to or have sensitivities to silver or other metals, ammonia and/or fluoride.
- There are painful sores or raw areas on your gums or anywhere else in your mouth.
- You have any other skin sensitivities.

Please tell us if you have any of the above.

What are the disadvantages?

- Areas of decay treated with SDF will stain black permanently (see photos at the end of this information sheet). The staining indicates the SDF is working.
  - You can choose to have it applied to the back teeth only.

The stained cavity may be able to be covered with tooth-coloured filling material. No injections (numbing) or drilling is required for this. This may not completely block out the staining, but it will improve the way the tooth looks. This can be done at the time the tooth is treated with SDF (ideally) or at a later appointment.

- SDF may discolour existing tooth-coloured fillings.
- If SDF is accidentally applied to the skin or gums during treatment, a brown stain may appear. This is not harmful. It cannot be washed off, but it usually goes away in 1-3 weeks.
- Some people get a metallic taste in their mouth after treatment. This should go away quickly.

Alternatives to SDF may include (but are not limited to)

- No treatment. The tooth will most likely continue to decay, and/or any pain may get worse.
- Application of fluoride varnish, a filling or crown, root canal treatment, extraction and/or referral for treatment under sedation or general anaesthesia.

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CONSENT FORM

CONSENT

I, _____ have read this form and understand the treatment.

- The treatment, including the risks and benefits, have been explained to me to a level I am happy with.
- I was given the opportunity to ask questions and have these answered.
- I understand that there is no guarantee that this treatment will be successful.

Please select one of the following:

☐ I give consent to treatment with SDF for myself or the person under my care on back teeth only.

☐ I give consent to treatment with SDF for myself or the person under my care on any tooth affected by decay, including both front and back teeth. I acknowledge that black areas will be visible, and I have been shown pictures of what to expect.

Patient or guardian

Name: _____ Signature: _____

Dental Practitioner

Name: _____ Signature: _____

Date: _____

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Tooth decay in baby teeth before and after treatment with SDF

Before SDF treatment

After SDF treatment

[Reproduced with the permission of Dr Tammy Duangthip, Non-restorative Approaches for Managing Cavitated Dentin Carious Lesions. January 2019, DOI:10.1007/978-3-319-93426-6_10. In book: *Pediatric Restorative Dentistry* (pp.141-160).]

Tooth decay in adult teeth after treatment with SDF

Before SDF treatment

After SDF treatment

[Reproduced with the permission of Dr Brooke Fukuoka.]

This informed consent for patients was developed by the NZ Oral Health Clinical Advisory Network's SDF Guidance Group. It was user-tested with patients and/or caregivers from a range of population groups and amended based on their feedback.

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APPENDIX 4 INFORMED CONSENT FORM

PEPA WHAKAAE MŌ TE RONGOĀ SILVER DIAMINE FLUORIDE (SDF)

E tonoa ana ko koe, ko tētehi atu rānei o tō whānau ki tētehi rongoā e tū ai te pīrau o tētehi niho (tunga niho), o tētehi niho rahirahi rānei.

Tēnā, pātai mai me e whai ana koe he māramatanga kē atu

He aha te Silver Diamine Fluoride (SDF)?

Ko te SDF he wē ka tāngia kia aukati ai te tunga niho me te rahirahitanga o te niho. Ko tā te mea hiriwā he whakamutu, he whakapōturi rānei i ngā moroiti nāna te tunga niho, ā, ko tā te pūkōwhai he whakakaha ake i te wahanga kua ngaua te tunga niho. Ka tāpirihia te haukini kia whakawhena ai i te wē. Ko tētehi anō mahi a te SDF, he purua te wahanga o te niho e rahirahi ai i ngā kai me ngā inu, mātao mai, wera mai hoki.

Kua whakamahia whānuitia te SDF e ngā tini whenua mō ngā tau maha.

E kore te SDF e whakatika, e whakahoungia rānei te niho kua whati. Me whai tonu pea koutou te whānau ētehi atu anō rongoā niho, pēnei i ngā whakakī kōhao niho, ngā pane niho me ngā rongoā awa pū e tiaki ai te niho.

Ngā hua o te rongoā SDF

- He māmā, he mamae kore. Kāore e wero, e kōwiri rānei.
- He kaha nōna ki te whakamutu tunga niho.
- Kāore e rongo te mamae, kāore hoki e poke i te niho kua tāngia.
- E taea ana te huhua o ngā niho te whakatika i te wā kotahi.
- Ka whai kainga rua te rangatahi, te mataku me te tangata ka mate ki te whakamoe i a ia, rānei te wero i a ia ki te rehu whānui mō ngā rongoā niho ukiuki.

Ka pēwhea e tā?

He māmā, he mamae kore te rongoā. Kāore e wero, e kōwiri rānei. Whai muri, ko tōna tikanga ka kore te niho e whakamamae, e whakapokea rānei.

Kia ārai te toenga waha i te SDF, ka uhia ngā niho ki ngā pōkaimiro, ā, he wā ōna ka horapa ngā ngutu ki te Vaseline, ki te monoku kōkō rānei. Ka whakawātea ngāwari nei te kōhao niho i ngā maramara kai, ka whakamaroketia te niho, kātahi ka uhia te wahanga tunga o te niho ki te SDF mō te 1-3 miniti. Ka whakamaroketia te toenga SDF ki te pōro miro-wūru. I ōna wā ka āhei te SDF te tā ki ngā piere niho pātata ki ngā niho e tā ana kia aukati te hua mai o te tunga niho. Me e taea, kaua e kai, kaua hoki e inu kia pau te kotahi haora a muri i te rongoā.

Ka kite anō pea i a koe hei te 4 wiki kia āta tirotiro mēnā rā kua whai hua te rongoā SDF. Hei tō uiuinga nahanaha mātou āta tirotiro ai mēnā ka tāngia anō ki te SDF. Mehemea e tāngia ana ki te SDF hei aukati i te tunga niho, e mea ana ngā rangahau, mō te nuinga, ko te painga atu kia tāngia kia rua kē ngā wā ia tau, tēnā i te kotahi noa ia tau.

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Ahakoa te pāpātanga angitū nui nei o te SDF, he wā ōna kāore e whai hua. Ki te kore tō tātanga tuatahi e whai hua, akenepea me tōai te tātanga, me whai rānei he whakakī kōhao niho, he pane niho, he rongoā awa pū, he huhuti niho rānei.

Kia ārai ō niho kia kaua e tunga rawatia, e tūtohu ana mātou kia wakuwaku i ōu niho kia rua ngā wā ia rā mā te pēniho pūkōwhai, inarā hei mea kapi i ngā mahi o te pō, ā, me waiho atu te kai me te inu, ka mutu, me iti hoki tā kōrua ko tāu tamaiti kai, inu anō hoki i ngā mea wainene, inarā whai muri, tōmua hoki i te kai. Pai kē atu te wai Māori me te miraka mō ngā niho.

Me kaua koe e tāngia ki te SDF mēnā:

- E pāwera ana koe ki te hiriwa, ki ngā metera, ki te haukini, ki te pūkōwhai rānei.
- He mamae harehare, he pahore kei ngā pūniho, ki ngā wahanga o te waha rānei.
- He pāwera kiri kē atu ōu

Tēnā, whakamōhio mai ki te hāngai ngā mea ō runga ki a koe

He aha ngā taumahatanga?

- Ka tawau rawatia ngā tunga niho kua tāngia e te SDF (tirohia ngā whakaahua kei te kapinga o tēnei pepa whakamārama)
- E āhei ana koe kia tāngia ngā niho ō muri anake. Ka āhei pea te niho tawau te horapa ki tētahi pani whakakikī he niho te tae. Kāore he wero (whakamoe), he kōwiri rānei kia pēnei. Kāore pea e mahea katoatia te tawau, engari ka whakapai ake te āhua o te niho. E taea ana kia pēnei i te wā kotahi e tāngia ana te niho ki te SDF, rānei i tētahi uiui a muri ake.
- Ka tawau pea te SDF i ngā niho kua whakakī kē
- Ki te maringi atu te SDF ki te kiri, ki ngā tako rānei, ka hua mai he tawau parauri nei. Ehara tēnei i te rihariha. Kāore e taea te horoi, engari ka mahea atu hei te 1-3 wiki.
- Ka rongo ētahi tāngata i te mētara whai muri i te tātanga. Tōna tikanga ka tere mahea atu tēnei āhuatanga.

Ko ngā ara kē atu i te SDF ko (Kāore e here ana ki ēnei anake)

- Rongoā kore. Māna te kore e pīrau haere tonu te niho, ka mutu, ka kaha ake te mamae.
- Ka āpiti ki te wānihi pūkōwhai, te whakakī kōhao niho, te pane niho, te rongoā awa pū niho rānei. Ka hutihuti te niho, rānei ka tono atu ki tētahi momo rongoā e wero ai koe ki te wero whakamoe, te wero rehu whānui rānei.

Ngā mihi nui Tawhiri Gilbert (Ngāti Raukawa ki te tonga, Ngāti Kahungunu ki te Wairoa) for translating this document in te reo Māori.

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PEPA WHAKAAE

PEPA WHAKAAE

Kua pānui ahau, a _____ i tēnei puka, ā, e mārama ana ahau ki ngā āhuatanga o tēnei rongoā.

- Kua whakamārama mai ki ahau te rongoā, tae rā anō ki ngā tūraru me ngā hua ki tētahi māramatanga e pai ana ki ahau.
- I whai wā ahau ki te tuku pātai, ā, kua whakautu ēnei.
- E mārama ana ahau kāore e toka te angitu o tēnei rongoā

Tēnā, kōwhiringia tētahi o ēnei::

☐ E whakaae ana ahau kia tāngia ahau anō, rānei te tangata e tiaki nei ahau ki te rongoā SDF **mō ngā niho ō muri anake**.

☐ E whakaae ana ahau kia tāngia ahau anō, rānei te tangata e tiaki nei ahau ki te rongoā SDF **mō ngā niho katoa kua pīrau, ngā mea ō muri me ngā mea ō mua**. E mārama ana ahau ka poapoa ētahi wahanga o tōku waha, ā, kua whakaaturia mai ngā whakaahua e mārama ai ahau ki tēnei āhuatanga.

Tūroro / Kaitiaki

Ingoa: _____ Waitohu: _____

Rata niho

Ingoa: _____ Waitohu: _____

Date: _____

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Te tunga niho o te tamaiti i mua atu, a muri ake hoki i te tānga SDF

[He mean tārua nā runga anō i te whakaae a Tākuta Tammy Duangthip]

I mua atu i te SDF

A muri ake i te SDF

Te tunga niho o te pakeke a muri ake i te tānga SDF

[He mean tārua nā runga anō i te whakaae a Tākuta Brooke Fukuoka]

I mua atu i te SDF

A muri ake i te SDF

This informed consent for patients was developed by the NZ Oral Health Clinical Advisory Network's SDF Guidance Group. It was user-tested with patients and/or caregivers from a range of population groups and amended based on their feedback.

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APPENDIX 5 GUIDANCE SUMMARY

CLINICAL GUIDANCE ON THE USE OF 38% SILVER DIAMINE FLUORIDE

In Aotearoa NZ, silver diamine fluoride (SDF) has been approved as a medicine for the arrest and prevention of dental caries, and treatment of dentine hypersensitivity for use by a registered oral health practitioner, within their scope of practice (see the Dental Council NZ's position statement within this summary).

This document provides summary guidance on the appropriate clinical use of SDF. For more information, practitioners are recommended to consult the *Guidance on the Use of Silver Diamine Fluoride in Aotearoa New Zealand* (available on all major oral health professional organisations' websites), on which this summary is based.

What is SDF?

Silver diamine fluoride (SDF) is a colourless or blue-tinted alkaline (pH 10-13) liquid solution that can be applied topically to a tooth surface.

SDF solution contains silver (as an antimicrobial and enzyme inhibitor), fluoride (to oxidise the silver and promote remineralization of tooth structures) and ammonia (to stabilise the solution). The silver and fluoride components work synergistically to form a highly mineralised surface rich in silver (predominantly silver phosphate), inhibiting the growth and metabolism of cariogenic bacteria in the dental biofilm, and (in turn) arresting the caries process.

SDF treatment is a safe and effective minimal-intervention option for children and adults to:

- arrest or slow the progression of, and potentially prevent, carious coronal lesions in primary and permanent teeth;
- arrest and prevent root caries in permanent teeth;
- desensitise hypersensitive teeth; and
- reduce hypersensitivity in patients with molar-incisor hypomineralisation (MIH).

SDF treatment can prevent further breakdown of a tooth and reduce pain, possibly improving future restorative options and reducing the need for extractions.

SDF is an additional tool for dental caries management that can be included as part of a patient's overall dental caries management plan – one that includes a caries risk assessment and other preventive measures, such as oral hygiene information and dietary advice. Tooth-coloured restorations (glass ionomer or composite) can also be placed over areas treated with SDF, either on the same day as SDF treatment or at a subsequent appointment.

Regular review is recommended, and follow-up treatment or re-application may be required. Two applications increase the chance of arrest over one application.

SDF solution is easy, fast and painless to apply. Whereas cavitated carious lesions have traditionally been treated by removing carious dentine and replacing the lost tooth structure with a restorative material, SDF treatment (typically) does not require removal of carious tooth tissue.

38% w/v fluoride SDF solution is most commonly used and the most effective in arresting carious lesions. It is possibly more effective in arresting carious lesions than other dental caries management options, including NaF varnish.

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Who would benefit from SDF treatment?

SDF treatment can benefit patients of all ages and stages.

For patients of any age, practitioners should consider the factors that determine the development/progression of dental caries and influence caries management, including the patient's caries risk, level of oral hygiene, and capacity to perform oral self-care, their diet, fluoride exposure and needs, and the wider social factors influencing their health.

INDICATIONS FOR USE	
Patient-level	**Examples**
Inability to tolerate local analgesia or conventional dental treatment or when comprehensive treatment is prohibited.	Anxious or fearful patients. People who are medically unwell, or who have cognitive or physical disability. Children whose behaviour limits invasive treatment.
Limited or no access to dental care	People living in rural and remote locations. Lack of dental services in the area. People who have physical, transport or financial challenges. People who frequently miss appointments.
High/extreme caries risk	People with early childhood caries, xerostomia, polypharmacy, cognitive or physical disability, salivary dysfunction, Sjogren's syndrome, head and neck cancer receiving radiation therapy, or low or no fluoride exposure.
Need to 'buy time' or delay definitive treatment and/or to relieve pain.	People with special care needs; who are medically unwell; have physical, transport or financial challenges accessing services, need general anaesthesia/sedation for restorative treatment; completing treatment over time; unable to complete treatment in one visit.
Dentine hypersensitivity or MIH-affected posterior teeth with hypersensitivity.	
Tooth-level	**Examples**
Established caries with no signs or symptoms of pulpal involvement	
Asymptomatic cavitated carious lesions that are not encroaching on the pulp	
Cavitated carious lesions on any surface, if they can be accessed	
Carious lesions in difficult-to-treat areas of the tooth or mouth	Furcations, crown margins, subgingival lesions, occlusal surface of a partially-erupted third molar
Inadequate tooth tissue for restoration	
Cavitated tooth surfaces that can be easily cleaned by the patient at home	

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In what situations can I consider using SDF?

Consider what it is you are aiming to achieve for the patient; in other words, determine treatment intent.

Preventive	Stabilising	Definitive
To prevent further progression of early or incipient carious lesions, or prevent dental caries development on susceptible surfaces.	To slow or stop caries progression if delays in conventional restorative treatment are anticipated. Short-term temporary therapy in moderate/severe MIH-affected posterior teeth with breakdown and/or caries, with or without hypersensitivity.	As a final procedure, where no further treatment may be required.
Examples		
Arresting early enamel caries. Preventing root caries in adults.	**For caries** Delaying conventional restorative treatments until a child matures. Child on hospital waiting list Patients receiving radiation therapy for head and neck cancer. **For MIH** Use in combination with GIC as part of a 'triage' plan until a definitive long-term plan made. Behaviour challenges and caries present, use on own to manage hypersensitivity and delay caries progression until placement of a long-term temporary restoration possible	Tooth due to exfoliate. Part of palliative care plan. When the carious lesion is in a location in the mouth or tooth that is difficult to access or restore.
Follow-up		
Initial follow-up in 2-4 weeks; a second application will increase the chance of arrest. For root caries prevention, apply annually.	Initial follow-up in 2-4 weeks; a second will increase the chance of arrest. Progress conventional treatment as planned. Apply SDF at recall appointments as needed.	For arrest of coronal carious lesions, reapply as needed based on the clinical assessment of lesion progression. It is recommended to apply every 6 months for the first 2 years. For root caries arrest, apply annually.

- **Indication of arrest:** lesions are darkly stained (dark brown or black), may have a shiny or glossy surface, and feel smooth and hard when probed with a ball-ended instrument, and remain stable in size. Note: the black discolouration alone is not an acceptable criterion by which to judge lesion arrest.
- For **all patients and/or caregivers**, reinforce twice daily toothbrushing with a fluoride toothpaste (at least 1000ppm), interdental cleaning, keep sweet foods and drinks to a minimum, ideally at mealtimes where possible, and suggest choosing plain milk and water over other drinks.

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What are the disadvantages of SDF treatment?

Dark staining of the carious areas of SDF-treated teeth is the main disadvantage. Consequently, SDF treatment may not be suitable or acceptable to patients and/or caregivers in every situation, especially for the anterior teeth.

SDF will not stain intact, mature enamel and dentine.

SDF can stain non-cavitated (white-spot) lesions, hypomineralised enamel and/or newly-erupted teeth with immature enamel.

SDF can stain and/or irritate oral soft tissues, effects that usually resolve within a few days. It will also stain clothing and other surfaces.

Some patients may find SDF to have a bitter taste.

How can I reduce the dark staining or improve treatment acceptability?

Place a tooth-coloured restoration over area(s) treated with SDF.

Offer to treat only posterior teeth or non-visible areas with SDF or use alternative management approaches.

Acceptability is improved if patients and/or caregivers are fully informed about the efficacy and benefits of SDF, especially relative to extractions or high-risk alternative treatment, such as sedation/general anesthesia.

Informed consent

It is important to obtain the patient's and/or caregiver's informed consent before treating teeth with SDF.

In keeping with the concept of informed consent, all non-surgical and restorative treatment options and their potential side-effects (such as darkened tooth surfaces) should be offered and explained to patients and/or their caregivers, as should potential staining of skin and clothes, and the need for reapplication for disease control, and that they have been offered the opportunity to ask questions.

It is the practitioner's responsibility to ensure that the discussion and the outcome of the discussion have been documented in the patient's notes. If practitioners are not sure that a patient and/or their caregiver understands the information provided, they should arrange for someone to provide further support or interpretation, or not proceed.

A patient information sheet and informed consent form, including a version in te reo, are provided with this summary.

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When should SDF not be used?

Patient-level	Tooth-level
Allergy to any component of the SDF solution (silver, fluoride or ammonia).	Exposed pulps.
Symptoms or radiographic/clinical signs of pulpal involvement.	Clinical and/or radiographic signs and/or symptoms of pulpal involvement.
Ulceration, ulcerative gingivitis, stomatitis and mucositis (relative contraindication).	Infection or pain from the pulp.
Aesthetic demands or requirements	Note: although not contraindicated for use in the following clinical situations, SDF will stain non-cavitated (white-spot) lesions, hypomineralised enamel and/or newly-erupted teeth with immature enamel. Clinicians should exercise care when applying SDF, in order to avoid inadvertent staining of adjacent teeth.
No informed consent.	
Exercise caution when treating patients who are pregnant or breastfeeding.	

Is SDF safe?

No major adverse effects of clinical/medical relevance from SDF use have been reported.

The relative safety margin of using an entire drop on a 10kg child (aged approximately 1 year old) is 400-fold. Reapplication is safe.

Age-appropriate dose forms and strengths for administration to infants and children are not required.

Maximum dose is 260µL (equates to eight drops) per treatment visit, based on the weight of a small 12-month-old child.

Clinical application procedure for SDF

Prior to application, provide the patient with protective glasses, along with coverings to reduce the risk of staining clothes, if the solution is accidentally spilt. SDF permanently stains clothes and surfaces.

- If possible and clinically appropriate, take radiographs to assess depth of lesion(s) and any periapical pathology.
- Remove gross debris from cavitation to improve SDF's contact with denatured dentine.
- Excavation of carious dentine prior to SDF application is not necessary. It may be considered for aesthetic purposes; it may reduce the proportion of an arrested lesion that becomes black.
- Caution should be taken to avoid staining the lips and skin. A protective coating, such as Vaseline or cocoa butter may be carefully applied to the lips and skin around the mouth to prevent SDF staining the soft tissues.

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- Isolate areas to be treated with cotton rolls or other isolation methods.
- Place a drop of the solution in a dappen dish.
  IT IS IMPORTANT TO IMMEDIATELY REPLACE THE CAP ON THE SDF BOTTLE
- Dry lesion with gentle flow of compressed air or a cotton wool pellet.
- SDF is best applied with a microbrush (NOT a cotton wool pellet). Careful application with a microbrush should be adequate to prevent intraoral and extraoral soft tissue exposure. Bend the microbrush and dip it into the SDF, and dab on the side of the dappen dish to remove excess liquid before application.
- Apply SDF directly to the affected tooth surface.
- Wait for up to 3 minutes (ideally) – but for at least 1 minute – to ensure absorption, while keeping the tooth isolated to prevent inadvertent staining or irritation of adjacent oral tissues.
- Remove any excess SDF by lightly blotting with gauze or a cotton pellet, or apply a gentle flow of compressed air until the tooth is dry (to minimise systemic absorption).
- If only shorter times are achievable (for example, very young or difficult-to-manage patients), monitor arrest progress carefully at subsequent visits and evaluate for reapplication.
- Caution should be taken to avoid inadvertent staining of teeth when applying SDF on teeth adjacent to teeth (particularly anterior) that may have non-cavitated (white-spot) lesions (that is, lesions that are sub-clinical), hypomineralised enamel and/or newly-erupted teeth with immature enamel. Patients and/or caregivers should be informed prior to applying SDF that such staining may inadvertently occur given such situations may not be clinically detectable.

Interproximal technique

SDF can be applied interproximally to treat lesions on interproximal surfaces or difficult-to-reach areas, as follows.

- Dry the contact point and surrounding tooth surfaces with air and/or cotton pellet and then either:
  - using a microbrush, saturate the embrasures (labial, lingual/palatal, occlusal) with SDF.

OR

  - place dry superfloss in the contact area and apply SDF on the labial/lingual and occlusal surfaces. Do not move the floss for at least 1 minute.
- In both methods, ensure that the surrounding soft tissue is protected (for example, by using a gloved finger) from contact from SDF or from SDF travelling along the floss.

Application to pits and fissures in teeth adjacent to teeth being treated

When treating posterior primary teeth, consider applying SDF, as a preventive measure, to the pits and fissures in the adjacent molar teeth.

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Optional application of sodium fluoride varnish

- International guidelines note the option of applying sodium fluoride varnish over the SDF,[1-3] although there is no evidence that this will improve outcomes.
  - Sodium fluoride varnish helps to keep the SDF in contact with the treated tooth surface for longer, reduces the risk of inadvertent staining on other teeth and masks the bitter taste of the SDF. Do not complete this step if a restoration is to be placed the same day.
- When covering SDF-treated lesions with fluoride varnish, the fluoride dose is additive.

Post-application instructions

- Instruct the patient (and caregiver, if relevant) to not eat or drink for one hour, if possible.
- SDF should be considered a treatment option in a patient's overall caries management plan, which includes twice-daily toothbrushing with a fluoride toothpaste and in which appropriate dietary modifications have been made.
  - Reinforce the requirement for the patient and/or caregiver to maintain good oral hygiene by brushing twice daily with at least 1000ppmF toothpaste and keeping sweet foods and drinks to a minimum, ideally at meal-times where possible. Suggest choosing plain milk and water over other drinks.

Note: Research investigating several SDF solutions for stability after opening suggested that SDF solutions be used within 60 days of opening, having found that fluoride and silver concentrations decreased substantially after that time.[4]

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Additional resources and guidance on SDF treatment

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GUIDANCE ON

THE USE OF SILVER DIAMINE FLUORIDE

IN AOTEAROA NEW ZEALAND

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