

Episodes of atrial fibrillation and meteorological conditions

Andrzej Głuszak¹, Stefan Kocoń¹, Katarzyna Żuk¹, Piotr Aljabali¹, Andrzej Gluza², Krzysztof Siwek²

¹ City Hospital, Świdnik, Poland

² Maria Curie-Skłodowska University, Lublin, Poland

Abstract

Background: Atrial fibrillation (AF) is the most common arrhythmia encountered in clinical practice. The natural history of AF tends to begin with short paroxysms which gradually evolve into longer episodes, frequently treatment-resistant, and finally take a permanent form. It is a polyaetiological condition and single paroxysms may be caused by a variety of factors. There is a prevailing belief that weather is a vital element affecting the functioning of the human organism. Accordingly, high variability in hospital admissions due to AF paroxysms may be associated with meteorological conditions.

Aim: To investigate the relationship between the incidence of AF paroxysms and atmospheric phenomena.

Methods: A total of 739 patients participated in the study [52% females, aged 18-91 (mean=65 years)], hospitalised for AF paroxysms in the Cardiac Care Unit (CCU) in 2005-2006. Patients with AF secondary to acute coronary syndrome, recent myocardial infarction, myocarditis, pericarditis, thyrotoxicosis, and disorders of the respiratory system, were excluded from the analysis. Statistical relationships were sought between the frequency of AF paroxysms and meteorological elements, such as: temperature change, atmospheric pressure, relative humidity, cloudiness, and wind speed. Using synoptic maps, such phenomena as weather fronts occurrence and baric systems were analysed.

Results: A considerable influence of a cold front and occlusion of cold front type on increases in admissions to CCU for AF paroxysms was observed. The absence of arrhythmia for many consecutive days was noted during the presence of stationary high-pressure areas. There were no significant relationships between meteorological elements and AF paroxysms. A seasonal distribution of AF episodes was found, with the maximum incidence in winter months and a decrease in the number of patients hospitalised from May to August. The impact of cold fronts may be explained by the effect of electromagnetic waves occurring in the zone of atmospheric changes, which may penetrate into buildings. On account of the translocation speed of electromagnetic waves, the effects may be felt many hours before an atmospheric front approaches.

Conclusions: Meteorological conditions may have some influence on the occurrence of paroxysms of atrial fibrillation. This study could serve as a starting point for further research investigating relationships between weather conditions and heart rhythm disorders.

Key words: paroxysm of atrial fibrillation, meteorological conditions

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Introduction

Atrial fibrillation (AF) is the most common arrhythmia in clinical practice, responsible for approximately 30% of all hospitalisations for cardiac arrhythmias. Further increase of prevalence of this condition is predicted [1]. The natural history of AF often starts with short episodes, usually clinically unnoticeable, which gradually become longer, quite often treatment refractory, finally leading to a permanent form of arrhythmia [2].

The diverse pathogenesis of AF, widespread and constant presence in the population, and high risk of threatening complications make it a significant medical problem. Most

patients are able to determine circumstances associated with the onset of paroxysmal AF, indicating the following situations: heavy meal, alcohol or coffee abuse, physical exercise or stress as well as single sudden movement, relaxation after stressful events and sleep [3]. The important element affecting functioning of the body are undoubtedly meteorological conditions. Since Hippocrates, the influence of atmospheric events on people's mood and health has been of great interest [4]. The first Polish studies on the impact of weather conditions on cardiovascular performance were carried out by Majer [5] in the first half of the nineteenth century. The pooled outcomes of clinical and meteorological studies indicated worsening of angina,

Address for correspondence:

Andrzej Głuszak MD, City Hospital, al. Lotników Polskich 18, 21-040 Świdnik, tel.: +48 81 751 30 54, e-mail: gluszak.andrzej@wp.pl

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increased incidence of myocardial infarctions and more pronounced fluctuations of blood pressure during short-term weather changes [6]. The large number of patients arriving to the hospital due to AF on particular days suggests an association with weather conditions. In one of the studies, meteorological conditions such as air temperature and humidity and atmospheric pressure were found to have an unquestionable influence on AF in about 87% of patients, in particular with concomitant ischaemic heart disease or arterial hypertension as well as in the elderly [7].

The aim of this study was to determine the relationship between the incidence of AF and atmospheric phenomena as well as to indicate the precipitating factors.

Methods

The study comprised 739 subjects treated for paroxysms of AF at the Intensive Cardiac Care Unit (ICCU) from 2005 to 2006. Our hospital practice allows all AF patients to be admitted directly to the ICCU. Medical history revealed that arrhythmia duration was less than 1 day. Episodes of AF stopped spontaneously, were terminated with electrical or pharmacological cardioversion or turned into the persistent form. Patients' age was 18-91 years (mean 65.1); 52% of patients were females. The aetiology of AF was variable; however, patients with AF secondary to acute coronary syndrome, acute myocardial infarction, myocarditis, pericarditis, hyperthyroidism or acute pulmonary disease were not included.

The statistical analysis was performed using synchronic and asynchronous correlations between AF episode rates and the following meteorological factors:

- air temperature (daily mean, daily amplitude, day-by-day changes);

- steam pressure (daily mean, daily maximum and minimum – with particular consideration of steam conditions – 18.8 hPa);
- cloudiness (total, low level clouds with particular attention to cumulonimbus);
- atmospheric pressure (daily mean, daily amplitude, day-by-day changes);
- wind speed (spot maximum speed).

A further stage of the analysis used the low level synoptic maps from the Deutsche Wetter Dienst (DWD) archive commonly available at www.wetter3.de, analyzing four maps per day that covered the following time ranges: 00:00-06:00, 06:00-12:00, 12:00-18:00, and 18:00-24:00.

Results

The analysed period included mainly days free of patients reporting due to recent-onset AF (271 days) or with one AF patient per day (264 days). There were nine days with a high admission rate of 4 cases per day and four days with 5 cases daily. On average one AF admission per day was recorded (Tables I and II).

During the whole year, the highest AF morbidity rate was observed in the winter (December to February) and in September, while the lowest one was observed from May to August (Figure 1). Also series of days free of AF admissions were observed comprising 4 to 6 days (Table III).

Results of synchronic correlation between individual meteorological factors and incidence of AF were statistically insignificant ($R^2=0.0357$). In asynchronous correlations, atmospheric pressure fluctuations preceded an AF episode by one to three days, showing better correlation ($R^2=0.3621$ for two-day shift).

Table I. Number of days with division to number of AF cases per day form 2005 to 2006 in each month

Month	Number of AF cases per day					
	0	1	2	3	4	5
January	20	22	13	6	0	1
February	12	24	11	7	2	0
March	23	24	10	2	1	2
April	22	20	13	5	0	0
May	24	24	12	1	1	0
June	23	26	6	5	0	0
July	28	22	10	1	1	0
August	27	21	7	7	0	0
September	19	21	10	9	1	0
October	26	20	11	4	0	1
November	26	20	12	0	1	1
December	21	20	14	5	2	0
Total	271	264	129	52	9	5

Table II. Number of recent-onset AF cases in each month in 2005-2006

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Total
Monthly total	71	75	64	61	55	53	49	56	72	59	53	71	739
Daily mean	1.15	1.34	1.03	1.02	0.89	0.88	0.79	0.90	1.20	0.95	0.88	1.15	1.01

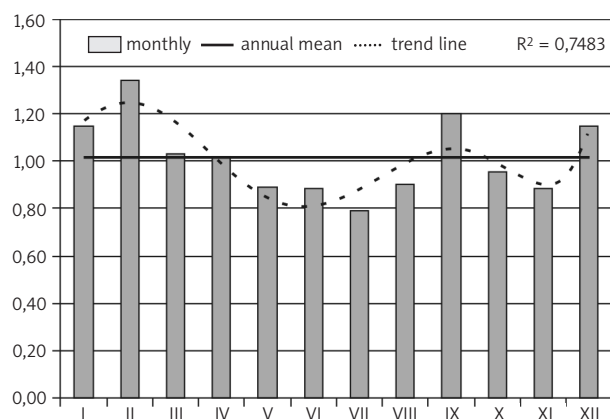


Figure 1. Mean daily incidence of AF in each month (2005-2006) $y = 5E-05x^6 - 0.0016x^5 + 0.0188x^4 - 0.0867x^3 + 0.0986x^2 + 0.1566x + 0.9803$

Analysis of synoptic maps allowed a clear relationship to be determined between cold atmospheric front or cold front-like occlusion and increased number of recent-onset AF cases per day. It was recorded in all days with 4 or 5 admissions due to AF per day, 24-36 hours prior to occurrence of atmospheric front events. No such relationship was confirmed for warm fronts. Paroxysms of AF were not present with high pressure systems. Several-day series free of AF admissions were noted for all occurrences of stagnating low gradient zones of high atmospheric pressure. For example:

- 7 July to 11 July 2006 – 5 days free of recent-onset PAFA. High pressure system with centre over the middle Russia developed over Poland. On the 6th of July a cold front passed east of Poland. The high pressure system blocked low pressure systems and related fronts which moved over the North Sea or north of Poland. High pressure from the east joined with systems moving from western Europe and on the 9th and 10th of July Poland was in the range of a high pressure wall. Fronts that were approaching and were blocked by the high pressure system became stationary ones. On the 12th of July the cold front started to approach from the west.
- On the 13th of July 2006 four patients with recent-onset AF were admitted. Poland was in the range of a weak high pressure system (wall). Low pressure systems with fronts were located over Scandinavia and the North Sea. On the 12th of July between 6:00 a.m. and 12:00 p.m. the

Table III. Multi-day series free of AF

Onset date	End date	AF-free period
2005-07-29	2005-08-01	4
2005-08-12	2005-08-15	4
2006-03-22	2006-03-25	4
2006-05-27	2006-05-30	4
2006-06-23	2006-06-26	4
2006-06-29	2006-07-04	6
2006-07-07	2006-07-11	5
2006-08-23	2006-08-27	5
2006-11-12	2006-11-16	5

cold front moved over Poland (over the northern part of the country). It turned to stationary form and moved as a cold front, leaving Polish territory on the 14th of July at about noon.

Discussion

Previous studies on the influence of selected meteorological parameters on cardiovascular system performance often brought ambiguous results. For example, Skrobowski [8] reported a significant relationship between differential mean daily temperature and atmospheric pressure and presence of acute myocardial infarction. Quite a distinct opinion was presented by Machatek [6], who described an evident increase of infarction rate with low gradient pressure systems and poorly differentiated atmospheric pressure. In contrast to Michalkiewicz et al. [7], we found no significant relationship between analysed basic meteorological parameters and AF episodes rate. This may be explained by the protective effect of rooms or clothes from the felt air temperature and humidity, cloudiness and wind.

In our study seasonal incidence of AF paroxysms was established. Most cases occurred in winter, while the minimum was observed from May to August. The extensive Danish population studies carried out for fourteen years and involving approximately 33,000 patients with AF paroxysms reported an inversely proportional influence of

mean outdoor temperature and similar effect of season [9]. Studies performed in Japan showed maximum AF incidence in autumn, with a significant reduction in summer [10].

As far as changes in atmospheric pressures are concerned, we found they were related to incidence of AF episodes, although with 24-48-hour advance. This was in some measure confirmed by the conclusions of Delyukov and Didyk [11], who described a negative effect of atmospheric pressure fluctuations on cardiovascular function – manifesting 3-24 hours prior to changes in weather parameters. Hessmann-Kosaris [12], reporting on body reactions up to 48 hours before weather changes, assumes however that they are due to disturbances in the electrical field occurring in advance of atmospheric front arrival. Our study found a clear relationship between the passing of a cold atmospheric front or cold front-like occlusion and increase of AF cases per day. A several-day period free of AF cases was associated with stagnation of stationary high pressure systems.

It seems that the above observations may be rationally explained by the effects of specific factors developing in the zone of a cold front such as electromagnetic waves. Those waves have the potential to penetrate construction barriers that protect people from the influence of other weather conditions. In the nineteen sixties, Tromp [13] reported that centres of deep low pressure systems and storm centres can emit electromagnetic waves of 6-100 km length and 3-5 kHz frequency. He also highlighted the possible influence of these waves on biological processes as they are able to penetrate buildings. Propagation speed of electromagnetic waves is close to 300,000 km/sec and speed of cold front movement equals tens of km/h, which results in feeling their effects about 24 hours before changes in atmospheric pressure associated with the front zone take place. Static electrical charges produce an electric field, while dynamic ones, e. g. in the atmospheric front zone, are sources of both electric and magnetic fields, which superimpose and induce electromagnetic waves [14]. Due to the significantly lower speed of a warm front its electromagnetic impact is weaker than a cold one. Moreover, the force vector associated with a cold front is directed to the earth surface while the warm one is directed upwards.

Electromagnetic waves penetrate into the tissue to a depth depending on the electric resistance and wavelength. In the very low frequency generated by atmospheric conditions (up to 10 MHz) vivid tissue acts as a conductor in which an alternating electric field produces Foucault eddy currents practically induced in the entire body [15].

These phenomena were also reported by Kozłowski [16], who claimed that electromagnetic field effects in the body tissues involve stimulation of particles and atomic movements which cause chemical reactions and bioelectric processes. Induction of these changes occurs in electromagnetic fields of relatively low intensities. This was also underlined by Hessmann-Kosaris [12], who

reported that even weak electromagnetic fields may affect metabolic processes of cells and cellular membranes. The lower the intensity of Foucault currents in the tissue, the smaller is the area affected by the closed current circuit; therefore the precordial area is subject to the greatest induction, being the largest body surface [15].

These phenomena were described by Siemiński as follows: 'They say some phenomena caused by electromagnetic fields are like throwing a stone from a high mountain. It may stop a few metres below, but may also cause a huge avalanche if its movement develops in a slightly different way and of course on an adequate slope' [17]. This seems to be the case with induction of AF from focal sources and then from division of the AF wave front into numerous child waves which randomly walk through the susceptible atrium and mutually decay or produce self-triggered activity [18].

Conclusions

An evident influence of cold fronts and cold front-like occlusions on increase of patients with recent-onset AF admitted to the ICCU was observed. No such relationship was confirmed for warm fronts. Presence of stationary high pressure systems was associated with several-day series free of arrhythmia. This could support reports that selected meteorological conditions may be a potential trigger mechanism inducing episodes of AF. No statistical confirmation of a direct influence of air temperature changes, atmospheric pressure, steam pressure, cloudiness or wind speed on the incidence of AF was provided. Evident seasonal incidence of AF was observed with the maximum in winter and a decrease from May to August.

References

1. Wattigney WA, Mensah GA, Croft JB. Increasing trends in hospitalization for atrial fibrillation in the United States, 1985 through 1999: implications for primary prevention. *Circulation* 2003; 108: 711-6.
2. Godtfredson J. Atrial fibrillation, etiology course and prognosis: follow-up study of 1212 cases. Munksgard, Denmark: *University of Copenhagen*, 1975.
3. Maryniak A, Walczak F, Bodalski R. Atrial fibrillation onset circumstances and their relation to patient's quality of life. *Kardiol Pol* 2006; 64: 1102-8.
4. Kozłowska-Szczęśna T, Błażejczyk K, Krawczyk B. Bioklimatologia człowieka. *IGiPZ PAN*, Warszawa 1997, Monografie: 1.
5. Majer J. Wpływ stanu meteorologicznego na śmiertelność oceniony według dziesięcioletnich spostrzeżeń w Krakowie. *Roczniki Wydziału Lekarskiego UJ*, Kraków 1845; 8.
6. Machałek A. Czy jestem meteoropatą? *W. A. B.*, Warszawa 1996.
7. Michałkiewicz D, Chwiałkowski J, Dziuk M, et al. Wpływ warunków atmosferycznych na występowanie napadowego migotania przedsionków. *Pol Merkuriusz Lek* 2006; 20: 265-9.
8. Skrobowski A. Wpływ wybranych czynników atmosferycznych na częstości występowania zawału serca. *Lekarz Wojskowy* 1989; 65: 691-9.

9. Frost L, Johnsen SP, Pedersen L, et al. Seasonal variation in hospital discharge diagnosis of atrial fibrillation: a population-based study. *Epidemiology* 2002; 13: 211-5.
10. Watanabe E, Kuno Y, Takasuga H, et al. Seasonal variation in paroxysmal atrial fibrillation documented by 24- hour Holter electrocardiogram. *Heart Rhythm* 2007; 4: 27-31.
11. Delyukov A, Didyk L. The effects of extra-low-frequency atmospheric pressure oscillations on human mental activity. *Int J Biometeorol* 1999; 43: 31-37.
12. Hessmenn-Kosaris A. Wpływ pogody na samopoczucie. *Diogenes*, Warszawa 1998.
13. Tromp SW. *Medical Biometeorology*. Elsevier, Amsterdam 1963.
14. Przystański S. *Elementy fizyki, biofizyki i agrofizyki*. Wydawnictwo Uniwersytetu Wrocławskiego, Wrocław 2001.
15. Siemiński M. *Fizyka zagrożeń środowiska*. PWN, Warszawa 1994.
16. Kozłowski S. *Gospodarka i środowisko przyrodnicze*. PWN, Warszawa 1991.
17. Siemiński M. *Środowiskowe zagrożenia zdrowia*. Wydawnictwo Naukowe PWN, Warszawa 2007.
18. Rubart M, Zipes DP. Geneza zaburzeń rytmu serca – rozważania elektrofizjologiczne. In: Braunwald E. *Choroby serca*. Elsevier Urban & Partner, Wrocław 2007.

Napady migotania przedsionków a warunki meteorologiczne

Andrzej Głuszak¹, Stefan Kocoń¹, Katarzyna Żuk¹, Piotr Aljabali¹, Andrzej Gluza², Krzysztof Siwek²

¹ Szpital Miejski, Świdnik

² Uniwersytet Marii Curie-Skłodowskiej, Lublin

Streszczenie

Wstęp: Migotanie przedsionków jest najczęściej występującą arytmia w praktyce klinicznej, stwierdza się je u ok. 30% wszystkich osób hospitalizowanych z powodu zaburzeń rytmu serca. Prognozuje się wzrost rozpowszechnienia tego schorzenia w populacji. Historia naturalna migotania przedsionków rozpoczyna się często od krótkich napadów, zwykle nieuchwytnych klinicznie, które stopniowo przechodzą w coraz dłuższe epizody, nierzadko odporne na próby terapeutyczne, by w końcu przejść w postać utrwaloną. Jest to schorzenie polietiologiczne, napad mogą wywoływać różnorodne czynniki. W powszechnym odczuciu bardzo ważnym elementem kształtującym funkcjonowanie organizmu człowieka są warunki meteorologiczne. Obserwuje się dużą zmienność liczby osób zgłaszających się do szpitala z powodu napadów migotania przedsionków w poszczególnych dniach, więc możliwe jest skojarzenie występowania tej arytmii ze stanem pogody.

Cel: Znaleźnienie związków między częstością występowania napadów migotania przedsionków a zjawiskami atmosferycznymi oraz wskazanie sytuacji wyzwalającej, potencjalnego „mechanizmu spustowego” dla napadu migotania przedsionków (ang. *paroxysm of atrial fibrillation*, FAP).

Metodyka: Badanie obejmowało 739 chorych, 48% mężczyzn i 52% kobiet, w wieku 18–91 lat, średnio 65,1 roku, przyjętych na oddział intensywnej terapii kardiologicznej w latach 2005–2006 z powodu FAP. Nie uwzględniano osób z wtórnymi zaburzeniami, występującymi w przebiegu ostrego zespołu wieńcowego, ostrego zawału serca, zapalenia mięśnia sercowego, zapalenia osierdzia, nadczynności tarczycy i chorób płuc. Przeprowadzono ocenę statystyczną, stosując korelacje pomiędzy częstością występowania FAP i elementami meteorologicznymi, takimi jak: zmienność temperatury powietrza, ciśnienia atmosferycznego, prężności pary wodnej, stopnia zachmurzenia, prędkości wiatru. Posługując się mapami synoptycznymi, analizowano sytuacje pogodowe, takie jak przechodzenie frontów atmosferycznych i występowanie układów barycznych.

Wyniki: W analizowanym okresie najwięcej było dni bez migotania przedsionków – 271, z jednym epizodem dziennie – 264 dni, z dwoma – 129, z trzema – 52. Dni z wyraźnym zwiększeniem przyjęć z powodu FAP, tj. 4 lub 5 na dobę, notowano odpowiednio 9 i 5 razy. Średnia dla hospitalizacji z powodu napadu migotania przedsionków to jedna osoba dziennie (1,01). Wyróżniło się też dziewięć okresów obejmujących 4–6 kolejnych dni bez FAP. Zaobserwowano wyraźny wpływ oddziaływania frontu chłodnego i okluzji o charakterze frontu chłodnego na zwielokrotnienie przyjęć na OIOK z powodu FAP. Nie obserwowano tych interakcji w odniesieniu do frontów ciepłych. Brak występowania arytmii w okresach wielodniowych notowano przy obecności stacjonarnych układów wyżowych. Uzyskane rezultaty wskazują, że nie ma istotnych zależności pomiędzy zmiennością temperatury powietrza, ciśnienia atmosferycznego, prężności pary wodnej, stopnia zachmurzenia, prędkości wiatru a FAP. Stwierdzono wyraźną sezonowość FAP, z maksimum w miesiącach zimowych i spadkiem zachorowań od maja do sierpnia włącznie. Oddziaływanie frontów chłodnych można wytłumaczyć falami elektromagnetycznymi powstającymi w strefie zmian atmosferycznych, które jako jedyne czynniki związane z pogodą mogą przenikać do pomieszczeń. W związku z prędkością przemieszczania się fal elektromagnetycznych ich skutki odczuwane są na wiele godzin przed nadejściem frontu atmosferycznego.

Wnioski: Zaobserwowano, że niektóre warunki meteorologiczne mogą być czynnikiem wyzwalającym FAP. Niniejsze opracowanie może być wstępem do dalszych badań potwierdzających związki między pogodą a zaburzeniami rytmu serca.

Słowa kluczowe: napad migotania przedsionków, warunki meteorologiczne

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Adres do korespondencji:

dr n. med. Andrzej Głuszak, Szpital Miejski, al. Lotników Polskich 18, 21-040 Świdnik, tel.: +48 81 751 30 54, e-mail: gluszak.andrzej@wp.pl

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