

Introduction

- There are an estimated 1.2-1.5 million recreational scuba divers
- Cardiac device implantations are increasing steadily, especially implantable defibrillator use in younger patients
- There are important potential risks for diving with an implanted device:
 - Device Malfunction (can compression occurs in >50% at <60 feet)
 - Cardiac complications
 - Unknown effects from pressure changes such as arrhythmia precipitation
- There are no major guidelines addressing this important topic

Study Objectives

To identify the key demographics, cardiac history, device characteristics, symptoms, diving practices, physician advice, and complications of the cohort who continue recreational diving.

Methods

- Inclusion Criteria
1. Age ≥18 years
 2. Certified diver
 3. Active diver
 4. Implanted cardiac pacemaker or defibrillator
- Investigator-developed survey was made available over a 3-month period.
 - Volunteers were invited through online media
 - Survey was administered electronically
 - Follow-up by telephone was made for clarification and to verify all post-diving complications.

DAN
Recommendations

Each diver or dive student must be evaluated individually. The two most important factors to take into account are:

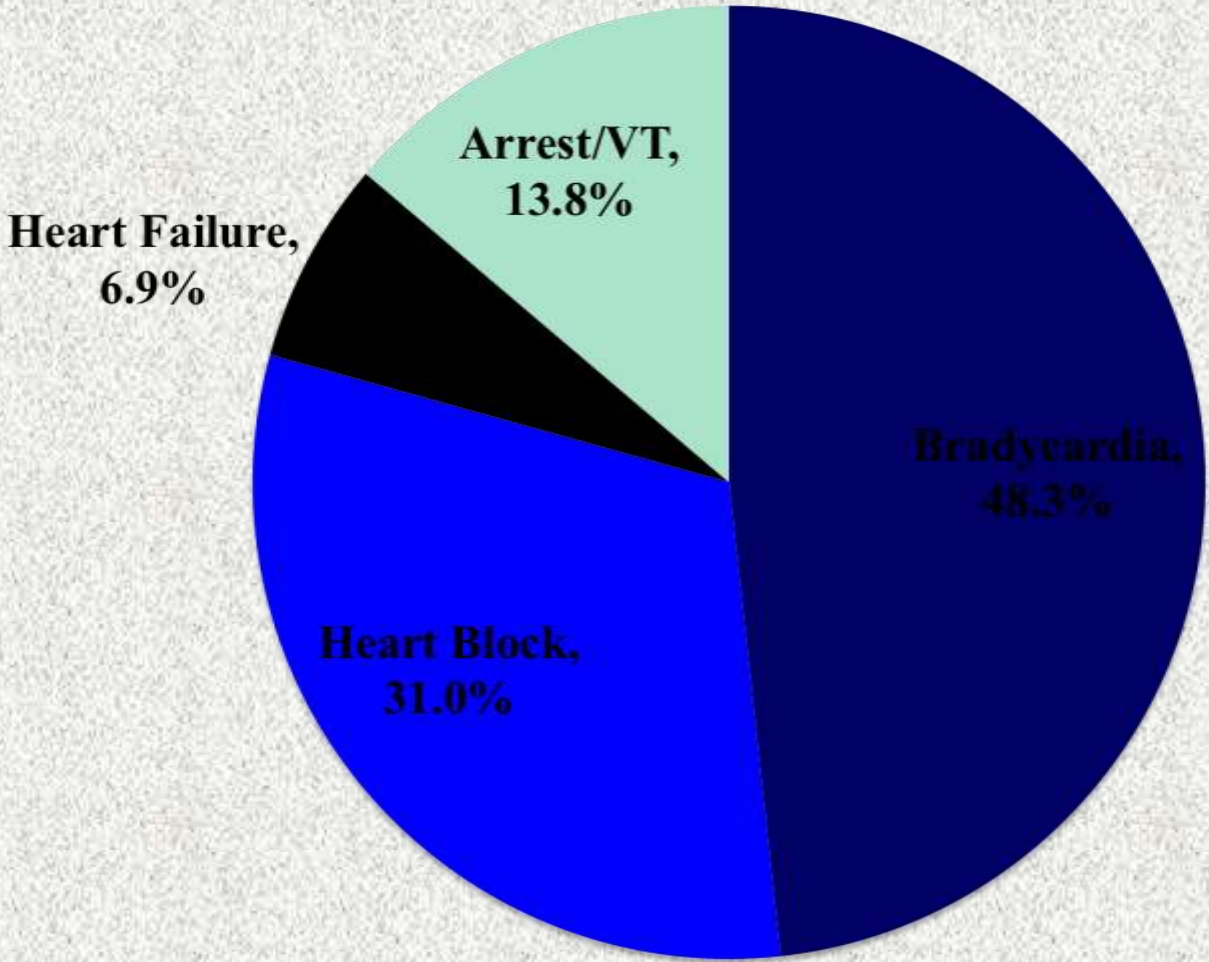
1. Why is the individual dependent on a pacemaker? and
2. Is the individual's pacemaker rated to perform at depths (i.e., pressures) compatible with recreational diving, including an added margin of safety?
3. Defibrillator is generally considered exclusion
 - Defibrillator is usually set to allow a short period of unconsciousness before activation
 - "...limited testing is reported to 40fsw. This is not considered to be an adequate testing depth for recreational diving".

Results

Demographics & Cardiac History

Characteristic	Respondents (n=29)
Age (median (25 th , 75 th percentile)	62 (56, 69)
Male gender	27 (93.1%)
Cardiac comorbidity (listed below)	17 (58.6%)
History of myocardial infarction	2 (6.9%)
History of coronary revascularization	3 (10.3%)
Congestive heart failure	2 (6.9%)
Atrial fibrillation	10 (34.5%)
Ventricular tachycardia	4 (13.8%)
Prior cardiac arrest	3 (10.3%)
Beta-Blocker	11 (37.9%)
Anti-arrhythmic	3 (10.3%)
Blood thinner	20 (69.0%)

Device Indications



44.4% report pacemaker dependence.

Weekly Cardiac Symptoms

- Chest pain – 3.7%
- Dyspnea – 25.9%
- Palpitations – 14.8%
- Presyncope – 40.7%

Note: None occurred during diving.

Diving History

Characteristic	Median (25 th , 75 th)
Years diving	26 (18, 34)
Lifetime dives	560 (195, 1163)
Dives since device	80 (15, 200)
Max dives per day	3 (2, 4)
Max depth	100 (85, 110)

The range of max depth was 20-180 feet.

Risky Diving Practices

Characteristic	Percentage
Decompression diving	27.6%
Solo diving	62.1%
Overhead environments	27.6%
Distance from hospital	
Up to 12 hours	75.0%
More than 12 hours	55.0%

Majority (69%) didn't change intensity of diving post-device.

Manufacturer Recommendations

Medtronic – Exposure to pressures >2.5 ATA (50 fsw) may affect device function (33% of devices)

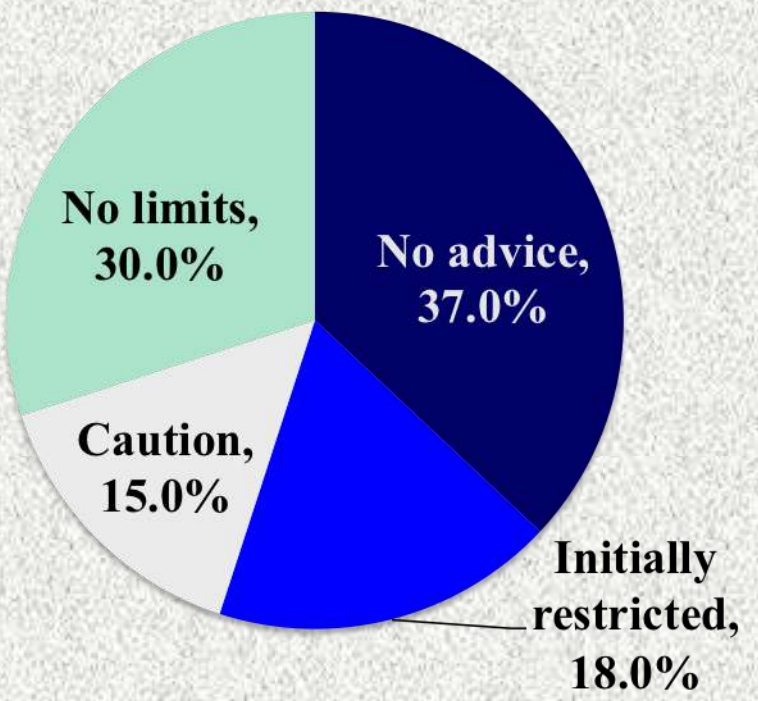
St. Jude – Avoid exposure >7 ATA (198 fsw) (33% of devices)

Boston Scientific – Some models tested to 5ATA (130 fsw) (33% of devices)

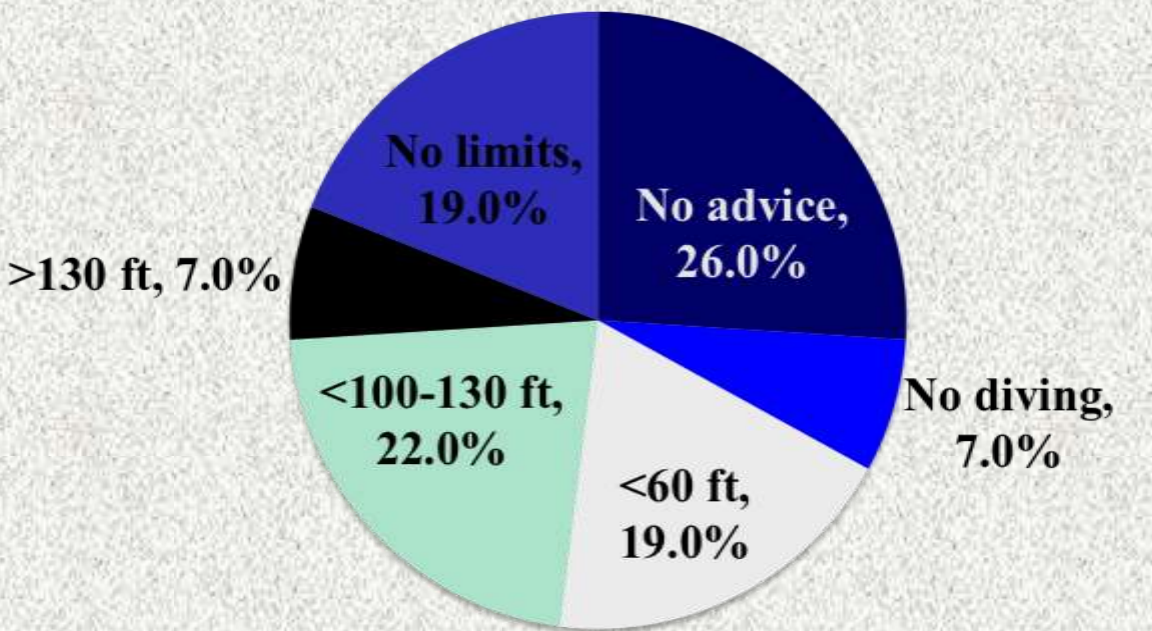
48.1% operated outside of manufacturer recommendations.

Advice Given

Physical Activity



Diving Activity



Complications

- 1 patients each with shortness of breath, weakness, and device site discomfort occasionally after diving
- MI (within 30 days of diving) – 1 patient
- ED visit for heart issue (immediately post-diving) – 2 patients
- DCI (immediately post-diving) – 1 patient
- No symptoms while underwater

Conclusions

Subjects who dive with implantable cardiac devices:

- Self-selected group
- Have substantial cardiac histories & rates of self-reported pacemaker dependence
- Frequently possess ongoing cardiac symptoms
- Pursue aggressive diving practices with maximal depth often below manufacturer recommendations
- Receive heterogeneous or no physician advice
- Have a risk for ongoing cardiac complications, though there is no evidence these are linked to diving

Future Directions

Further research

- Registry of divers with devices and long-term follow-up
- Research of effects of devices on complication rates
- Review ICD memory for recorded events while diving

Guidelines

- Standardization of physician advice
- Communication of manufacturer recommendations