

**Identifying Multiple Forms of Benign Fasciculation
Syndrome (BFS)**

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Abstract:

Objective: The purpose of this paper is to explore the statistical relationship between Benign Fasciculation Syndrome (BFS) symptoms, body parts affected by BFS, the potential causes of BFS, and potential remedies for BFS.

Patients and Methods: To accomplish this task, a survey was conducted and data was obtained from 161 people. Of the 161 (9 outliers) a total of 152 have been diagnosed with BFS. The data was modeled using a linear regression analysis to determine if there is correlation between symptoms, potential causes or triggers, body parts affected by BFS, and potential remedies.

Results: From this data (Tables 1 through 7) it is possible to identify nine unique forms of BFS that stem from a variety of triggers. Each BFS form has its own set of unique symptoms, conditions that make symptoms worse, and remedies that appear to work best.

Conclusion: Although BFS symptoms, on average, remain the same for BFS sufferers - only those sufferers whose trigger is stress related can significantly reduce symptoms over time. Many people who suffer from BFS claim multiple triggers have brought forth BFS symptoms. Their symptoms reflect a cross between different forms of BFS. For this reason, we speculate that it would be difficult to find a single cure for BFS.

Key Words (Search Terms):

Benign Fasciculation Syndrome (BFS)

Peripheral Nerve Hyperexcitation (PNH)

Muscle Twitching

Symptom Triggers

Symptom, Remedy, and Trigger Correlation

Background:

Defining and understanding neurological disorders can be medically challenging. Benign Fasciculation Syndrome (BFS) is a disorder characterized by fasciculation or muscle twitching of unexplained causes. Other BFS symptoms may include muscle fatigue, cramps, pins and needles sensations, muscle vibrations, headaches, itching, sensitivity to temperatures, numbness, muscle stiffness, muscle soreness and pain. [1] BFS is considered to be a disorder of Peripheral Nerve Hyperexcitability (PNH). BFS or PNH causes are not entirely understood. Some theories state that the cause of BFS or PNH may involve the potassium channel of the nerve terminal's inability to properly close its gates when a motor nerve impulse reaches the nerve terminal, resulting in a still-remaining active muscle fiber. [2] This imbalance is what causes involuntary impulses that consequently stimulate the nerve endings causing them to fire and twitch. [1,3,4] Like many neurological disorders, there is no known cure for BFS. BFS sufferers are prone to dealing with anxiety since their symptoms are similar to other crippling disorders such as Parkinson's disease, Amyotrophic Lateral Sclerosis (ALS), Multiple Sclerosis (MS), and even brain tumors. Based on a Microsoft Research Study conducted by White and Horvitz, there is a .50 probability that a quick internet search on "muscle twitching" leads them to sites related to ALS. Needless to say this causes a great deal of distress for the individual knowing the relationship of twitching and ALS. In fact, some fairly recent studies have cited rare cases of individuals who started with twitching and cramping symptoms and later developed ALS years later [5]. While these cases are extremely rare, the knowledge of them can cause anxiety in the BFS sufferer.

Because of their symptoms, BFS patients often have undergone advanced medical testing including Magnetic Resonance Imaging (MRI) performed on the brain as well as an

Electromyography (EMG) to rule out other neurological disorders. [1] While this disorder is considered “benign” it contains symptoms that are very real and in some cases both psychologically and physically debilitating. [6] This is substantial due to the potential prevalence of this disorder. One study claims that up to 1% of the population may suffer from BFS [7]. In fact, many BFS sufferers have similar symptoms to other neurological disorders including Neuromyotonia (NMT), Benign Cramp Fasciculation Syndrome (BCFS), fibromyalgia, Reflex Sympathetic Dystrophy (RSD), stiff person syndrome, continuous muscle fiber activity, continuous motor nerve discharges, and Isaac Syndrome, usually differentiated by an EMG. [1] Many remedies attempted to relieve BFS symptoms are exactly the same as those remedies used for NMT, BCFS, RSD and other neurological disorders. [1] At this time there is no evidence that BFS sufferers are any more likely to acquire other more serious neurological disorders, such as ALS or MS, than any person without BFS. [4]

Objective:

What is being hypothesized in this study is that due to the unique symptoms of people afflicted with BFS, there may be variants to BFS. The objective was to identify the different types of BFS from various triggers in order to better understand the illness and its potential remedies.

Methods:

The subjects for this study included 152 individuals who have been formally diagnosed with BFS.

People were contacted via social network forums listed below:

Facebook: <https://www.facebook.com/#!/groups/88467288815/>

Internet: <http://www.nextination.com/aboutbfs/>

Information regarding all data gathering and the survey / tools used, is listed below:

A survey was created in Google Docs and can be found at the following link:

https://spreadsheets.google.com/spreadsheet/viewform?hl=en_US&authkey=CJvBgaQM&formkey=dElCQkFBRWlvY1ZSTThKTmNsbEg4d0E6MQ#gid=0

The survey will be open indefinitely with the hope to grow the sample size and therefore, better understand the disorder.

The Survey can also be reached from the Author's BFS webpage:

<http://patrickbohan.home.bresnan.net/BFS.htm>. Click on the link "BFS Survey".

The correlation results for the 152 participants (total participations was 161; however, 9 were considered outliers due to not having a BFS diagnosis) in the survey can be found at:

<http://patrickbohan.elementfx.com/BFS.htm>. Click on the link "Survey Data" and look at the excel file tab titled "Correlation Results" to find statistical correlation data between variables (t-statistic data). [8] This excel file was included as supplementary data.

The data was first analyzed to determine if outliers exist for the data of each variable. Those data points outside of plus or minus 3 standard deviations are considered outliers and omitted from the calculation by placing brackets [] around the result.

Most of the models generated from the BFS survey have very low adjusted R^2 [8] values (the results are not linear) and are therefore, not very good models to predict future outcomes.

However t-statistic measurements are a good measure of correlation. T-statistic results with an absolute value greater than 2 have strong correlation (~95% probability), and t-statistic results

with an absolute value between 1.8 and 2 (~85 to 95% probability) is considered moderate correlation.

Each question in the survey, e.g., age, sex, experiencing pins and needles, how well yoga works, etc., is a variable or parameter (terms used interchangeably in this paper). When modeling variables using a linear regression model, there are two sets of variables - x and y. In the data result array (on the “Correlation Results” tab) the horizontal axis is for y variables and the vertical axis is for x variables (this is reversed from conventional algebra, but it facilitated getting the data into the table using this reversed format, in this case). Only one variable is allowed for y in a linear regression analysis, but multiple variables can be used for x (as long as there are more equations than unknowns). For this study, the x variables were grouped into seven classifications – General (G), Causes / Triggers (CA), Stressors (ST – those variables that can make BFS symptoms worse), Symptoms (S), Body Parts Affected (B), Remedies (RE), and Various (V). For instance, the General (G) classification of variables consists of 7 parameters: age, sex, region, number of years with symptoms, years diagnosed, EMG, and MRI. Various includes variables such as are symptoms getting worse over time or what part of the day is worse for symptoms.

The “Correlation Results” tab is a matrix of t-statistic results that is 57 long by 57 wide. T-statistic data was not obtained for x variables within the same classification. For instance, Age as a y variable was not modeled against other General (G) parameters such as sex, region, years with symptoms etc. These results are designated as “na” within the t-statistic matrix. Also, data in the matrix signified with ND (No Data) indicates the data was not linear dependent so no results were computed.

The data on the “BFS” tab was used to model all results except for Remedies (RE). When Remedy parameters were the y variable the excel file tab “BFS No Zero” data was used to model the results. It isn’t necessary to find correlation to remedies that people have not tried (a “0” response means people did not try the remedy). Hence, the data within the “BFS No Zero” tab is the same as the data on the “BFS” tab except “0” responses to Remedy questions were omitted from the data. The model results of RE parameters using the “BFS No Zero” tab will result in fewer data points (smaller sample size, n) in the model. For this reason, the results from these models may prove to be less conclusive because the data size is in some cases significantly smaller. Hence, when evaluating the data models for RE correlation, sample size should be noted. When Remedies (RE) are grouped together as the x variables, the data on the “BFS” tab was used to run the models. Only a few people have tried all potential remedies, hence the sample size would only be a single digit number if the “BFS No Zero” tab data was used to model RE results as the x variable.

Please note: this survey does meet human research criteria as outlined by the “Committee on Human Experimentation” and the “Helsinki Declaration of 1975” for the following reasons: 1. The survey was anonymous; 2. The participation in the survey was voluntary; 3. The privacy and confidentiality of the participants is maintained and protected; and 4. Survey participants were notified in advance that results would be shared publicly.

The video example of BFS in the lower leg of a subject, sent as supplementary data, is of the primary author of this paper. All tabulated data is original. The survey and subsequent data was not a clinical trial of any kind. Finally, the authors of this paper have no conflicts of interest and therefore, no information to disclose. In fact, the authors are independent and have no affiliation

to any university, group, organization, or company what so ever and therefore, received no funding for this project.

Results and Discussion:

We have identified nine categories of BFS associated with its main trigger, and have found associated, common characteristics for each one.

As an example, one can examine the results of one y parameter, Stress. In the survey, participants were asked if they believe a stressful period in their lives triggered their BFS symptoms (yes or no). Six Stress linear regression models were run using Stress as the y variable and G, S, ST, B, RE, and V classification of parameters as x variables respectively. These results are displayed in Tables 1 through 7 which provide t-statistic data for each parameter versus stress. The Tables (1 through 7) also contain a summary from the “Correlation” tab results to include those parameters with the strongest correlation versus the listed variable when it is modeled as the y variable. Parenthesis () around the result indicates a negative correlation.

Table 1: Stress vs. General

Parameter	t statistic (No Units)	Correlation (<85% Probability)
Age	-2.59	Cramps, Acupuncture, (Stress), (Stress1), Remedies, (Upper Leg)
Sex	0.08	(Yoga)
Region	1.79	(Prescription Drugs), Stress, (History)
Years Diagnosed (YD)	0.82	(Yoga), Altitude
Years with BFS Symptoms (YBFS)	-0.47	Benzodiazepine, (Yoga), Remedies
EMG	-2.52	Exercise1, Sickness, (Stress1), Anti-Seizure, Muscle Relaxants, (Yoga), Remedies
MRI	1.45	(Twitching), Pins and Needles, Muscle Fatigue and Weakness, (Numbness), Remedies

Table 2: Stress vs. Stressors

Parameter	t statistic (No Units)	Correlation (<85% Probability)
Sickness1	-2.73	Sensitivity to Temperatures, Exercise, (Acupuncture), (Stress)
Exercise1	5.35	(Age), (EMG), Stress, (Anti-Seizure), Homeopathic, Missing
Stress / Anxiety 1 (SA1)	-1.28	Sensitivity to Temperatures, Sleeping Pills, (Acupuncture), Missing, Sickness

Table 3: Stress vs. Symptoms

Parameter	t statistic (No Units)	Correlation (<85% Probability)
Twitching	-0.78	(MRI), Time, Day, Lower Leg, Prescription Drugs
Pins and Needles (PN)	-0.51	Time, Feet, Sickness1, Flu Shot, (Chest), (Homeopathic), (Yoga)
Cramps	-0.63	Hands, Supplements, Time
Muscle Fatigue and Weakness (MFW)	-0.08	Back
Headaches	-0.62	(Exercise), (Chest), (Acupuncture), Head, Homeopathic, Massage, (Supplements)
Itching	3.09	Stress, Head
Numbness	-0.71	Anti-Depressants, (Day), (Exercise)
Muscle Stiffness (MS)	-1.33	Years with Symptoms, Sickness, Head, (Exercise)
Vibration / Buzzing Sensation (VBS)	1.01	Sickness1, Feet, Abdomen, (Altitude)
Muscle Pain / Soreness (MPS)	1.18	Exercise1, Anti-Depressants
Sensitivity to Temperatures (STT)	-0.80	Exercise1, (Abdomen), Muscle Relaxants, Sickness1, Homeopathic, Missing

Table 4: Stress vs. Body Part

Parameter	t statistic (No Units)	Correlation (<85% Probability)
Feet	-0.34	Muscle Relaxants, Sickness1, Twitching
Lower Leg (LL)	-1.71	Twitching, Sickness1, Cramps, Time
Upper Leg (UL)	1.84	(Age), Muscle Fatigue, Time, Prescription Drugs

Hip / Buttock Region (HBR)	-1.68	Prescription Drugs, Stress1, Sensitivity to Temperatures
Back	1.65	(Age), Muscle Fatigue, Muscle Vibration
Abdomen	0.28	(Age), Muscle Vibration
Chest	-1.49	Prescription Drugs, Muscle Vibration, (Diet)
Neck / Head (NH)	2.59	Stress, Stress1, Remedies, Time, (Flu Shot)
Hands	-1.38	(Age), (Years Diagnosed), (Prescription Drugs)
Arms / Shoulder (AS)	-0.35	(Age), EMG, Exercise1

Table 5: Stress vs. Remedies

Parameter	t statistic (No Units)	Correlation (<85% Probability)
Anti-Convulsants (AC)	-0.55	EMG, Sickness1, Exercise, (Chest)
Anti-Depressants (AD)	0.35	(Twitching), (Day), Stress
Sleeping Pills (SP)	-0.97	Region, (Abdomen), (Remedies)
Muscle Relaxants (MR)	-2.09	(Chemicals), Sickness
Homeopathic Treatments (HT)	0.23	Stress
Supplements	0.83	Exercise, Cramps, Muscle Vibration, Sensitivity to Temperatures
Diet	-0.26	Muscle Vibration
Acupuncture	0.65	(Sex), History, Cramps, (Numbness), (Sickness)
Massage	0.08	(Sex), Itching, (Lower Leg)
Yoga	-.15	(Sex)
Benzodiazepine Drugs (BD)	1.67	No Correlation

Table 6: Stress vs. Various

Parameter	t statistic (No Units)	Correlation (<85% Probability)
Remedies	-0.76	Prescription Drugs, (Hip), Head, Anti-Seizure
Time	-1.83	Sex, Chemicals, Twitching, Pins and Needles, (Feet), (Back), Hands, Anti-Seizure, (Homeopathic)
Day	1.23	Twitching, (Hip), (Sleeping Pills), Supplements
Missing	0.99	Sickness, Sickness1, Pins and Needles, Chemicals
Altitude	-1.147	Years Diagnosed

Table 7: Cause (Trigger) Correlation

Parameter	Correlation (<85% Probability)
Flu Shot (FS)	Pins and Needles, Acupuncture
Chemicals	(Hip), (Chest), Arms, Time, Missing, (MRI), Twitching, Pins and Needles
Prescription Drugs (PD)	(Sex), Upper Leg, Missing, Sickness, (Hands), Remedies
Spine and Neck Injury (SNI)	Feet
Sickness	(Years with Symptoms), Sickness1, (Arms), Missing, (Headaches), Sensitivity to Temperatures, Hands, Muscle Fatigue
Exercise	Exercise1, Muscle Vibration, Supplements, (Headaches), (Hands), (Itching)
Stress / Anxiety (SA)	(EMG), Stress1, Itching, (Muscle Relaxants), (Age), Head, (Time), Upper Leg
History	(Region), Arms, Exercise, Acupuncture
Other	Arms, (Day), (MRI)

From the correlation data (Table 1 through Table 7), unique forms or groups of BFS are defined, that stem from or are triggered by different ailments or conditions (listed in order from most common type to least common type).

Stress BFS [4] – This is the most common classification and it is the one group that can see its symptoms reduce over time by managing their anxiety levels. It is not surprising this classification of BFS sufferers are more likely to consist of the most common statistical trends of BFS sufferers (had an EMG, are male, suffer twitching in the lower leg, and symptoms are exasperated by Stress). Stress BFS is more likely to afflict younger people. Stress will exasperate symptoms. Symptoms include itching where the neck and head region of the body are most likely to be affected. Symptoms can affect the upper leg and people with stress BFS are less likely to get an EMG. Muscle relaxants do not work very well to combat symptoms.

Sickness BFS [2] – The main characteristic of this BFS group is that symptoms are exasperated by an illness. Symptoms are less likely to affect the arm and shoulder region than other types. A person inflicted with sickness BFS is more likely to be sensitive to temperatures and suffer from muscle fatigue and weakness, but less likely to get headaches. People in this classification of BFS are more likely to find a remedy that works for them that was not included in the survey, but anti-seizure medications appear to help.

Prescription Drug BFS [4] – This category of BFS sufferers believe their symptoms started following the use of a prescription drug, most commonly the use of antibiotics to combat infections, or medication for attention deficit disorder or medication to combat allergies. A sickness will make their condition worse and women are more likely to be afflicted than males. This classification of BFS sufferers is likely to share the same statistical trends of BFS suffers (had an EMG, are Male, suffer Twitching in the Lower Leg, and symptoms are exasperated by Stress). Data indicates people afflicted with this type of BFS have symptoms that can affect many regions of their body (i.e., symptoms are not localized). Symptoms are less likely to occur in the hands, but more likely to occur in the upper leg region of the body. People in this group also feel a potential remedy that works well for them was not included in the survey. There is no data to suggest what other remedies that BFS sufferers have tried.

Exercise BFS [2] – People with this ailment of BFS believe their symptoms started due to hard and or strenuous exercise. People classified in this group can control their symptoms by cutting back on exercise. Symptoms can consist of muscle vibrations and will be worse in the

leg region, but will be less likely to occur in the hands. People in this group generally suffer from more symptoms than other categories of BFS, however, this group appears to have the best opportunity to find remedies. They seem to find some relief from supplements (e.g., magnesium, potassium, and quinine) or anti-seizure medications. People in this group are less likely to suffer from headaches and itching.

History BFS [1] – There is evidence that neuromuscular joint disorders such as BFS can be hereditary. People in this group are more likely to come from the U.S. and have suffered from symptoms longer than others. Symptoms are more likely to occur in the arms and shoulders. Acupuncture is unlikely to alleviate symptoms. People in this group also feel exercise can exasperate symptoms.

Spine Injury BFS [2] – This is the hardest class to describe because it does not have a strong correlation with other parameters, however, it's easier to identify. People with a spine injury are more likely to see symptoms in their feet than in their upper leg and arms. People with a spine injury are also less likely to find a remedy to work for them probably since they have physical damage to their bodies whereas other classifications are not related to injury.

Vaccine BFS [4] – This group of people believe their symptoms started after a vaccine, most notably the influenza vaccine. This classification of BFS has very little correlation to other parameters. The symptoms include pins and needles. Acupuncture may help to alleviate symptoms.

Chemical BFS [2] – This is the rarest classification of people who believe their symptoms started after being exposed to chemicals, most notably organophosphates used in pesticides and herbicides. People in this group are less likely to get an MRI even though their symptoms will get worse over time. Twitching and pins and needles are the primary

symptoms and will most likely occur in the arms. Finally, symptoms are less likely to occur in the hip, buttock and chest regions. Symptoms for this classification of BFS sufferers are more localized and finding a workable remedy is unlikely.

Other BFS – This is a group of people who feel their symptoms of BFS were triggered by something other than those classifications defined within this survey. People in this group are more likely to experience symptoms in the arms and shoulders. People are less likely to get a MRI to rule out MS. Symptoms are more likely to occur or be worse earlier in the day. Several other causes of BFS have been theorized including such causal factors of drug addiction/alcohol abuse, or gluten sensitivity. [4] Drug and alcohol addiction were not included in the study since the author believed admission may prevent people from participating in the survey.

In addition to identifying categories of BFS, the author was also able to draw some other conclusions from the results found in Tables 1 through 7. Some of these include: 1) cramping symptoms are more likely to occur in older people; 2) sufferers are more likely to get an MRI if they suffer from muscle fatigue, weakness or pins and needles, than if they suffer from twitching; 3) twitching, pins and needles, and muscle fatigue symptoms get worse over time while muscle vibration symptoms improve over time; 4) symptoms in the feet and back improve over time, but symptoms in the legs and hands get worse over time; 5) altitude affects people older people's symptoms than those younger sufferers; 6) only people who suffer from stress induced BFS see their symptoms improve over time; 7) numbness and sensitivity to temperature symptoms are generally worse earlier in the day while twitching symptoms are worse later in the day.

Conclusions:

The nine forms of BFS hypothesized in this paper are unique because there is very little overlap between the correlation of symptoms and remedies for these different BFS classifications. In some cases, people believe they have had more than one potential trigger – meaning they may have a combination of BFS types. For instance, with the author’s own experience with BFS, he believes there may have been a multitude of triggers for his symptoms including exercise (high altitude climbing and mountaineering), history (grandmother with Parkinson’s disease), sickness (had a gamma globulin deficiency that caused infectious boils), prescription drugs (regular use of antibiotics for folliculitis, and allergy medications), and most like others surveyed, had experienced a great deal of stress.

It is possible that once afflicted with BFS that other triggers can make symptoms worse and introduce new symptoms. This should be explored further. Our findings show that each form of BFS is unique. Considering this uniqueness in this umbrella diagnosis, it is no surprise that it is difficult to cure or find solutions to alleviate symptoms. While BFS is benign, it is still an illness for which its sufferers would benefit from an effective treatment or cure. We hope by identifying these categories that further research can take place on exploring them further, and help doctors understand this mysterious ailment better.

List of Abbreviations:

BFS – Benign Fasciculation Syndrome

PNH – Peripheral Nerve Hyperexcitation

ALS - Amyotrophic Lateral Sclerosis

MS - Multiple Sclerosis

CA – Causes; V – Various; G – General; RE – Remedies; B – Body Part; S – Symptoms; ST - Stressors

Competing Interests:

The authors do not have any affiliation to any institution (university or company) and received no grant support for this project and subsequent paper. Therefore, the authors have no competing interests.

Author Contributions:

The authors and contributors have agreed to conditions noted in the authorship agreement and approved this manuscript for publication.

PTB created the survey, analyzed the data, and wrote the paper draft.

MW edited the draft and did research of prior work on BFS used in the background section.

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Additional files provided with this submission:

Additional file 1: BFS_Questionnaire5.xls, 539K

<http://www.biomedcentral.com/imedia/950409877281883/supp1.xls>