Relationship of Extreme Cold Weather and Implantable Cardioverter Defibrillator Shocks

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Cold weather to 0°C has been implicated as a risk factor for ventricular arrhythmias and implantable cardioverter defibrillator (ICD) shocks. The effect of more extreme cold weather on the risk of ventricular arrhythmias and ICD shocks is unknown. We sought to describe the relationship between extreme cold weather and the risk of ICD shocks. We retrospectively identified patients seen at the Pacemaker and Defibrillator Clinic at St. Boniface Hospital in Winnipeg, Manitoba, Canada between 2010 and 2015 with an ICD shock. We excluded multiple shocks occurring on the same day in a single patient. We collected weather data, and evaluated the relationship between ICD shocks and weather on the same day as the shock using Negative Binomial regression. Three hundred and sixty patients experienced a total of 1,355 shocks. When excluding multiple shocks occurring in a single patient on the same day, there were 756 unique shocks. The daily high (DH) was the strongest predictor of receiving an ICD shock. Compared with the warmest days (DH above 10°C), shocks were 25% more common on the coldest days (DH below −10°C), and 8% more common on cold days (DH between −10°C and 10°C). This linear trend was statistically significant, with a p-value of 0.04. In conclusion, we found an association between extreme cold weather and ICD shocks.

Methods

We performed a retrospective audit of all patients seen at the Pacemaker and Defibrillator Clinic at St. Boniface Hospital.

Implantable cardioverter defibrillators (ICDs) have revolutionized the care for patients at risk for sudden cardiac death. In patients with previous ventricular arrhythmia (VA), ICDs reduce the risk of arrhythmic death by approximately 50%. Although patients with ICDs benefit from a reduction in the risk of sudden cardiac death, they also suffer from anxiety, depression, and reduced quality of life after receiving a shock. Known risk factors for appropriate ICD shocks include secondary prevention indication, older age, decreased ejection fraction, and ischemic cardiomyopathy. Conversely, the presence of atrial fibrillation, hypertension, nonischemic cardiomyopathy, smoking, and technical issues (such as oversensing and far-field sensing) put the patient at increased risk of inappropriate shocks. Cold weather has been hypothesized to increase the risk of both VA and supraventricular arrhythmia, and previous studies have shown increased risk of VAs and ICD shocks down to temperatures of 0°C. Few have examined the risk of ICD shocks and VAs at temperatures below 0°C. We sought to describe the relationship between extreme cold weather and ICD shocks in Winnipeg, Manitoba, Canada, the coldest Canadian city.

In November 2016, the Pacemaker and Defibrillator Clinic at St. Boniface Hospital in Winnipeg, MB, Canada, the coldest Canadian city, between January 1, 2010 and December 31, 2015. Data were accessed through PACEART (Medtronic, Minneapolis, MN). We excluded multiple shocks occurring in a patient on the same day. Medical records were reviewed to ascertain if the shocks were appropriate or inappropriate. We assessed if the shocks occurred contemporaneously with ST elevation myocardial infarction (STEMI). We subsequently collected the time of day when the shock was delivered for patients on whom these data were available.

We collected weather data through Environment Canada, including daily high (DH), low, and average temperature (°C), and snowfall.

The daily count of ICD shocks was linked with daily weather characteristics obtained by Environment Canada to form the final study dataset. Univariable negative binomial regression modeling was used to identify the relationship between daily weather characteristics and the observed number of unique ICD shocks observed by the Pacemaker and Defibrillator Clinic on a given day. Multivariable modeling was considered, but no combination of 2 or more variables improved the Akaike’s Information Criteria above the univariable analysis. The daily number of patients at risk was not feasible to obtain; however, the number of patients being followed by the clinic at the end of each year was applied to each day in the respective calendar year to account for the yearly variation in the clinic’s patient population. A log transformation of the clinic’s estimated daily number at risk was applied as an offset variable to all statistical models.

Several weather characteristics were examined in the univariable analysis, including DH, mean, and daily low temperature, precipitation, and snowfall. Temperature data were analyzed as both continuous and categorical variables. Temperature...
categories were defined as less than $-10^\circ$C, between $-10^\circ$C and $10^\circ$C, and greater than $10^\circ$C. These cutoffs were chosen to include the largest number of outcomes below freezing temperatures. We also analyzed $<0^\circ$C and $>0^\circ$C as temperature categories.

All rates were expressed as shocks per 1,000 person years at risk. Descriptive statistics were used to analyze the time of day that the shocks occurred for a subset of the cohort in which the time of day was available for. All analyses were performed using SAS version 9.3 (Cary, NC).

Results

Between January 1, 2010 and December 31, 2015, we identified 360 patients who received 1,355 shocks (Figure 1). The average monthly DH and shock cases per month over the study period are shown in Figure 2. The average DH was below $0^\circ$C for the months of December, January, and February. Of the 2,158 total days in the study period, 290 (13%) had a DH of less than $-10^\circ$C, 752 (35%) had a DH between $-10^\circ$C and $10^\circ$C, and 1,116 (52%) had a DH of greater than $10^\circ$C. We then tested the relationship between DH temperature and ICD shocks on a given day. The absolute shock rate by DH is shown in Figure 3. When stratifying the DH temperature into extremely cold (DH $<-10^\circ$C), cold (DH $-10^\circ$C to $10^\circ$C), and warm (DH $>10^\circ$C) categories, we found a statistically and clinically significant linear trend showing an increased rate of shocks on the colder days (Figure 4). Compared with warm days, shocks were 25% more common on the extremely cold days, and 8% more common on cold days (Figure 4, $p = 0.04$).
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