Are There Seasonal Patterns to Ruptured Aortic Aneurysms and Dissections of the Aorta?

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Objective: to test the hypothesis that there are seasonal increases in aortic aneurysm ruptures and dissections.

Methods: a retrospective, population-based time series analysis of hospital admissions for dissection and rupture of the aortic aneurysm in the Province of Ontario from 1988–1997. Analyses were carried out on weekly and monthly aggregations of hospital admissions.

Results: there is weak statistical evidence of seasonality in the weekly time series (BKS = 0.0987, p = 0.03) and no evidence of seasonality in the monthly time series. There is no evident seasonality in the time plots. The incidence of dissections increased significantly over the study period while the incidence of ruptures decreased.

Conclusions: this large population-based study, contrary to other published reports, fails to find convincing evidence of seasonality in rupture or dissection of aortic aneurysm though did demonstrate contrasting trends in incidence.

Key Words: Time series analysis; Aortic rupture; Aortic dissection; Administrative data.

Introduction

Seasonal increases of disease incidence are common features of communicable diseases such as influenza and foodborne illness. Mortality from myocardial infarction and cerebrovascular accidents have demonstrated seasonal occurrence.1,2 Seasonal occurrence on a consistent basis is a clue to disease aetiology, which in turn may provide a basis for the development of treatment and prevention programs.

Recently, several studies have purported to demonstrate a seasonal occurrence in aortic aneurysm ruptures and aortic dissections.3–12 Climatic variables are asserted as the major explanation for seasonal increases in incidence. Temperature has been proposed as a possible explanatory variable.13,14 This study, using a large population-based administrative database tests the hypothesis of seasonality in aortic aneurysm ruptures and aortic dissections and describes the trends for hospitalisation of both conditions.

Material and Methods

We conducted a retrospective, population-based study to assess temporal patterns in the incidence of aortic aneurysm rupture from fiscal years 1988 to 1996. Approximately 14 million residents of Ontario eligible for universal healthcare coverage during this time were included for analysis. The Canadian Institute for Health Information Discharge Abstract Database was used to obtain information on the incidence of hospitalisation for aortic aneurysm rupture. This database records discharge from any Ontario acute care hospital, documenting a scrambled patient identifier, date of admission, up to 16 diagnoses as coded by the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM), and up to 10 procedures.

Researchers using these databases have found that diagnoses and surgical procedures are coded with a high degree of accuracy.15 There is very little missing information in the Ontario databases; other studies have similarly found that less than 1% of the basic information on patients is missing in various provincial databases.16–20 All admissions with diagnoses of dissecting aneurysm (ICD-9-CM code 441.0) or ruptured

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Table 1. Descriptive statistics of weekly and monthly totals of aortic aneurysm ruptures and dissections.

<table>
<thead>
<tr>
<th>Series</th>
<th>Mean (SD)</th>
<th>Median (IQR)</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekly</td>
<td>5.04 (2.44)</td>
<td>4 (3)</td>
<td>0–13</td>
</tr>
<tr>
<td>(n=471 weeks)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monthly</td>
<td>21.9 (5.37)</td>
<td>21 (7)</td>
<td>9–42</td>
</tr>
<tr>
<td>(n=108 months)</td>
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aortic aneurysm (ICD-9-CM code 441.5) were captured along with the fate of admission during the study time period. The data was divided into equal weekly intervals and the total number of admissions were assessed for each time interval.

Spectral analysis was conducted to assess cyclical patterns in event occurrence. The data series was detrended using ordinary least squares regression prior to conducting spectral analysis. Two tests for the null hypothesis that the series is strictly white noise were conducted. The Fisher–Kappa (FK) Test is designed to detect one major sinusoidal component buried in white noise whereas the Bartlett Kolmogorov Smirnov (BKS) Test accumulates departures from the white noise hypothesis over all frequencies.21

**Discussion**

This study failed to find convincing statistical evidence of seasonality for ruptured abdominal aortic aneurysms and aortic dissections on either the weekly or monthly analysis. The incidence of ruptured aortic aneurysms declined significantly over the study period. At the same time, the incidence of aortic dissections increased.

What explains the previously reported findings? The previously reported observations likely represent a spurious association as a result of the aggregation of data into months. Other studies have simply aggregated many years of data into months and examined these differences. Aggregating monthly totals assumes that atmospheric influences such as temperature, humidity and barometric pressure are largely invariant from year to year. In fact, these variables are highly dynamic and monthly aggregates will miss this dynamic influence. This study uses weekly and monthly aggregation of data and evaluates the data longitudinally. The weekly data is more sensitive to influences in the external environment. Season *per se* has no standing as a variable, but is a placeholder for other influences such as temperature and air quality. Finally, the seasonal patterns reported by the disparate studies are inconsistent, which would argue in favour of statistical association artifact accounting for the results rather than some biological phenomenon.

The monthly series fail to show either a major seasonal component (FK = 5.60, m-1 = 53, p>0.01) or a cumulative effect of several small components that would lead to a departure from the white noise hypothesis (BKS = 0.129, m-1 = 53, p>0.05). The spectral density estimates for the monthly series revealed patterns consistent with the weekly series.

The incidence of dissecting aortic aneurysms increased during the study period (log simple exponential smoothing model; LEVEL weight = 0.0575, >p = 0.0061). The incidence of ruptured aortic aneurysm decreased during the study period (simple exponential smoothing model; LEVEL weight = 0.15688, p<0.001).

**Results**

During fiscal years 1988–1996, 2373 records of aortic aneurysm were observed. Table 1 summarises the descriptive statistics for the weekly and monthly series.

Figure 1 shows the weekly series of dissections and ruptures of abdominal aortic aneurysms in Ontario. Although the weekly series fails to show a single major sinusoidal component (FK = 6.06, m-1 = 236, p>0.1), several small components may lead to overall departures from the white noise hypothesis (BKS = 0.0987, m-1 = 236, p = 0.03). This would imply small and perhaps less meaningful seasonal variations in the data. The spectral density estimates for the weekly data suggest a weak cycle that may occur approximately every 6 months (i.e. every 22 weeks; Fig. 2). The peaks of these cycles would occur in the winter months and the troughs in the summer months.

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The declining incidence of ruptured aortic aneurysms may be a result of improved detection of operable aneurysms via diagnostic imaging modalities such as ultrasound and CT. Further research is warranted to examine this phenomenon. The increase in dissections is likely a consequence of an aging population.

The strengths of this study are the large sample size, long duration and use of more sophisticated statistical analysis of time series. If climate were to play a significant aetiological role it should be apparent in Canadian data given the extremes of temperature in summers and winters.

The chief limitation of the study is that those ruptures and dissections that were immediately fatal and not operated on are not captured. Aortic aneurysm ruptures and dissections are more common in the elderly. Death certificates poorly reflect the actual
cause of death. Most deaths occur in hospitals and given the dramatic presentation of an aortic rupture, are likely to be diagnosed. This analysis used discharge diagnosis and not procedure codes, so diagnosed dissections and ruptures that were not operated on are captured as well as those that were repaired.

Fig. 1. (A) Weekly and (B) monthly incidence of aortic aneurysm rupture in Ontario.
This longitudinal, retrospective, population-based study failed to find convincing evidence of meaningful seasonal patterns of rupture or dissection of abdominal aortic aneurysms. The trend for aortic aneurysm rupture was downward over the study period while the trend for dissections was upwards.

References


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