Stony Coral Tissue Loss Disease

Antibiotics Treatment Fact Sheet

MPA connect

A partnership between:

GCFI Gulf and Caribbean Fisheries Institute

NOAA Coral Reef Conservation Program

Stony coral tissue loss disease (SCTLD) is spreading in the Caribbean region.
Are you wondering what the best course of action is to treat the disease?

This fact sheet is intended to help coral reef managers evaluate best practices for treatment of SCTLD

Why address this new coral disease?

SCTLD has a devastating effect on the slowest-growing and longest-lived reef-building corals, including the iconic pillar, star and brain corals. It causes tissue sloughing and multiple, rapidly spreading lesions in 34+ species of hard corals (J. Lang 2021, personal communication, April 29). It causes 66%-100% mortality of affected corals which die rapidly within weeks to months (Precht et al., 2016), leading to loss of coral density and diversity (Walton et al., 2018).

What can we do to treat the disease?

Since SCTLD first affected corals in Florida in 2014, a number of treatments have been tried to halt or slow its progression:

- Physical barriers eg. trenches or smothering;
- Natural remedies eg. medicinal plants, organic compounds;
- Chlorine;
- Antibiotics

Which treatment is most effective?

The only effective field treatment known to date is the topical application of antibiotics to lesions on the corals. Field treatment success with amoxicillin mixed in Base2B averaged 91% across all species (Neely et al., 2020). Multiple tests in lab and field, ongoing coral monitoring in the field and peer-reviewed publications indicate that antibiotics are the only known effective treatment for SCTLD that is currently available for field application.

What about chlorine treatments?

Chlorine treatments have been tested in studies in lab and field and determined to be largely ineffective. Chlorinated epoxy applied directly to lesions had varying impact, depending on the species being treated - success rates after 3 months ranged from 32% in mountainous star coral and 27% in great star coral to <5% success for boulder brain coral, symmetrical brain coral and grooved brain coral (Neely, 2020a). By June 2020 Florida agencies agreed to halt chlorinated epoxy treatments due to ineffectiveness.

And other approaches?

The use of firebreaks or trenches together with application of antibiotics provides a moderate increase in effectiveness but substantially increases time required to apply treatments (Walker & Pitts, 2019). Various natural remedies were tested in Mexico in 2019 and achieved 0% treatment success. None of the non-antibiotic products or placebos so far tested in the region have halted the disease. Probiotic treatments are in the research and development phase but are not yet ready for field use.

What is the current best practice for treating SCTLD?

Powdered amoxicillin (98% purity) is mixed 1:8 by weight into an ointment called Base2B and applied directly onto the edge of the diseased lesion. Training materials, including videos, available from MPAConnect explain the preparation and application process in depth see www.gcfi.org/emerging-issues-florida-coral-disease-outbreak. Treated corals are re-visited after one month and at two-monthly intervals to monitor success and to re-treat lesions as needed. In Florida approximately 1/3 of corals needed no follow-up treatments, 1/3 of all corals needed an additional treatment at 1-2 months and the other 1/3 required regular treatments every two months. For practical guidance on treating corals please see GCFI's SCTLD video series.

FAQ Antibiotics Treatment

How much antibiotic is used to treat diseased corals?

Approximately 1.6 grams of amoxicillin is used per coral, depending on the size of the coral and the number of lesions, and re-treatments typically require less product than the initial treatment (K. Neely, pers. comm. 2020).

What are the concerns about using antibiotics on coral reefs?

The release of antibiotics into the environment sometimes raises concerns about potential for the development of antibiotic resistance, impacts on the coral microbiome (bioaccumulation in the tissues of non-target organisms and the removal of beneficial bacteria from the system), impacts on the growth and reproduction of treated corals and surrounding organisms and transfer through the food chain (Kovalakova et al., 2020; Elizalde-Velázquez et al., 2016; Kümmerer, 2009). Some people are allergic to beta-lactams, the class of antibiotics to which amoxicillin belongs, and should not handle them.

Weighing up specific concerns against knowledge gained so far.

Existing information and anecdotal evidence shed light on these concerns:

- **Is there an increase in antibiotic-resistant genes in the coral ecosystem?** A pilot study showed a resistant gene in 2 of 24 post-treatment samples (D. Griffin, pers. comm.). A larger sample size with temporal component would allow for further assessment of this concern.

- **Does amoxicillin bio-accumulate in healthy coral tissue or untreated tissue?** Amoxicillin is known to degrade quickly in the environment - when mixed with Base2B it degrades 1.5% every day (Favero et al., 2019), more quickly when exposed to light and water (Kovalakova et al., 2020). This reduces bio-accumulation. Evidence against bio-accumulation also comes from the fact that the effectiveness of the antibiotic treatment is localized to the application site and new lesions still occur on treated corals and others nearby (Neely et al., 2020).

- **Does amoxicillin remove beneficial bacteria?** Within an animal, antibiotics can remove beneficial bacteria as well as pathogens, however, this has never been tested in corals.

- **Does amoxicillin impact surrounding organisms?** The antibiotic treatment for SCTLD is not broadcast onto the reef nor is it dosed in the water. It is applied directly onto the lesions which minimizes its introduction into the marine environment. By embedding amoxicillin into Base2B we further target its delivery using the most effective known topical applicant. Base2B is specifically designed to create a polymer network of micro-pores that maximizes transmission of the amoxicillin into the coral membrane and minimizes transmission to the water column. Observations a year after treatment with amoxicillin showed no notable die-offs, diseases, or other visible changes in surrounding organisms (Neely, Walker and Voss: unpublished data).

- **Does amoxicillin enter the food chain eg. via reef fish ingesting SCTLD treatment?** Antibiotics can transfer through food chains and this could also be true of reef ecosystems, however, corals polyps are not a major component of the food web in a reef ecosystem. A Caribbean study is planned to assess the impact of SCTLD treatment on selected reef fish. Some countries are meanwhile choosing to focus their treatment of SCTLD on corals in marine protected areas where no-take regulations reduce the risk of human consumption of fish that might ingest SCTLD treatment.

- **How do amounts of amoxicillin used in treatment of SCTLD compare with background levels of antibiotics in the marine environment?** Antibiotics have widespread human and animal applications and are released into the marine environment through sewage and livestock waste, as well as from their use in aquaculture. These sources represent persistent releases of antibiotics into the environment, whereas the treatment of SCTLD involves discrete, single or periodic application of antibiotics. The concentration of antibiotics released into the environment from treatment of SCTLD at an outbreak site might theoretically be calculated considering factors such as the number of corals treated, the amount of antibiotic applied, the number of re-treatments, the flow of water to move and degrade the antibiotic, the area covered by reef and the depth of the water column. Calculations by the authors indicate that conservative estimates of antibiotic concentrations associated with SCTLD are comparable or inferior to background levels found in waters near developed areas, and greatly inferior to levels of antibiotics released through aquaculture.

- Several expert partners in the region have expressed willingness to research specific concerns about the use of antibiotics. In the meantime, managers and researchers with firsthand experience of SCTLD suggest pragmatism in evaluating the best course of action – given such high coral mortality rates associated with SCTLD (in excess of 90% for many species), they consider that concerns about whether corals will develop resistance or have a healthy microbiome to fight off the next disease are less worrisome than whether corals will survive the current disease if left untreated.

FAQ Antibiotics Treatment

Have other countries approved the use of antibiotics for treatment of SCTLD?

Yes, in the USA the Food and Drug Administration approved the experimental use of amoxicillin on threatened pillar coral and other species that are susceptible to SCTLD. Several Caribbean countries and territories have granted permits for treatment of SCTLD by Fisheries Officers and trusted and trained local partners, and for treatment in MPAs where other risks can be reduced.

What is the advice of other managers whose reefs are affected by SCTLD?

Coral reef managers from Florida who have been dealing with SCTLD for several years advise their Caribbean counterparts to act quickly and aggressively upon detecting SCTLD; they recommend that other managers learn from their experiences and rapidly implement the most effective known approaches, or else they face the certainty of significant losses in coral cover and species richness (Walton et al, 2018).

Should we run our own SCTLD treatment trials?

We encourage coral reef monitoring to detect SCTLD, to track its progression, to measure the effectiveness of treatments and to address particular concerns of local managers. However, managers and permitting agencies do not need to re-rest treatment methods that have already been proven unsuccessful elsewhere in the region. Given the reality of scarce resources available for coral reef conservation, managers should prioritize the application of treatments that have proven most effective. There is now a large body of work on the emerging issue of SCTLD that provides evidence about the efficacy of treatments for SCTLD on Caribbean coral reefs.

Do we need to treat every coral?

Recognizing resource limitations, locally agreed-upon selection criteria should guide the **prioritization of corals for treatment**. For example, corals that contribute substantially to ecosystem services and reproductive capacity could be prioritized for monitoring and treatment (ie. large, old, spawning corals close to others of the same species). Corals with a large amount of remaining tissue and a small number of active lesions are considered more treatable. Also take into account the regulatory framework (eg. protected status), proximity to supporting infrastructure (eg. dive partners) and the iconic status of particular corals or reef sites for communications purposes.

How much does SCTLD treatment with amoxicillin cost?

Base2B costs US$50 per 400g jar (*oceanalchemists@gmail.com*) and amoxicillin costs US$122 per 100g (*https://phytotechlab.com/amoxicillin*). This is about US$5.50 per treated coral, although we note that amoxicillin can sometimes be sourced via government agriculture/veterinary departments at much reduced rates and Ocean Alchemists have kindly provided free samples of Base2B to Caribbean agencies upon request.

What might be the next developments?

Whole colony treatments with antibiotic feed, probiotics and phage therapy are being explored to treat SCTLD and, although much-anticipated, are still in the experimental phase.

On balance what is the recommended approach?

Although new treatments are being developed, SCTLD is progressing further in the Caribbean region and, left untreated, causing high mortality of stony corals. The most successful option we currently have to treat SCTLD is topical application of amoxicillin mixed with Base2B. Given the devastating impact of SCTLD on critically important Caribbean coral reefs for fisheries, tourism economies and shoreline protection, and knowing the success of amoxicillin and Base2B in treating SCTLD, the benefits of using amoxicillin can be considered to outweigh the risks of the small additional concentration of antibiotics that would be introduced into the marine environment through its use.

What else should I take into account?

Disease prevention, stakeholder engagement, partnerships and coordination, clear communications, links with coral restoration and potential for coral rescue are important parts of action planning for response to SCTLD.

For more information

Please see the many outreach materials, reports, journal publications, webinars and videos about SCTLD at:

https://www.gcfi.org/emerging-issues-florida-coral-disease-outbreak/

and *https://www.agrra.org/coral-disease-outbreak/*

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