

Data about Natural History of Some Acute Coronary Events at Days of High Cosmic Ray (CRA)-Neutron Activity and Following 48 Hours (2000-2012)*

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Received 21 January 2016; accepted 13 March 2016; published 16 March 2016

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Abstract

In recent years, many studies were published describing a wide scope of changes related to extreme (stormy) geomagnetic activity. In some countries, prediction of such days is a part of weather prediction information. A number of risk factors like blood coagulation parameters, arterial blood pressure, inflammation markers, and some blood proteins were changing at days of GMA storms. Concomitant studies were published on an inverse phenomenon—increased cardiovascular event at days of Zero GMA, accompanied by high Space Neutron activity on the Earth's surface—a marker of high Cosmic Ray activity. The aim of this study was to compare two groups of Acute Cardiovascular Events (ACE)—Acute Myocardial Infarction (AMI) and deaths from Ischemic Heart Disease (IHD) at days of extreme Cosmic Ray (CRA)-Neutron activity. Patients & methods: 4749 days at years 2000-2012 were studied considering ACE in a 3000 bed hospital in Kaunas, Lithuania. Cosmophysical data of this period was obtained from USA, Russia, and Finland. ACE was calculated at day of extreme High levels of CRA and following 48 hours. 13629 AMI and 3128 deaths from IHD were included. Results: It was a significant rise in AMI morbidity at day of high CRA (Neutron) activity (≥ 9300 imp/min). By analysis for each of gender, and patients age groups that were significant difference of AMI for all patients and male >65 y. old at Neutron activity ≥ 9400 imp/min ($p = 0.048$; $p = 0.03$), both gender > 65 y. old at Neutron activity >9500 ($p = 0.078$) and female >65 y. at Lag 2 ($p = 0.07$). For deaths from IHD, it was a significant rise at Neutron activity below 9300

*In memory of our Coauthor and Colleague Professor Stanislava Domarkiene.

How to cite this paper: Stoupel, E., Richardas, R., Vidmantas, V., Gailute, B., Abdonas, T. and Evgeny, A. (2016) Data about Natural History of Some Acute Coronary Events at Days of High Cosmic Ray (CRA)-Neutron Activity and Following 48 Hours (2000-2012). *Health*, 8, 402-408. <http://dx.doi.org/10.4236/health.2016.85042>

imp/min (662 days (13.8%) were above the average of the full observation time- 8935 ± 538.083)). **Conclusion:** At days of high CRA-Neutron activity, it was significantly more AMI. For IHD mortality was higher, but at lower Neutron activity—closer to average Neutron activity and higher GMA.

Keywords

Cosmic, Ray, Activity, Neutrons, Myocardial Infarction, Ischemic Heart Disease

1. Background

From the first decades of the XX century, Geomagnetic Activity (GMA) was an object for intense research, including both physical parts of the problem and, also, possible biologic and medical effects [1]-[11]. As a result, a graduation of GMA was accepted, that included Quiet (I^0), Unsettled (II^0), Active (III^0) and Stormy (IV^0) levels (Table 1). The GMA Stormy days were always a central issue for many studies and many medical phenomena were connected with changes of GMA. In some countries, the coming GMA Storms were included in weather prediction in mass media. Special attention GMA Storms got in cardiovascular medicine, a longtime leader in human morbidity and mortality in many industrial countries. In many publications, it was shown that GMA storms were linked to a number of cardiovascular risk factors: arterial blood pressure, blood coagulation parameters, inflammation markers, some immunoglobulin fractions changes etc. and Cardiovascular Events (CVE) [6]-[26]; on the other hand, some important human pathology component's, like Sudden Cardiac Death (SCD)—one of the most frequent sorts of cardiac death for many years showed some “affinity” to low GMA [27]-[32]. Also Acute Myocardial Infarction (AMI) was in this group [27]. In recent decades, an inverse situation to high GMA-Zero GMA was studied and connected to them Cosmic Ray Activity and their marker on our Planet- Neutron activity on the Earth surface (in impulse/minute) [22]-[27]. In one of publications, Zero GMA was described as “antipode to GMA storms” [26]. It was suggested that Neutrons, raising at low GMA, might be involved in some human pathologies, like Cardiac Arrhythmias—a close predictor and mechanism of SCD [12]-[15] [27]-[33], or be involved in atheroma (atheromatous plaque in the arterial wall) splitting and/or fissuring, the most frequent cause of AMI [34] [35], resulting a blockade of blood supply in the Culprit Artery to the heart muscle and its necrosis (death) with a wide scope of clinical pictures from SCD to routine AMI with many variants of natural history.

The interrelationship between the mentioned Space Weather forces in the last decades was CRA/SA (Solar Activity) was $r = -0.86$, $p < 0.0001$, CRA/GMA $r = -0.70$, $p < 0.0001$ (both inverse related), and SA/GMA = 0.55 , $p < 0.0001$ [28] [36]. In years of low SA, we had about 15 days of Zero GMA yearly. In years of high solar activity, this number dropped to 1.5 yearly. The aim of this study was to compare the morbidity of AMI and mortality from IHD on days of high CRA (Neutron) and following 48 hours, taking in account that Neutron activity concomitant with Zero (or low) GMA could achieve maximum hours and days after the extreme drop of GMA, and biological effects of extreme high/low GMA could be more prominent at days after the extreme event (28).

Table 1. Geomagnetic activity gradation.

Category	“A” index range	Typical “K” values	Amplitude (Nanotesla)
1. Quiet (I^0)	$0 < A < 8$	Usually No. > 3	0 - 20
2. Unsettled (II^0)	$8 < A < 16$	Usually No. > 3	21 - 40
3. Active (III^0)	$16 < A < 30$	Few indices of 4	41 - 70
4. Minor storm (IV^0)	$30 < A < 50$	Mostly 4 & 5	71 - 120
5. Major storm (IV^0)	$50 < A < 100$	Some indices 6	121 - 200
6. Severe storm (IV^0)	$100 < A$	Some indices 7	201 - >550

2. Methods and Patients

Data of Acute Cardiac Events—AMI admissions and death from IHD in cardiology departments of a 3000 beds tertiary hospital of the Lithuanian University of Medical Sciences for years 2000-2012 (4734 days) was used as a base for our observation. The cosmophysical data came from Space Service Centers in the USA, Russian Federation and Finland [37]-[44]. At all 13629 AMI patients and 3128 deaths from IHD were included in this study. Separate groups for each gender and age groups of 25-64 years, ≥ 65 y. and also all patients for each of both gender and all patients of each gender and the total group of all patients suffering AMI, or IHD related death were studied. The average daily Neutron activity for the last 25 years (1990-2014) was 8757.8 ± 650.455 imp/min. for 2000-2012 it was 8936 ± 538.08 imp/min. We analyzed AMI morbidity and IHD mortality at days with Neutron activity (result of high CRA) ≥ 9300 imp/min. (1798 days, 38% of all), ≥ 9400 (1254 days, 26.9% of all) and ≥ 9500 imp/min. (793 days, 16.8% of all studied days). 13629 patients suffering AMI, 8026 male, 5603 female) and 3128 (2075 male, 1053 female) deaths from IHD were studied. The maximal Neutron activity registered at the time of the study was 9935 imp/min. 662 days (13.98%) remained above the average of Neutron activity for the 13 year time of the study (8936 ± 538.08 imp/min.) and the lowest level of considered high Neutron activity (9300 imp/min).

Statistics

Due to the skewed nature of the variables distribution, a non-parametric Wilcoxon test was used to compare the three groups—total number of 4734 all days, and acute cardiac events at full studied time interval and days with three levels of high Neutron (CRA) activity. Probability by differences 95% and more was accepted as significant, these of 94.9% - 90% as a strong trend to significance.

3. Results

Table 2 presents the significant results of AMI morbidity and IHD mortality risk at days with higher Neutron activity and number of patients in each of analyzed groups, age and gender of the patients, also the probability of the significant results that were obtained by comparative analysis for each of gender, and age of patients. The groups that were significant different were AMI patients for all studied data ($p = 0.048$) and male ≥ 65 y. old at Neutron activity ≥ 9500 imp/min ($p = 0.03$), both gender ≥ 65 y. old at Neutron activity >9300 ($p = 0.023$) at strong trend level for both gender ($p = 0.078$) at >9300 imp/min and female AMI at Lag 2 - 48 hours post extreme Neutron activity ($p = 0.07$). For deaths from IHD it was a significant rise at Neutron activity below 9300 imp/min. ($p = 0.0001$); 662 days were above the average of the full observation time (8935.52 imp/min), but lower than the low border of extreme Neutron activity (>9300 imp/min).

4. Discussion

It's a long history of studies and publications about GMA effects on humans [1]-[12]. For a long time, it was accentuated predominantly by the possible negative effects of high (Stormy) GMA. It was not only supported by

Table 2. Significant links between acute cardiac events and high cosmic ray (Neutron) activity (impulse/minute), 2000-2012.

	Exp (B)	95% Conf. Interval	<i>p</i>	Pts. No.	Morbidity	Mortality	Neutron Limits	Age	Gender
1	1.054	1.000 - 1.110	0.048	6042	AMI		>9500	All	Both
2	1.129	1.012 - 1.261	0.03	1330	AMI		>9500	>65	Male
3	1.111	1.015 - 1.216	0.023	3140	AMI		>9300	>65	Both
4	1.045	0.995 - 1.097	0.078	2264	AMI		>9300	>65	Both
5	1.33	0.98 - 1.80	0.07	3899	AMI		2 d Lag	>65	Female
6	0.898	0.848 - 0.951	0.0001	3348	AMI		>9300	25 - 64	Male
7	0.806	0.668 - 0.973	0.025	1334		IHD	>9300	>65	Male

*B—relative risk in the Poisson regression system.

statistical data of medical events distribution [9] [20]-[23], but also by changing risk factors at days of high GMA [12]-[15] [24]-[27]. For example, such cardiovascular events (IHD, AMI, Stroke etc.) risk factors like high arterial blood pressure, blood coagulation markers, inflammation markers were seen significantly higher at days of high GMA. In many places the weather prediction reports include GMA Stormy days. In the last years it was established that GMA is correlated with Solar Activity (SA) by $r = 0.55$, $p < 0.0001$ and the both are inverse related to Cosmic Ray activity (CRA) (expressed by Neutron Activity by the Earth's surface in impulse/minute (imp/min)—SA/CRA $r = -0.85$ - -0.86 , $p < 0.0001$; GMA/CRA = -0.66 , $p < 0.0001$. [30] [34]. In recent years, a number of studies were published describing events dominating at low (Quiet) GMA [29]-[33] [36] [40]; in the last decade not only low GMA was studied in the context of clinical cosmobiology, but also concentrated on days of Zero GMA [28] [33] [41] [43]. It was seen that many pathologies, such as AMI, SCD are raising at low and Zero GMA. The possibility of Neutron action as a trigger of such events was presumed-Neutron activity is raising at low and Zero GMA [47]-[51]. Possible mechanisms of Neutron biological action were discussed [29] [52] [53]. The average of Neutron activity at different daily levels of GMA was: at Stormy GMA-8090-8095; Active-8049-8501; Unsettled-8731-8691; Quiet-9168-9154; on days of Zero GMA -9492.8 imp/min. The inverse relationship between S.A. and GMA levels from one side and CRA (Neutron) activity from other side resulted to great differences of days of Zero GMA at different parts of the 11-year S.A. cycle [8]-[44]. If at the most active months, of the 11 year Solar cycle, when also GMA was higher, Zero GMA days were on average 1.5 yearly, on the minimal years of S.A. and GMA it rose to average 15 days yearly [40]. Our previous study show higher mortality from repeated AMI at days of Zero GMA. (Kaunas data, IDC 10) [40]. Another study [36] also shows that AMI is significantly related to CRA (Neutron) activity; the Intermediate Coronary Syndrome clinically similar to AMI, but without myocardial necrosis-with GMA [28] [38] [41]. This, partially, can explain the timing of the part of IHD related deaths that occurred at lower Neutron activity and higher GMA. In addition we must not forget other environmental factors like temperature, air pressure that are also involved in IHD morbidity and mortality [23] [24]. In an older study considering circannual rhythmicity of deaths in our countries it was shown that in both, despite geographical and climatic differences, the monthly deaths distribution is rhythmic and similar: the yearly acrophase of mortality, general and cardiovascular, is in February : a month with low temperature [54].

If we extrapolate the Neutron action as it's accepted in radiotherapy [55] [56], we can presume that Neutron biological action is related with Neutrons are connecting with the H^+ anion (that is in high concentration in some lipid tissues and atheromatous plaques), converting to Protons, acting as damaging subject on cells and tissues, especially in damaged heart muscle, lipid infiltrated arterial walls, heart conduction system [54] [55]. The possible shield by the magnetic field from high Neutron activity in AMI and SCD was confirmed in a number of recent studies [28]-[30] and in a big international study of Mayo clinic (USA, Italy, Czech Republic [32]) that confirmed previous observations about inverse relationship of GMA with life threatening cardiac arrhythmia, [47]-[50] [52] [53] [56] treated by Implantable Cardiac Defibrillators [30] [32] [54] and, also, at days of electrical hearts storms, when life threatening arrhythmias occurred three and more times daily (and also treated by implanted electrical defibrillators). The role of cosmic rays in physics and human life is widely discussed in recent publications [51] [57]-[59]. It was also discussed if Neutrons are invading our bodies per se, or can, partially, been absorbed by a carrier in form of air pollution nanoparticles. Their role as a risk factor for Cardiovascular Diseases was demonstrated in the recent years repeatedly [60] [61]. It's not clear if the mentioned cosmophysical factors are affecting biological objects isolated, or, partially, combined with air pollution elements.

The role of physical factors in the time distribution of many acute medical events and the recent progress in genetics as a homeostasis regulating factor give some impetus to assume that Space Physical Activity can affect, also, the gene functional activity, changing the genetic related human medical effects intensity [62].

Limitations of the Study

Relatively small IHD related deaths number can affect the obtained results. In other studies on this subject we used greater groups and obtained more confident results about CRA (Neutron) activity and different forms of IHD, but most were linked to AMI and Sudden Cardiac Death (SCD), Stroke (CVA). This study is an addition to studies showing that low GMA with high CRA (Neutron) activity is also potentially dangerous, by itself, and not only high GMA-GMA Storms are related to raising cardiovascular events.

5. Conclusion

In addition to published studies, it is new evidence that AMI morbidity is higher at days with high CRA (Neutron) activity. Mortality from IHD is influenced by mechanisms related to both extreme Space Weather events CRA and GMA. The mechanisms of pathogenic influences and mechanisms related to these Space Weather phenomena actions on humans need additional studies.

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