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Background:

- Marine toxins are concentrated in contaminated seafood worldwide.
- Marine intoxications can cause neurological, gastrointestinal, and cardiovascular syndromes, potentially leading to high mortality and lasting morbidity.
- With increasing seafood consumption, globalization, and climate change, there is increased risk of exposure to these toxins.
- We aim to synthesize existing evidence around diagnosis, treatment, and prevention of marine intoxications into a clinical resource.

Methods:

• Four electronic databases were searched: PubMed (NCBI), Medline (OVID), and BioSIS (Web of Science) from database inception to August 2019

- using combinations of the search terms 'marine' and 'intoxication'
- Iterative inclusion and exclusion of search terms was employed to maximize article extraction
- The search was refined to humans only
- We included observational studies, case reports, case series, and cohort studies, as well as clinical trials and therapeutics tolerability and efficacy
- Abstracts and full-text articles will be systematically double screened by two reviewers and subsequently by a tertiary arbitrator
- The GRADE approach will be employed to assess quality of studies reporting therapeutic interventions
- Evidence will be summarized using descriptive measures for each intervention type
- Data will be grouped and summarized for ease of clinician use by marine toxin, intoxication syndrome, prevention and therapeutic strategies, and according to geographic location and implicated seafood species.
- Meta-analysis will be planned if sufficient efficacy measures exist

Results: collated from analysis of 109 abstracts selected for full text review up until November 12, 2019



Table 1: Summarized Data of Marine Intoxications from Analyzed Abstracts

Type of Intoxication or Syndrome	Type of Toxin Isolated	Seafood Type/Species Ingested	Causative Agent	Countries/Regions Reporting	Treatments
Paralytic	Saxitoxin Endotoxin	Mussels Shellfish Softshell Clams Bivalve Mollusc Finfish Oysters Perna viridis Ostea iridescens Anadara similis Anadara tuberculosa Modiolus sp. Plicopurpura columellans Gastropds Atlantic Mackeral Scomber scombrus Purple clam (Hiatula diphus)	Gonyaulux tamarensis Dinoflagellates Diatomes Vibrio Norwalk virus Alexandrium catenella/tamarensis Plankton Pyridium bahamense Allgal bloom Prorocentum micans Gymnopdium catenatum	Canada USA Italy Japan Mexico Trinidad El Salvador Taiwan	Symptomatic Exposure Resistance
Neurotoxic	Tetrodotoxin Palytoxin Clupeotoxic	Puffer fish Lagocephalus scleratus (Takifugu oblongus) Crab (Demania reynaudi) Moray fish		Turkey Bangladesh Japan Phillipines	
	Botulism (Type E)	Salted Fish Faseikh Salmo trutta(trout) Fermented seal, arctic fish Whale White fish Kapchunka	Clostridium botulism	Egypt Arab Gulf Canada	Antitoxin polyvalent Supportive
	Brevetoxin		Red Tide Gymnodinium breve		
Diarrhetic	Gempylotoxin Enterotoxin	Oysters Escolar Shrimp Bivalve mollusk Seaweed	Aeromonas hydrophilia Wax estars Vibrio cholerae Dinophysis forti Dinophysis acuminate Enteric viruses Hepatitis A Vibrio alginolyticus Vibrio parahaemolyticus Vibrio Cholerae Vibrio vulnifus	USA Bangladesh Portugal Adriatic Sea Sardinia	
Amnestic		Molluscs Scallops Mussels Oysters Clams	Domoic Acid Diatom Nitzchia pungens	Belgium Canada Angola	
Ciguatera	Ciguatoxin	Tropical Fish Barracuda Grouper Amberjack Snapper Shark Coral Reef fish Turtle Sardine Epipephelus foscogutatus	Dinoflagellate Agmbierdiscus toxicus	France Caribbean USA Mexico Puerto Rico South Pacific Islands Madagascar	IV mannitol
Scromboid		Herring Tuna Mahi Mahi	Biogenic Amine Histamine	Russia USA (imported from Vietnam)	Temperature control Anti- histamines
Allergic		Anisakis simplex		Spain	
Hepatotoxic		Sea hare Aplysia kurodai	aplysianin	Japan	IV fluids IV glyzirrhizin
Cytotoxic		Seafood	cyanobacteria	Brazil Australia	
Myotoxic		Buffalo Fish	Haff/rhabdomyolysis	USA	
Heavy Metal	Mercury	Shark Osteichthyes Tuna Bivalve (Marcia optima) Fish (Mullet, Tarli, Surmai, Dohtar) Blackshrimp Sushi/Sashimi Sportfish Crustacea Swordfish		Canary Islands Pelagic Ethiopia Finland Baltic Sea Thailand Colombia Pakistan Brazil USA Turkish Sea Iraq	
	Arsenic	Fish (Cirrhinus reba)		Pakistan Korea Belgium	
Cardiotoxic		Fish	Polychlorinated biphenyls	Sweden	

Number of Articles Remaining After Removal of Duplicates	Total n = 9205	LILACS n = 627	
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Figure 1: Workflow highlighting breakdown of abstracts by database



Figure 2: Geographical Distribution of Reported Marine Intoxications

Discussion and Conclusion:

 Increased transoceanic movement of people and seafood has facilitated distribution of contaminated seafood to non-endemic regions where clinicians lack familiarity with intoxication syndromes and appropriate treatment. Paralytic shellfish poisoning, ciguatera toxicity, and mercury poisoning are common causes of ingested marine intoxication; usually implicated by contaminated shellfish, large predatory reef fish, and tuna respectively. By synthesizing the evidence, we hope to inform the development of appropriate management and risk mitigation protocols.

Figure 3: Breakdown of top reported intoxications



1. Sobel, J. & Painter, J. Illnesses Caused by Marine Toxins. *Clin. Infect. Dis.* **41**, 1290–1296 (2005). 2. Vilariño, N. et al. Human Poisoning from Marine Toxins: Unknowns for Optimal Consumer Protection. Toxins (Basel). 10, 324 (2018). 3. Friedman, M. A. et al. An Updated Review of Ciguatera Fish Poisoning: Clinical, Epidemiological, Environmental, and Public Health Management. Mar. Drugs 15, 72 (2017).