Trickle Research

Every raging river, every great lake, every deep blue sea starts … with a trickle

# Initiating Research Coverage

# BioSig Technologies, Inc.

**(NasdaqCM: BSGM)**

**Report Date: 04/05/20**

**12- 24 month Price Target: $10.50**

**Allocation: 4**

**Closing Stock Price at Initiation (Closing Px:04 /03/20): $5.14**

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**Disclosure:** Portions of this report are excerpted from BioSig's filings, website(s), presentations or other public collateral. We have attempted to identify those excerpts by *italicizing* them in the text.

## Company Overview

BioSig is *"a commercial stage medical device company that has developed a proprietary biomedical signal processing technology platform to extract information from physiologic signals. Their initial emphasis is on providing intracardiac signal information to electrophysiologists during electrophysiology ("EP") studies and cardiac catheter ablation procedures for atrial fibrillation ("Afib" or "AF") and ventricular tachycardia ("VT"). Cardiac catheter ablation is a procedure that involves delivery of energy through the tip of a catheter that scars or destroys heart tissue in order to correct heart rhythm disturbances".*

The Company's first product, PURE EP™ System is *"a proprietary signal acquisition and processing technology. The device is a computerized system intended for acquiring, digitizing, amplifying, filtering, measuring and calculating, displaying, recording and storing of electrocardiographic and intracardiac signals for patients undergoing electrophysiology (EP) procedures in an EP laboratory. The device aims to minimize noise and artifacts and acquire high-fidelity cardiac signals. Improving fidelity of acquired cardiac signals may potentially increase the diagnostic value of these signals, thereby possibly improving accuracy and efficiency of the EP studies and related procedures".*

Atrial fibrillation is the most common cardiac arrhythmia, and industry estimates suggest it affects 6 million people in the U.S. alone. According to the CDC, AFib causes about 1 in 7 strokes and strokes caused by complications from AFib tend to be more severe than strokes with other underlying causes. Briefly, in people with AFib, an irregular heartbeat in the upper chambers of the heart prohibits blood flow to the lower chambers which in turn can cause blood to pool/clot. If those clots are carried to the brain, they can result in stroke. The CDC further notes "m*ore than 454,000 hospitalizations with AFib as the primary diagnosis happen each year in the United States, and the condition contributes to about 158,000 deaths each year. The death rate from AFib as the primary or a contributing cause of death has been rising for more than two decades".*

Currently, there are two general standards of care related to the treatment of Afib; drugs and/or surgery. Drugs prescribed for Afib typically include things like beta blockers to reduce heart rate and/or blood thinners to mitigate the clotting. There are multiple types of Afib surgery as well, depending on the cause of irregular heartbeat. Surgery options typically include some sort of "ablation" or intentional scarring of portions of the heart that are creating the aberrant electrical impulses, and stray electrical signals that lead to the arrhythmia. As we will delineate further in this report, in some instances, surgery is the preferred approach, however, current ablation technologies do not always allow for the accurate ablation of the precise area of the heart that is creating the irregular impulse. For a variety of reasons we will discuss throughout this report, Afib ablation surgery is not always successful and much of that shortfall involves the inability of current technology to precise target the misfiring portions of the heart. In short, BioSig's technology improves that precision.

Given the above background, recognize that as a result of a number of milestones over the past several quarters, BioSig is just entering the commercialization phase of PURE EP™. These milestones include (among other things) the following:

- In March 2017 BioSig *"signed a ten-year strategic agreement with Mayo Clinic and Mayo Clinic Ventures. This new, expanded collaboration with Mayo builds upon the work realized under the Advanced Clinical Research Program that was signed with Mayo Clinic in March 2016*. The agreement included collaboration with "*leading Mayo electrophysiologists, to develop advanced clinical features and applications for its PURE EP System, as well as to leverage the company's core competency in physiologic signal processing to develop future technologies. Mayo is expected to contribute know-how, intellectual property and clinical support to the partnership. The company expects joint patent filings to come out of the relationship"*.

- In March 2018, the Company filed a 510(k) application with the U.S. Food and Drug Administration (FDA) for their first product the PURE EP™ System, and in August 2018, they received 510(k) clearance for the device. Obviously, that was a milestone.

- In November 2018, the Company formed NeuroClear Technologies, Inc. ("NCTI"), a Delaware Corporation, for the purpose to pursue additional applications of the PURE EP™ signal processing technology outside of electrophysiology. In September 2019, NeuroClear Technologies, Inc. raised $3.7 million. *"In subsequent private placements closed from October 21, 2019, through December 19, 2019, NeuroClear sold an aggregate of 157,690 shares of NeuroClear's common stock at $8.35 per share, for an aggregate consideration of $1,316,664, pursuant to a securities purchase agreement with certain accredited investors".* SO then, in aggregate, NeuroClear raised approximately $5 million We believe this portion of the business could provide an additional valuation leg to the BioSig.

- In July 2019 BioSig received nearly $1 million in financing from the Mayo Clinic, which purchased 252,000 shares of BioSig common stock at $3.75 per share ($945,000).

- In February 2020 BioSig successfully completed its 100th patient cases with its PURE EP(tm) System.

- Also, in February 2020, BioSig Technologies, completed the public offering of 2,500,000 shares of its common stock at $4.00 per share or gross proceeds of $10 million.

As a result of these and other topical milestones, we believe BioSig will enter commercialization and PURE EP™ sales in the current fiscal year (2020). We would add, they are also in the midst of trials aimed at establishing the efficacy of PURE EP versus current standards. We believe positive results in that regard could markedly enhance their sales efforts.

BioSig Technologies Inc. (the "Company" and/or "BioSig") was initially incorporated on February 24, 2009 under the laws of the State of Nevada and subsequently re-incorporated in the state of Delaware in 2011. The Company went public via an Effective S-1 registration statement in mid-2014. The Company's IP portfolio is significant with 26 allowed/issued worldwide design and utility patents.

## Industry Overview

We don't need to dig too deep to conclude that healthcare innovation over the past 50 years, both on the pharma side and on the medical device side have been remarkable. While we hear a great deal these days about the high costs of healthcare, much of the equation involves the development of therapies that looked more like science fiction a few decades ago. We would argue, that probably includes as much as anything the marked improvement of our general (and specific) understanding of the complexities of the human body and its disease states. While we can certainly argue about the "fair" price tag of those developments, therapies and understandings, as well as ultimately how and who is going to allocate and pay for them, the magnitude and import of the advances are from our perspective profoundly and indisputably beneficial to mankind. Specifically, the space which BioSig's first product occupies, cardiac electrophysiology, is no exception.

The Official Journal of the Canadian Society for Clinical Investigation provides an eloquent account of the history and advancement of electrophysiology (https://cimonline.ca/index.php/cim/article/view/2794 By: R. Ducas) :

> *Throughout the ages there has been little else as impressive to both the patient and physician as abnormalities and aberrancy in the heartbeat. It was through careful observation and characterization of physiology that the tactile measurement of the pulse translated and evolved into the vast field of cardiology we know today. For thousands of years the only window physicians had into the hearts of their*

*patients was through palpation of a pulse. The ancient Egyptians, Chinese and Greeks are credited with measurement and characterization of peripheral pulses and their association with illness. The work of Claudius Galen (129-199) furthered the association of pulse to cardiac function. Galen's work set the stage for William Harvey's (1578-1657) first description of the circulatory system and thereafter the function of the heart. However, it was not until the advent of electrocardiography that modern, efficient studies of cardiac rhythm began. The work of August Desir Waller (1856-1922) and Willem Einthoven (1860-1927) revolutionized the study of arrhythmia with the advent of the electrocardiogram (ECG). This instrument transformed the diagnosis of heart disease and catalyzed the creation of cardiology as a subspecialty. It was through the use of the ECG that cardiac rhythm disorders were first characterized. James Mackenzie and Arthur Cushny first recognized atrial fibrillation and the work of Drs. Wolf, Parkinson and White theorized the neuro-cardiac function of the heart. Further study led to the discovery of the Purkinje system and the mechanics of cardiac electrical conduction. Medicine has thus used many approaches in the treatment of arrhythmias, employing pharmacology, electricity and surgery, with an ever-evolving spectrum of treatment. It was through observation, innovation and determination that diseases of the heart are understood and treated today.*

Further, from the American Journal of Cardiology (Gregory K Feld, MD Published: **August 16, 2004**):

*"The field of clinical cardiac electrophysiology has evolved dramatically over the last 30 (*now 45*) years, beginning with description of the first His bundle recording in 1969. Subsequently, in the early 1970s, more sophisticated diagnostic electrophysiologic techniques were developed to diagnose and guide drug treatment of arrhythmias. These diagnostic techniques were further advanced during the late 1970s and 1980s to electrically map arrhythmias and guide their surgical ablation. Surgical treatments of both supraventricular and ventricular arrhythmias proliferated in the 1970s and 1980s, with overall excellent results. However, because of the morbidity and mortality associated with arrhythmia surgery, it was ultimately replaced in the 1990s by radiofrequency catheter ablation (RFCA) for treatment of most forms of supraventricular tachycardia and idiopathic ventricular tachycardia, and by the automatic implantable cardioverter defibrillator (ICD) for treatment of life-threatening ventricular arrhythmias associated with coronary artery disease and dilated cardiomyopathy".*

To be sure, electrophysiology has advanced markedly over the past 3 decades and that includes both the processes and the frequency of ablation therapies to treat atrial fibrillation, ventricular tachycardia ("VT") and other associated arrhythmias. We believe the advances in these procedures has led to considerable overall growth in ablation treatment and along those lines, we believe further progress in those procedures will continue to contribute to that growth. Specifically, industry estimates suggest that ablation procedures will continue to grow into the foreseeable future, supported by a considerable network of hospitals/EP labs both inside and outside of the U.S.:

The growth in arrhythmia ablation is being driven by a handful of variables. First, there are multiple types of arrhythmias, some more complex and acute than others. As a caveat to the following and as we often note in our research, industry statistics from government and other respected industry sources often vary widely from one to the next. Those variations often have to do with differing study designs and methodologies around the collection, interpretation and extrapolation of that information. It's not a perfect science by any means, but it's the best we have. We tend to focus more on the identifiable trends that support these underlying market size theses and there are certainly some of those we can hang our hats on in this case. With that said, here is a collection of some of that industry data (and supporting trends) that we think are topical regarding both collective and specific arrhythmias.

First, atrial fibrillation is the most common cardiac arrhythmia. Estimates indicate 10 million people in the U.S. and the EU are affected by Afib, and collectively, that number will increase by 250,000 to 500,000 per year. The incidence of Afib increases with age, and it is estimated that 5-10% of the population above the age of 70 have Afib. The lifetime risk for developing AF is 25% for individuals over 40 years of age. PubMed.org suggests that (U.S.) "*Afib prevalence is projected to increase from 5.2 million in 2010 to 12.1 million cases in 2030*". The CDC notes that *"more than 454,000 hospitalizations with AFib as the primary diagnosis happen each year in the United States. The condition contributes to about 158,000 deaths each year. The death rate from AFib as the primary or a contributing cause of death has been rising for more than two decades*".

A 2015 article from Current Cardiology Revue (Volume 11, Issue 3) entitled; **How does Chronic Atrial Fibrillation Influence Mortality in the Modern Treatment Era?** (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4558350/) notes the following:

> *"Large population studies both in North America and Europe have demonstrated incontrovertibly the impact of AF upon mortality. The landmark Framingham Heart Study analyzed a cohort of 621 individuals who developed AF (out of a study population of over 5000) during 40 years of follow-up; the excess in all-cause mortality rates attributable to AF was 50% for men, and 90% for women, even when controlled for the presence of a wide range of cardiovascular co-morbidities [5]. This effect on mortality became apparent early, with 15% of deaths occurring within 30 days of diagnosis. Amongst the group of patients aged between 55-74 years, the 10-year mortality was 61.5% in men with AF compared to 30% in men without AF. Amongst women in a similar age group, the 10-year mortality was 57.6% in the AF group versus 20.9% in women without AF. Similar findings have been found from many other cohorts. The Renfrew-Paisley study followed-up 100 patients with AF for 20 years out of a cohort of over 15,000 men and women aged between 45-64 years in two Scottish towns and showed that AF increased all-cause mortality by 50% amongst men and 120% amongst women".*

Further a different article published in March 2017 from the Journal of Cardiology (Volume 14, Issue 4) titled **"Atrial Fibrillation: The Current Epidemic"** (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5460066/ ) suggests that:

> *"The consequences of AF have been clearly established in multiple large observational cohort studies and include increased stroke and systemic embolism rates if no oral anticoagulation is prescribed, with increased morbidity and mortality. With the worldwide aging of the population characterized by a large influx of "baby boomers" with or without risk factors for developing* ***AF, an epidemic is forecasted within the next 10 to 20 years".***

Clearly, Afib appears poised to continue to be a marked problem for a growing portion of the world population for well into the foreseeable future, driven in part by the aging of a large population demographic, but perhaps also because of other social factors that contribute to poor cardiovascular health. Moreover, beyond Afib there are other arrhythmias that are also treated with ablation therapy that in turn likely enhance BioSig's opportunity. For instance, ventricular tachycardia ("VT") is an arrhythmia in heart's ventricles (the two lower chambers of the heart). While Afib may be the most common arrythmia, ventricular tachycardia may be the most dangerous. A CDC study from 2005-2010 reported that there were 300,000 sudden cardiac death's in the U.S. each year and VF

is responsible for a considerable portion of those. To that end, the peer reviewed Mayo Clinical Proceedings (2009 Mar; 84(3): 289–297) notes that "*catheter ablation has the potential to control recurrent VT without the adverse effects of antiarrhythmic drug therapy. As such, it has an important role in nearly all forms of monomorphic VT that are recurrent and not responsive to medical therapy. In patients with symptomatic idiopathic VT, catheter ablation is a reasonable option when β-blockers or nondihydropyridine calcium channel blockers fail or are undesirable. For VTs that originate from the outflow tract regions, ablation is successful in 80% to 90% of patients…"*

In conjunction with the growing arrhythmia problem(s), ablation therapy is a well-established, safe and effective treatment for a variety of both common and deadly arrhythmias. At the same time, as we noted above, ablation is not the only available treatment for arrhythmias, as there are a handful of drug alternatives, for instance blood thinners to reduce the risk of Afib related stroke, as well as betablockers to slow heart rate as well as others. While we think the prior narrative provides a good argument for the notion that arrythmia is a growing health problem that will require more aggregate treatment going forward, given the existence of alternative therapies that narrative does not necessarily speak to the corresponding growth of ablation therapy and therefore any role that PURE EP™ might play in that going forward. In part because of personal experience, as we prepared this research the notion of the effectiveness of ablation vis-à-vis drug therapies is a data point that we have viewed as germane to our analysis. To that end, there has been a major study aimed at trying to ascertain the effectiveness of ablation versus drug therapy.

- **The CABANA Trial**

The Catheter Ablation vs Antiarrhythmic Drug Therapy for Atrial Fibrillation ("CABANA") trial, is/was *"an investigator-initiated, multicenter, prospective, randomized, open-label clinical trial funded by the National Heart, Lung, and Blood Institute and industry partners".*

*"The CABANA Trial had the overall goal of establishing the appropriate roles for medical and ablative intervention for atrial fibrillation (AF). The CABANA Trial was designed to test the hypothesis that the treatment strategy of left atrial catheter ablation for the purpose of eliminating atrial fibrillation (AF) will be superior to current state-of-the-art therapy with either rate control or rhythm control drugs for decreasing the incidence of the composite endpoint of total mortality, disabling stroke, serious bleeding, or cardiac arrest in patients with untreated or incompletely treated AF".* https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6517320/ .

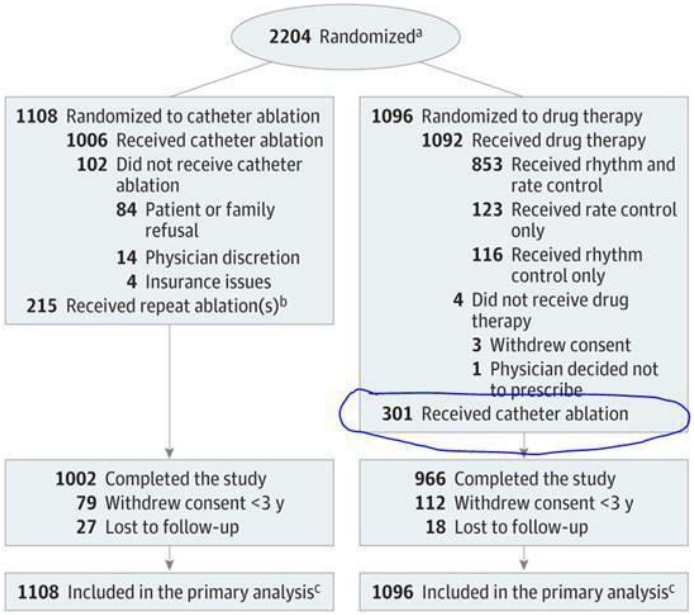
For those who wish to further review the trial and its conclusions in detail, the trial's Identifier Number at ClinicalTrials.gov is: NCT00911508.

The randomized clinical trial involved 2204 patients with atrial fibrillation and sought to compare catheter ablation with medical (drug) therapy, in terms of their respective efficacy in reducing the primary composite end points of death, disabling stroke, serious bleeding, or cardiac arrest. Between November 2009 and April 2016, 2204 patients from 126 sites across 10 countries were randomly assigned to receive catheter ablation (1108 patients) or drug therapy (1096 patients). Of those receiving drug therapy, 545 received 1 antiarrhythmic drug, 296 received 2, 106 received 3, and 22 received 4 or more different antiarrhythmic drugs over the course of the trial.

Here is one synopsis for the results of the trial: (https://www.ncbi.nlm.nih.gov/pubmed/30874766).

> *"Among patients with AF, the strategy of catheter ablation, compared with medical therapy, did not significantly reduce the primary composite end point of death, disabling stroke, serious bleeding, or cardiac arrest. However, the estimated treatment effect of catheter ablation was affected by lower-than-expected event rates and treatment crossovers, which should be considered in interpreting the results of the trial".*

To translate, the general *consensus* of the trial amongst medical professionals (and we use the term consensus lightly because there is often much disagreement amongst medical professionals regarding studies and their conclusions) is that for the treatment of Afib, ablation is not a measurably better option than drug therapy in terms of the study's stated endpoints in terms of either preventing death, disabling stroke, serious bleeding, or cardiac arrest. On the other hand, the study did suggest ablation reduced related hospitalization by 17% compared to drug therapy and it also established that ablation was largely safe. What is not apparent from the conclusions above is that the study did provide some evidence that ablation led to better "quality of life" conclusions, some of which are perhaps more subjective, although the study did determine that ablation was more effective in terms of post procedure recurrence of Afib. We would note, some who have evaluated the study are quick to note something we have highlighted in the trail summary table below:



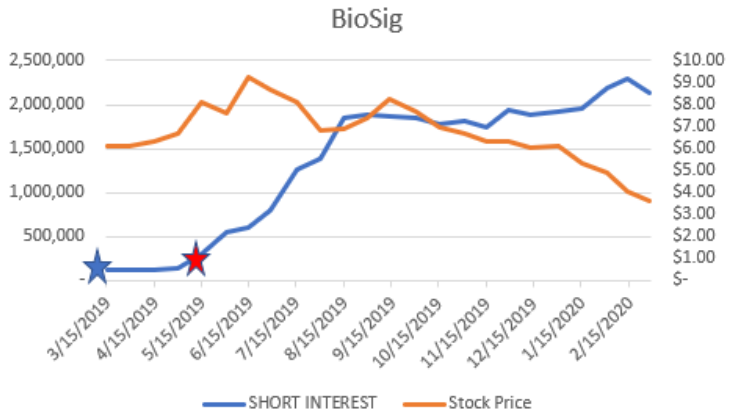

https://jamanetwork.com/journals/jama/fullarticle/2728676

Notice, 301 of the patients in the drug therapy group ultimately opted for ablation at some point in the trial. Significantly, those 301 patients represent 27% of all randomized patients on the drug therapy side and nearly 1/3rd of the drug therapy subjects that eventually completed the trial. Just to be clear, and without wading too far into the weeds, we understand the importance of reflecting study results within the rules of Intention-to-Treat analysis. To edify, Intention-to-Treat analysis considers each patient's outcome(s) *according to the groups to which they were originally assigned.* So, in the case of CABANA, the 301 subjects that switched over to ablation therapy inside of the trial, were still included in the drug therapy group for assessing the outcome/endpoints of the trial. Recognize, Intention-to-Treat protocols are meant to protect the trial from investigator bias. We get that. However, it doesn't keep us from wondering and asking, "what made nearly 1/3rd of the patients in the drug therapy group apparently opt to have ablations"? Further how would the outcomes/conclusions of the trial in terms of primary endpoints have differed if these "crossovers" had been accounted for? Again, we understand the importance of reporting results within the established Intention-to-Treat protocols, but we are still inclined to ask, if there is little difference in primary outcomes between ablation and drugs, why did so many subjects in the trial willingly switch to ablation? It seems a bit like the elephant in the room to us, but we suspect the answer lies in what some of the investigators have focused on, which is the quality of life issue.

We think it is important to note that there are accepted quality of life drawbacks to drug-based solutions for Afib and other arrhythmias. For instance, beta blockers essentially block the body's production of epinephrine (adrenaline), which reduces heart rate and blood pressure. The side effects of beta blockers include drowsiness,

fatigue, headaches and others. Generally, beta blockers are not meant to be long term solutions, and as such may not be optimal for chronic Afib or other arrhythmias. That may explain the "quality of life" advantages of a more permanent procedure like ablation vis-à-vis drugs and why many arrythmia sufferers might choose that path. In that event, it follows that ablation is likely to continue to be a desirable option for many arrythmia sufferers.

To reiterate, we have spent some time here attempting to illuminate the issues around the CABANA study because on the face, we believe the establishment of ablation as a safe, effective and in some cases better alternative to arrythmia treatment than non-invasive and less expensive drug therapies is relevant to the continued administration of ablation therapy and the willingness of payers to keep reimbursing it. Obviously, that notion is paramount to BioSig's opportunity. That said, we think the study albeit perhaps anecdotally, has negatively impacted the street's view of the Company and its resulting opportunity and valuation. The chart below reflects the relationship of BioSig's stock price relative to its short interest. The blue star on the chart reflects the public release of the CABANA study, while the red star reflects the date of a particularly negative article we found that took exception to the conclusions of report investigators. More generally, we think it took some time for interested parties to evaluate the conclusions as well. Succinctly, for some time now the stock has been under some short selling pressure, we think CABANA, right or wrong, has formed at least a portion of the short thesis. However, as we have noted, we don't believe (apparently contrary to others) that CABANA implies a less robust market for ablation therapy going forward. We would add, as fundamental analysts, we don't typically focus on short interest, but in this case it just happened to tie into a major due diligence point, so we included it here for additional color.




Moving on from CABANA, according to the American Board of Internal Medicine ("ABIM") as of 2019 there were approximately 2,600 *certified* Clinical Cardiac Electrophysiologists in the U.S. Further, industry estimates suggest that we add about 150 new EP's each year in the U.S., although we also lose some to retirement, so we estimate that net new EPs are likely in the 75 to 100 range annually. One of the graphics above suggests there are 3,425 EP labs in the U.S. According to the American Hospital Association, there are 6,146 hospitals in the U.S of which approximately 5,200 are community hospitals (excludes federal hospitals and others not accessible by the general public, such as prison hospitals or college infirmaries). We believe many of the largest hospitals support multiple EP labs and we also believe many of the federal hospitals (the VA for instance) also have labs. On the other side of the equation, there are many community hospitals that do not support EP labs. We estimate that perhaps 1/2 of all community hospitals do not have EP services. Adding and subtracting all of that, we can believe that there may be 3,425 EP labs in the U.S., but frankly, that number seems a bit high given the ABIM statistics that there are just 2,600 certified electrophysiologists nationwide. Obviously, that number is quite important to the exercise of trying to estimate the size of BioSig's potential market. As an adjunct to the analysis, in 2018 the Canadian Electrophysiology Labs Registry, indicated that there were 31 EP centers in Canada, and those supported anywhere from 1 to 4 labs each and averaging about 2 labs per center.

To take the above industry information a bit deeper, as we understand it, many of the country's largest hospitals have multiple EP labs and even those in the middle of that metric have more than one. That said, we estimate that

the largest 600-700 hospitals in the U.S likely support half of the total EP labs in the U.S. From another angle, we also think that the 50 largest healthcare systems in the U.S. likely control about 40% of all the community hospitals. Specifically, the Mayo Clinic, which has made a direct investment into BioSig, has 3 major campuses (Rochester, Minnesota, Scottsdale / Phoenix, Arizona, Jacksonville, Florida) as well as 23 hospitals and 60 total locations. Other entities that have participated in BioSig's trials, collectively include several associated hospitals as well:

- Texas Cardiac Arrhythmia Institute is part of the St. David's hospital systems, which supports 8 surgery centers and 8 hospitals in and around Austin Texas.
- Mount Sinai Health System has 9 (applicable) hospitals through New York City.
- Greenville Memorial Hospital is part of the Prisma Health System, which has 13 hospitals throughout South Carolina.
- The Indiana University systems has 18 hospitals across the state of Indiana.
- University of Pennsylvania (Penn Medicine) system has 6 hospitals and 10 multispecialty centers in and around Philadelphia.
- UCLA Health has a handful of major hospitals and dozens of other locations across California.

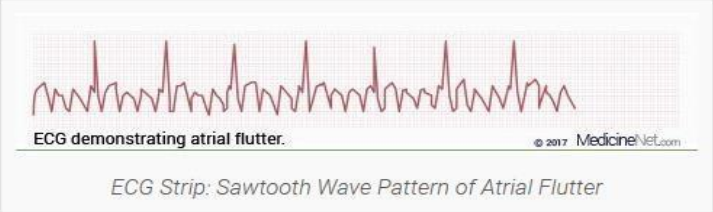
Succinctly, we believe that the healthcare organizations that BioSig has collaborated with to date in terms of its PURE EP™ System collectively include over 100 hospitals, all of which we believe likely have EP labs. Further, we think some of these locations have multiple labs. We think this bucket of potential sites represent a good place for BioSig to start given the each of these sites has had at least some exposure to PURE EP™. Further, we think if they can establish some reference customers among this group, they can use that success to perhaps open the doors to some of the other large hospital systems we noted above. Specifically, our unit sales estimates for 2020 thru 2022, are not dissimilar to the number of potential locations we believe exist amongst the systems they have collaborated with up to this point and we have highlighted above. More specifically, the Company's most robust collaborations have been with Mayo and with TCAI. Our current unit sale estimates for 2020 thru 2021 represent about 60%-65% of the total potential units that we estimate these groups currently support.

## Product/Technology Overview

To reiterate, Biosig's PURE EP™ System assists Electrophysiologists in performing catheter ablation procedures. Catheter ablation procedures are performed on patients who are experiencing heart arrhythmias. Heart arrhythmias are basically heartbeats that are "irregular" which means too fast, too slow or out of normal cadence sometimes referred to as "flutter". There are a host of believed "causes" associated with arrhythmia and they include both behavioral and hereditary factors.

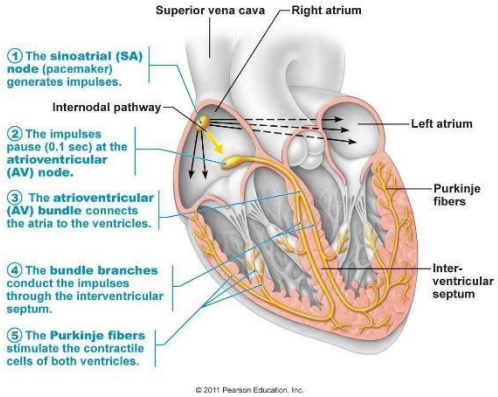
Generally, an Electrocardiogram ("ECG") is used to measure/detect arrhythmias, although there are also a handful of other technologies and procedures that are sometimes deployed to the same end. The ECG below reflects the differences between a normal heartbeat and one that is experiencing arrythmia:

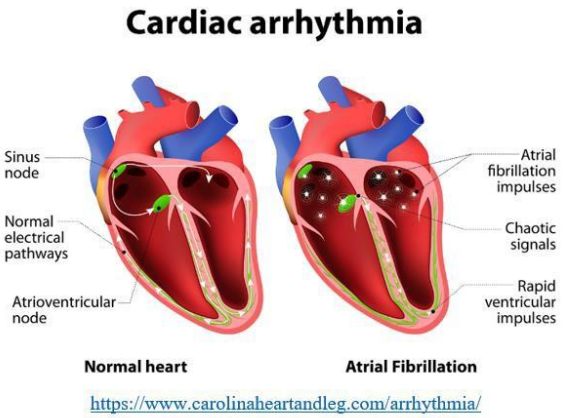

ECG strip of Normal Heart Rhythm




ECG Strip: Sawtooth Wave Pattern of Atrial Flutter

We will try not to belabor this, but the diagrams (to the left and below) depict the conducting system of the heart and the impact of arrhythmia on the same. As illustrated, the heart's electrical system includes a complex network of conductive fibers that generally fire in a consistent sequence that allow the different chambers of the heart to expand and contract in a regimented order. The heart is effectively a pump, and its electrical system controls its flow. That process starts with the sinoatrial node (a battery of sorts), which creates a regulated electrical stimulus that flows to the atrioventricular node, which acts a bit like a capacitor, holding the impulse long enough for the ventricles to clear. The impulse then passes through the atrioventricular bundle (often referred to as the bundle of HIS) and then to the Purkinje fibers throughout the ventricles. When operating properly, the system's impulse work in unison to create a consistent rate to pump blood through the body. As the body requires more blood flow (for instance during exercise), it beats faster to accommodate the requirement. The system is quite complex. In fact, it even includes some redundancies that allow it to continue operating when key elements of the system are compromised. For instance, Purkinje fibers do not typically set the heart rate, but they will pick up that slack in instances where the sinoatrial node has been compromised.



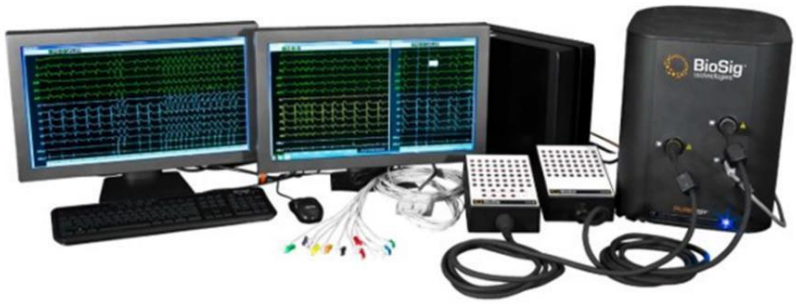

https://www.carolinaheartandleg.com/arrhythmia/

For a variety of reasons, some understood, and others not-so-understood, the system sometimes develops short circuits in some of the myriad points of impulse. Ablation involves identifying and then cauterizing (or freezing) the short circuits so they stop disrupting the normal rhythm of the heart. Again, because of the system's complexity and redundancy, portions of the system can be "disabled" and still allow for the reasonable operation of the whole.

The above said, the following narrative is excerpted from BioSig's filings. We think the Company provides a good overview of their product with respect to its function and advantages:

*The PURE EP™ System is a proprietary signal acquisition and processing technology. The device is a computerized system intended for acquiring, digitizing, amplifying, filtering, measuring and calculating, displaying, recording and storing of electrocardiographic and intracardiac signals for patients undergoing EP procedures in an EP laboratory under the supervision of licensed healthcare practitioners who are responsible for interpreting the data.*

*The current PURE EP System*




*The device aims to minimize noise and artifacts from cardiac recordings and acquire high-fidelity cardiac signals. Improving fidelity of acquired cardiac signals may potentially increase the diagnostic value of these signals, thereby possibly improving accuracy and efficiency of the EP studies and related procedures.*

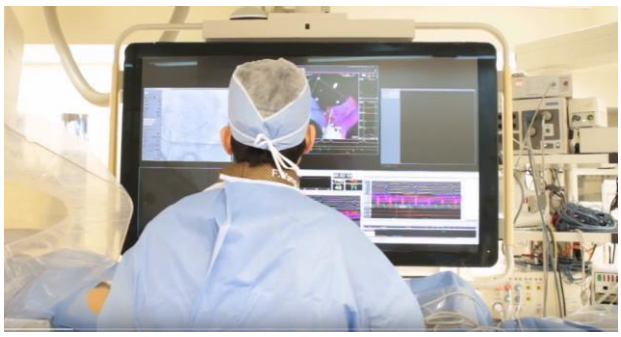
*Our initial focus is on improving intracardiac signal acquisition and enhancing diagnostic information for catheter ablation procedures for complex and potentially life-threatening arrhythmias like AF, the most common cardiac arrhythmia, and VT, an arrhythmia evidenced by a fast heart rhythm originating from the lower chambers of the heart.*

*We believe that the PURE EP System and its advanced signal processing tools may contribute to improvements in patient outcomes in connection with catheter ablation due to the following advantages over the EP recording systems currently available on the market:*

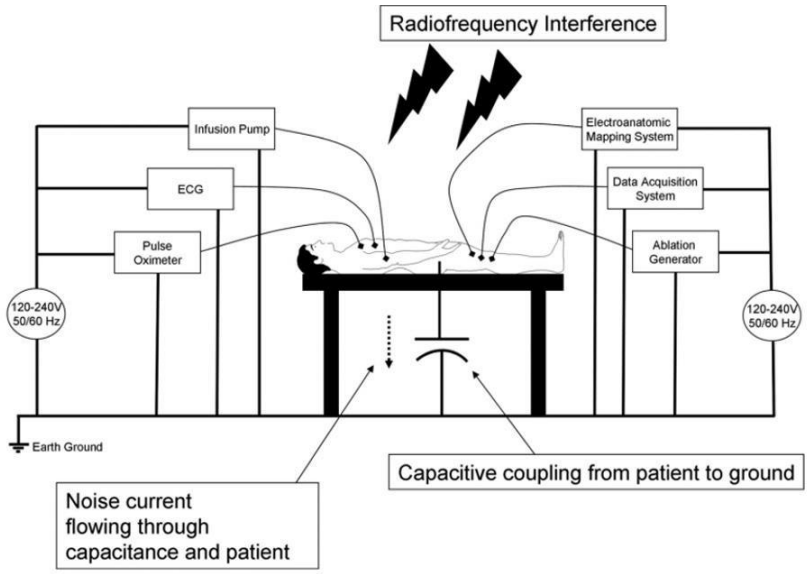
- *acquisition of raw cardiac signals enabled by proprietary system architecture;*
- *preserved signal fidelity;*
- *user interface optimized for enhanced visualization; and*
- *very low noise, maximum frequency bandwidth and wide dynamic range*

*We believe that these features may allow physicians to better determine precise ablation targets, strategy and end point of procedures with the objective of reducing the need for multiple procedures. The PURE EP System is intended to operate in conjunction with the existing EP lab equipment.*

- ***EP Lab Environment and EP Recording Systems***



*The EP lab environment and recording systems create significant amounts of noise and artifacts during EP procedures. Current surface and intracardiac recording systems typically consist of large workstations interconnected by a complex set of cables that contribute to significant amounts of noise during signal acquisition. Additional noise and artifacts generated from the EP lab equipment further hamper recordings of small electrophysiological potentials. Preserving spaciotemporal (space and time) characteristics of the signal in a very challenging EP recording environment is a difficult task. To remove noise and artifacts,*

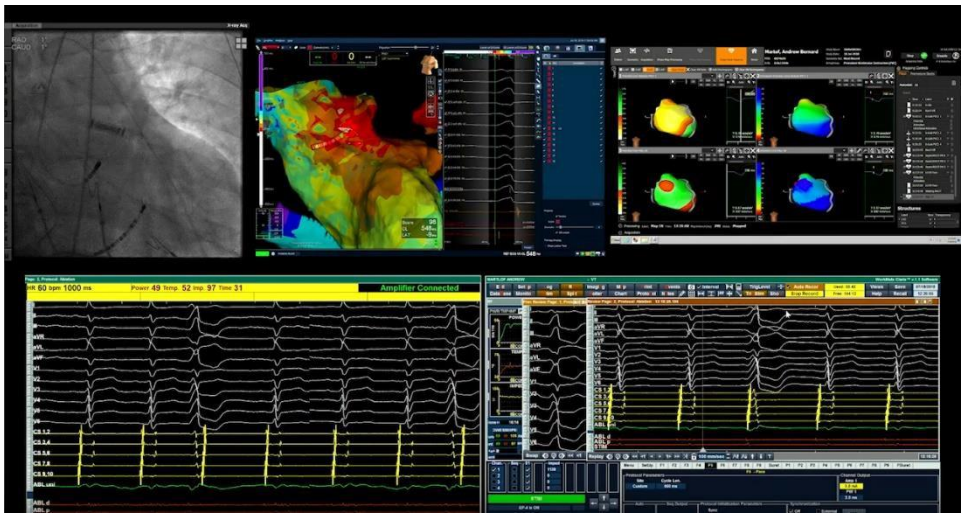


https://d1io3yog0oux5.cloudfront.net/_1cc60ae13e5eecff62191ed543724fdb/biosigtech/db/389/2404/pdf/IDSS+Presentation.pdf

*recorders that are currently on the market offer a family of low pass, high pass and notch filters, but these filters alter signal information context.*

*The shape and amplitude of electrocardiograms, unipolar and bipolar electrograms, and, consequently, reconstructed endocardial and epicardial maps, are influenced not only by electrophysiological and structural characteristics of the myocardial tissue involved, but with characteristics of the recording system. Amplitude and morphology of electrocardiogram and intracardiac signals are significantly affected by filters used to remove noise. Because of the number of amplitude and interval measurements made during an EP study, it is imperative that the recording system faithfully acquires surface electrocardiogram and intracardiac electrograms. We believe that the recording systems that are currently available on the market are ineffective in preserving the optimal amount of original information contained in the cardiac signals.*

*In addition, the EP lab consists of sophisticated equipment that requires an electrophysiologist to mentally integrate information from a number of sources during procedures. There are numerous monitors in an EP lab that provide and display this variety of information. An electrophysiologist needs to evaluate the acquired cardiac signals and the patient's responses to any induced arrhythmias during*

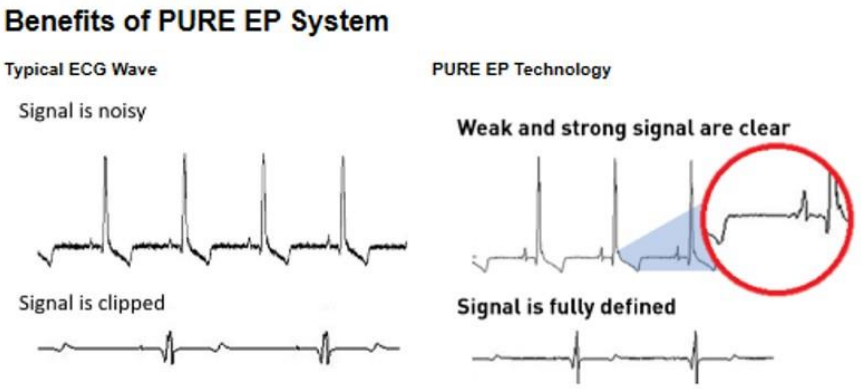


*the procedure. However, it can be difficult for an electrophysiologist to synthesize the disparate information produced by the numerous monitors in the lab and calculate the real-time, three-dimensional orientation of the anatomy and the location of the recording and ablation catheters. As the number of EP procedures increase, a variety of diagnostic and therapeutic ablation catheters are becoming more widely available and new highly specialized catheters are being developed. In addition, remote robotic and magnetic navigation systems are being developed to address limitations of dexterity in controlling the catheter tip, especially during complex arrhythmia*

*ablation procedures. We believe that, considering the improvements being made with respect to other equipment used in the EP lab and the continual increase of ablation procedures, the EP recorders currently available on the market are not sufficiently advanced with respect to the quality of their recordings to deliver adequate results. We believe that the PURE EP System will be able to deliver superior quality of recordings that will allow it to successfully integrate with the other advanced equipment found in the EP lab.*

*The requirement for optimal signal integrity is amplified during ablation treatments of AF and VT. Presently, one of the main objectives of the AF ablation procedure is to precisely identify, ablate and eliminate pulmonary vein potentials and one of the main objectives of the VT procedure is to map the arrhythmia substrate and precisely identify, ablate and eliminate small abnormal potentials. The information provided by recorders is essential for an electrophysiologist to determine ablation strategy during termination of both pulmonary vein potentials and VT. Therefore, it is important that the recording system's noise removal technique does not alter the appearance and fidelity of these potentials. As a result, it is necessary that any new signal processing technology preserves signal fidelity as much as possible during EP recordings; otherwise, the signals that are needed to guide the ablation procedures will be difficult to distinguish due to noise interference.*

The above said, below are two opinions regarding the benefits that PURE EP provides. We submit, the first illustration entitled "Benefits of PURE EP System" is from a BioSig's presentation. The second illustration entitled "Conclusion" is from a Powerpoint illustration from the Mayo Clinic. That presentation titled, **Enhanced Electrophysiology Recording Improves Signal Acquisition & Differentiation** was made in March 2016 at the 13th Annual Dead Sea Symposium; Tel Aviv, Israel. The presentation was prepared and delivered by doctors and researchers from Mayo Clinic; Ammar M Killu; Niyada Naksuk, K L Venkatachalam, Christopher V DeSimone, Nicholas Tan, Tom Foxall, Sina Fakhar, Budimir S Drakulic, Scott Suddendorf, Joanne Powers; Dorothy J Ladewig and Samuel J Asirvatham.




- These are diagrams of heart rhythms taken from the Pulmonary Vein, which brings blood from the lungs to the heart.
- This is an important location in determining ablation treatment for Afib, which current systems have difficulty in visualizing.
- The European Society of Cardiology stated "Additional unnecessary ablation and possibly complications can be avoided" by being able to clearly see signals from the Pulmonary Vein.
- On the left chart, with existing systems, the important but delicate high-frequency information is being drowned out by the noise which makes the signal looks thick.
- Rapid up and down curves show high-frequency information.
- High-frequency information is very valuable because signals close to the electrode position in the heart will have higher frequencies.
- In our PURE EP System the doctors can apply additional filters to acquire valuable clinical information.
- In the close-up of the signal in the circle on the right, you can see a short upward spike that is almost lost in the noise on the existing system's recording.
- In determining where to ablate, doctors look for exactly these types of small changes on these charts that are often filtered out or get lost in the noise you see on the left side of the chart.
- This currently results in more treatments and more hospital visits being required until the right areas are found and ablated.

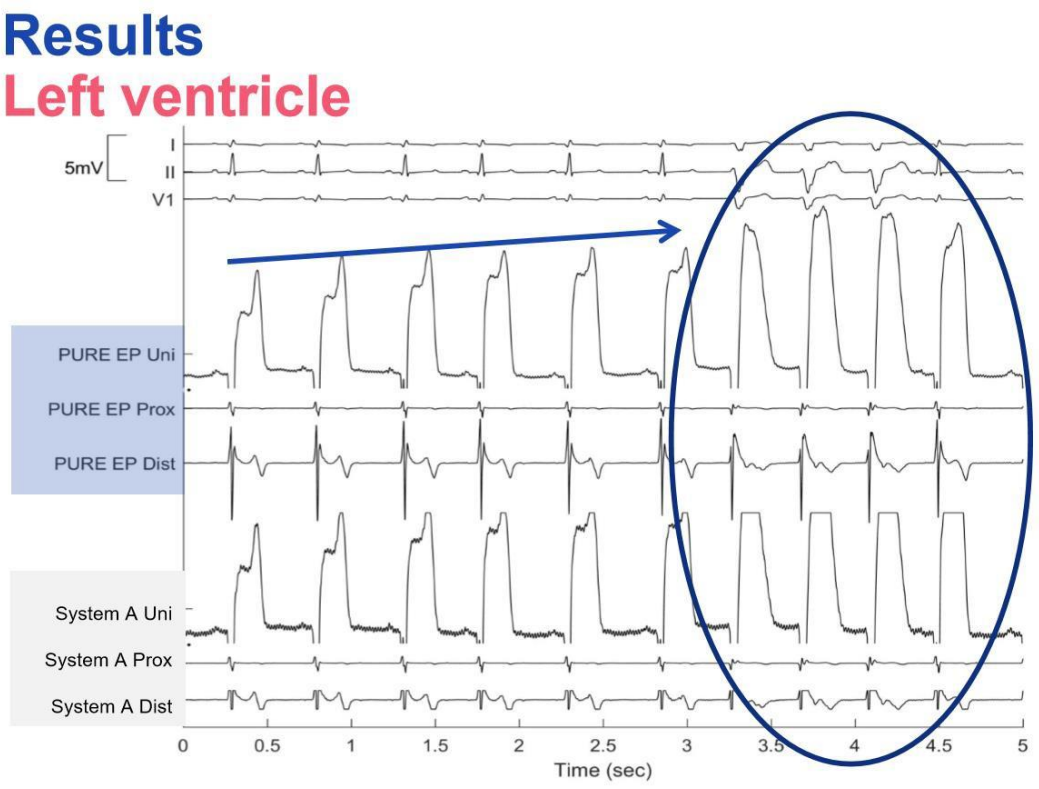
## Conclusion

- Improved cardiac signal recording
  - Signal-to-noise ratio
  - Visualization of juxtaposed signals
- Likely of value in EP procedures
- Further work needed

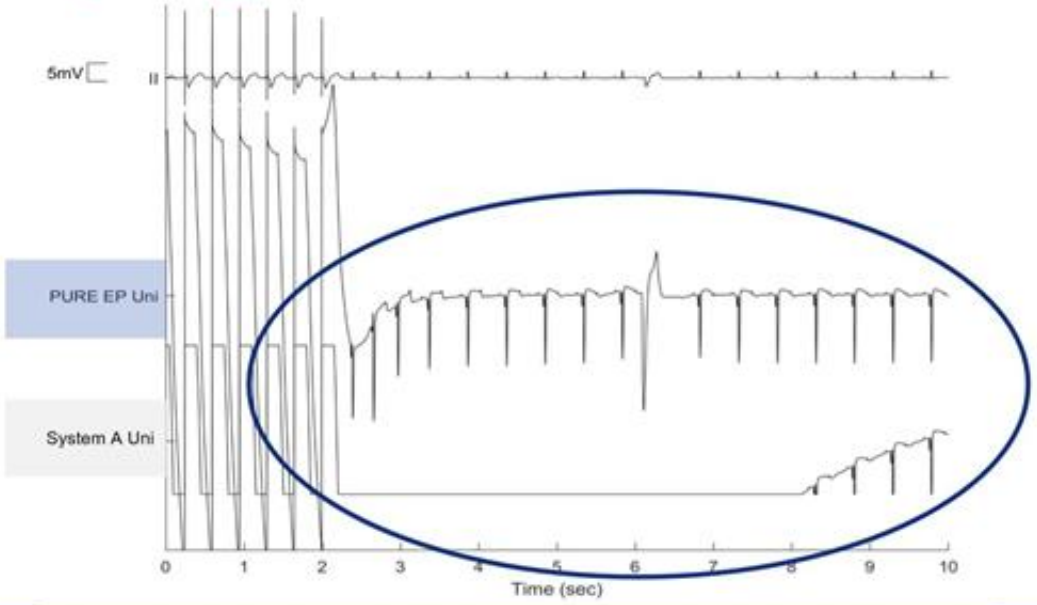
MAYO CLINIC



As perhaps some support of the above conclusions, below are several illustrations from the Mayo presentation we referenced above. We recognize these may mean more to attendees at an electrophysiology conference, but the differences are simple enough to identify even by an untrained eye in terms of the added detail provide by PURE EP vis-à-vis current standards.



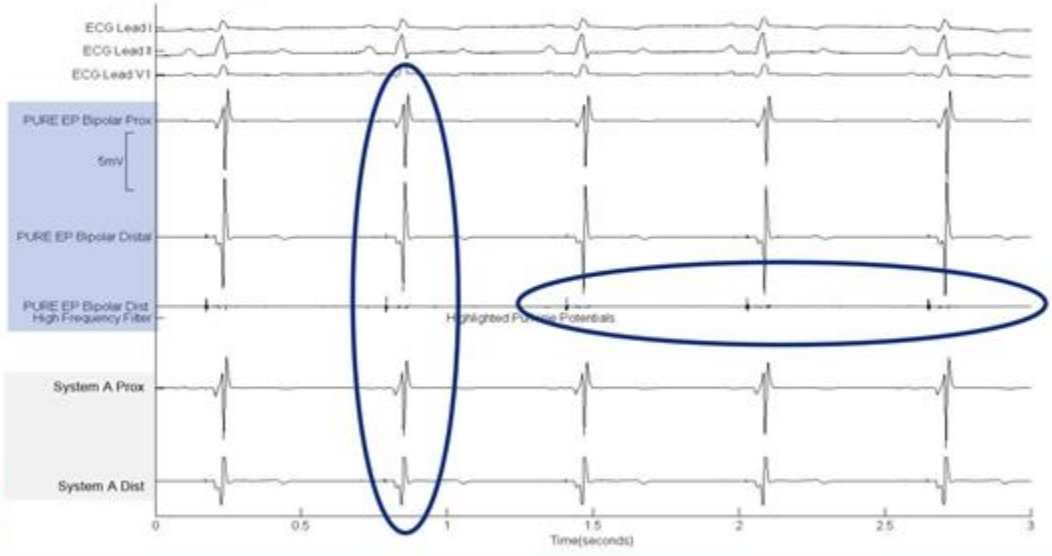
# Results
## LV pacing








# Results
## Papillary muscle



## System comparison

| | System A | PURE-EP™ |
|---|---|---|
| Bandwidth | 0.05-500 Hz (Based on 977 s/s) | 0.05-1,000 Hz |
| Sampling rate | 977 Samples/sec | 2,000 Samples/sec |
| Dynamic range | N/A (Noise unknown) | 105 dB |
| A/D converter | 12-bit | 24-bit |
| Minimum CMRR @ 60 Hz | 100 dB | 110 dB |
| Input impedance | $>10^9\ \Omega$ | >500 MΩ |
| Noise | | 1 µV RMS |
| Gain | Programmable (From 50-10,000 in 8 steps) | 10 |

To summarize this overview, there are a few things we know about the ablation market and/or BioSig's potential participation therein.

First, the population base of citizens approaching ages where cardiovascular disease and more specifically arrhythmia becomes more acute is growing. In addition, as we covered, there are treatments for arrhythmia outside of ablation, most notably drug therapies, but we think ablation is desirable for many arrythmia patients which we think will continue to provide a basis for the continued growth of ablation procedures. For instance, drugs like beta blockers have negative side effects that impact multiple metabolic and physiologic functions and for some patients may not represent a longer-term solution. In short, while ablation (for example) may or may not help arrythmia patients live longer, we think it does provide a better quality of life option for many patients.

Second, PURE EP has been approved by the U.S. FDA, which is the "gold standard" of such approvals, and we know the Company is preparing to acquire European CE Mark approval in the near future as well. As most who follow the pharma and/or medical device space can attest, FDA approval is a major milestone and provides a clear degree of validity to PURE EP. FDA device approvals are not a rubber stamp.

Third, we also know that there are professionals in the EP space who believe that PURE EP is valuable and additive to ablation procedures. We have provided some of the evidence of that in the tables above from the Mayo Clinic. Further, recall that the Mayo Clinic made a direct investment in the Company about 9 months ago at roughly the current price of the stock. To belabor that a bit, U.S. News & World Report's 2019-20 recently named Mayo's Rochester campus the "Best Hospital in America." Moreover, they named Mayo's Cardiology & Heart Surgery as the second best in the nation as well. Clearly, the demonstrated value add of PURE EP will ultimately determine its success in the marketplace, and we don't think there is a better endorsement of that value add than having one of the foremost entities in cardiology in the world participate in multiple clinical trials, present the product's attributes at major arrythmia conferences and invest $1 million in the Company. We submit, that does not guarantee commercial success, but it's a very good place to start. Moreover, we suspect Mayo may end up being BioSig's first commercial customer.

Fourth, we know that ablation, while largely safe and generally successful is not perfect. Statistics regarding the need for multiple procedures (often due to EPs missing the exact spots) vary but indicate room for improvement. They don't always get it right and that may be a function of multiple variables, some of which the Company (and

apparently the Mayo Clinic) believe are related to problems that PURE EP helps solve. That brings us to an additional point regarding the market as we see it.

As noted, ablation is not always completely successful and thus sometimes results in multiple procedures. Again, the Company believes it can improve results by helping Electrophysiologists better identify exact ablation targets. However, industry research also seems to indicate that ablation success is correlated with the volume of procedures performed by EPs. That is, EPs who perform more ablations tend to have better success in terms of avoiding multiple procedures. Obviously, concluding that doing something more times rather than less improves outcomes is not a huge stretch. (We would guess that generally, golfers who play 4 times per week generally play better than those who play 4 times per year). We think this is an important distinction about the market and EP labs specifically as it may pertain to BioSig's sales efforts. To edify, we fully expect the Company to focus its initial sales efforts on the largest cardiovascular/arrythmia centers in the country. On the face, those centers typically do more procedures each year so they can spread the costs over more procedures, which suggests that they are the most optimal initial targets. However, as the advantages established above allude to, the Company also believes PURE EP can potentially reduce procedure times and "time is money". However, we think there may be an additional element to consider as we think about sales targets amongst the smaller EP providers.

To reiterate, it should not surprise anyone that in general EPs at large centers doing more ablations per year have higher success rates (fewer multiple procedures) than EPs at smaller centers doing fewer ablations per year. To that point, while smaller labs' success rates may be impacted by less "repetition" they can't likely do much about trying to get more of it. That is, they can't control the number of arrhythmia patients who walk through their doors. However, we do think technologies like PURE EP could help to improve their outcomes in spite of their lower procedure numbers. In fact, from that perspective, while smaller labs may not be able to realize the same scale value that larger labs might accrue from PURE EP, they may be able to achieve higher *marginal* outcome improvements than their larger counterparts, which we think could create a compelling value proposition for smaller players.

- **NeuroClear Technologies, Inc.**

To this point in our report, our focus has been on PURE EP and the Company's core EP competencies. However, as we touched on briefly, they have a subsidiary called NeuroClear Technologies, Inc. ("NCTI") that we think requires some delineation, and that notion has been enhanced by another recent announcement as well.

As we alluded to, NeuroClear is a BioSig subsidiary they established in 2018. Its purpose is to develop and *"pursue additional applications of the PURE EP™ signal processing technology outside of electrophysiology*". To that end, in 2019 NueorClear completed aggregate financings totaling approximately $5 million to advance NeuorClear's purpose. As a result of that financing, BioSig retained roughly 88% of NCTI. Incidentally, just as a point of interest, these transactions peg the valuation of NTCI at around $40 million. In addition to the raise in 2019, BioSig/NTCI also *"entered into patent and know how agreements pursuant which they paid Mayo Foundation for Medical Education and Research ("Mayo") whereby they paid Mayo an aggregate of $175,000 and warrants with an estimated fair value of $3,162,342".* We think the funding and Mayo collaboration are significant developments for BioSig/NTCI.

To reiterate, NTCI's focus is to leverage BioSig's signaling platform to disciplines outside of electrophysiology. that said, here is a brief overview of NTCI's opportunity from the Company's most recent 10K:

*NeuroClear is an early stage medical device company that is developing an advanced biomedical signal recording and processing technology platform for high-speed electroneurogram (ENG) recordings based on the core competencies of the PURE EP™ signal processing technology, such as broad dynamic range of recorded signals and low signal-to-noise ratio. Through NeuroClear, we aim to address unmet clinical needs in the global and growing sector of neurological disorders through recordings and analysis of action potentials, the impulses along*

*the membrane of a muscle cell or a nerve cell. These impulses carry valuable clinical information but may be difficult to detect through conventional recording platforms NeuroClear aims to extend the core competencies of BioSig's proprietary technology, which has been validated in pre-clinical studies, which have been conducted by Mayo Clinic, to address what we believe as the two main challenges of bioelectronic medicine devices: achieving accurate and targeted stimulation of specific nerves in a nerve bundle and implementing an effective feedback loop that can self-adjust for the optimal amount and timing of stimulation. We believe that advancements in overcoming these challenges will improve the safety and efficacy of current treatments and contribute to the developments of new therapy lines.*

*NeuroClear will focus on ENG recordings – methods used to visualize directly recorded electrical activities of neurons in the central nervous system (brain, spinal cord) and/or the peripheral nervous system (nerves, ganglions). ENGs are usually obtained by placing an electrode directly in the neural tissue. ENGs consist of small, high frequency, low amplitude signals, which have been proven hard to detect with conventional signal recording systems.*

*Other applications under our investigation include renal denervation, ADHD, eating disorders, Alzheimer's, addiction, epilepsy, dementia and pain management. Alzheimer's as an application for DBS is currently undergoing clinical trials at several national and international institutions that target the hippocampal outflow pathways by increasing ACh availability, influencing the limbic system, and improving lead placements. NeuroClear may seek additional research collaborations with other academic centers active in one or more fields of clinical interests described above.*

*The global neurostimulation devices market is predicted to grow at 11.2% CAGR during the forecast period with the market size reaching $12.2 billion by 2024. Geographically, North America is the largest neurostimulation devices market, estimated to be $5 billion in 2019, as the region has a high prevalence of chronic diseases and the growing geriatric population. The neurostimulation market is primarily driven by deep brain and spinal cord stimulation. The overall neurostimulation market is expected to grow due to societal factors such as an increase in the geriatric population, as well as the associated increase in the prevalence of chronic diseases.*

We submit, NueroClear is an early stage enterprise, with little visibility in terms of framing the opportunity but in our view, it already has a handful of positive attributes that we think may demonstrate value that we do not believe is reflected in BioSig's shares. First, the Company is developing solutions for the growing neurostimulation ("NS") market based on an EP platform that is already developed, FDA approved and on the cusp of commercialization. We think that existing platform should accelerate development of adjunct pieces like NS. In addition, they have established (another) collaboration with the Mayo Clinic to help develop the NS technology. We have viewed Mayo's participation in EP as validating and highly additive so we would make the same assumption here. Moreover, they have managed to fund the entity without diluting BioSig directly, which we also view as favorable.

Before we leave this issue, we would note, we believe the adjunct opportunities for BioSig's platform outside of EP, are likely much larger than the EP market itself. For instance, we believe that the use of neuromodulation therapies to treat a host of neurological disorders like pain, Parkinson's and many others. If BioSig's platform can help refine those procedures, we think the opportunity could be bigger than their EP opportunity. As an extension to that notion, on March 4, 2020 the Company announced *a consulting agreement with John W. Osborn, Ph.D, Professor, Department of Surgery and Director of the Minnesota Consortium for Autonomic Neuromodulation (MCAN) at University of Minnesota Medical School. "Dr. Osborn is considered to be one of the leading experts in autonomic neuroscience. One of his main research interests is directed towards integrative understanding of the role of the sympathetic nervous system in the long-term regulation of arterial pressure and the pathogenesis of hypertension. Dr. Osborn is widely regarded for the contributions of his research to the development of novel catheter-based renal nerve ablation therapies for treatments of hypertension. Dr. Osborn authored over 100 scientific publications and leads the newly formed Consortium for Autonomic Neuromodulation*

*at University of Minnesota".* Succinctly, inasmuch as EP is a problem, hypertension (high blood pressure) is a bigger problem.

In addition to the above, on March 25, 2020, BioSig announced that *"NeuroClear acquired a license for a broad-spectrum anti-viral agent that may treat COVID-19*". (For *future* historical reference, that announcement came amid the global spread of COVID-19, which has paralyzed the entire planet). Here is an excerpt from that release:

> *In a preliminary internal review, the orally administered, broad-spectrum anti-viral agent Vicromax(tm) demonstrated strong activity against COVID-19 in cell cultures in laboratory testing. In this analysis, Vicromax(tm) was added to a tissue culture assay for SARS-CO-2 coronavirus (the causative agent for COVID-19) and an anti-viral effect was observed, which led to a reduction of over 90% of infectious viruses. The Company intends to pursue development of this agent for the treatment of COVID-19 through FDA-approved clinical trials.*
> *The product candidate already completed Phase I and three Phase II trials in other indications, and underwent extensive animal testing and human clinical experience. The Company expects that Vicromax(tm) could be used alone or in a combination with other anti-viral agents or immune modulators.*
>
> *"Stopping the COVID-19 pandemic and preventing similar viral threats in the future must be the number-one priority of all of us in the healthcare community," said Kenneth L. Londoner, Chairman and CEO of BioSig Technologies, Inc. "This very promising anti-viral is the result of tireless efforts by an accomplished group of pharmaceutical industry veterans, and we are doing everything in our power to ensure it gets tested and brought to market as soon as possible."*
>
> *The Company intends to develop Vicromax(tm) and take it through clinical trials under a new NeuroClear subsidiary, ViralClear Pharmaceuticals, Inc. The Company appointed Mr. Nick Spring as Chief Executive Officer of ViralClear and Mr. Steve King as Chief Operating Officer.*

If this treatment were to prove effective and able to gain approval, we think it is fair to say that it would be worth considerably more than the current market cap of BioSig. The stock reacted in kind upon this announcement, and this could certainly be the basis for valuation inflections as we move forward. On the other hand, the Company has not provided much detail to the transaction, or any other minutia that would be necessary for us to properly evaluate the opportunity. We believe at least some of that is forthcoming. That said, we have no idea how to handicap this and we are not going to try, but this clearly provides a potential valuation driver to the story.

## Operating Overview

BioSig is a pre-revenue company that we believe is in the midst of transitioning to a revenue producer. As our model indicates, we expect them to begin recognizing sales through 2020. Given that, the historic numbers are of no particular value in terms of guiding future revenue projections, but we do think they may provide some reference for the expense side of things. While we expect revenues to commence in the coming months, we submit visibility is poor and projecting revenues over the next several quarters will be difficult and likely subject to considerable error.

The above noted, here is our take on some of the emerging revenue metrics.

The Company has not disclosed specific information regarding the anticipated sales prices of their PURE EP systems although they have provided some potential ranges. We believe they are looking at a sale price of the hardware of something between $150,000 and $250,000. Further, we think they expect to collect additional fees for installation, and then annual recurring revenues around software and maintenance fees. We are estimating the recurring piece at a rate of around 25% of purchase price. This high margin recurring piece will be a significant

valuation driver in the story. We will adjust our model around these important datapoints as visibility improves. We would add, we suspect pricing (and the associated revenues) could be quite fluid. For instance, the Company has alluded to some creative acquisition programs for purchases that might even involve leases or rentals. More simply, we expect there may also be some more favorable pricing on the front end of the commercial launch, and there may be more favorable pricing for labs they have been collaborating with. Again, we expect pricing and revenue recognition to be fluid.

As we noted, the Company is seeking approvals from FDA equivalent agencies around the world to sell into their countries. Most notably, they are currently preparing to submit for the European Union CE mark. We have not modeled sales in that regard since they still need to procure these designations. However, we believe that potential has marked value (especially since they already have FDA approval so we believe things like CE mark should be forthcoming) and we have been cognizant of that as we derived our target assumptions.

On the expense side of things, we believe the Company anticipates unit costs of between $40,000 and $50,000 per unit and we suspect that may include some costs associated with installation and training. We would assume that that there may be some leverage at scale.

Historically, the Company has provided two primary expense line items in the financial statements; Research and Development and SG&A. Those line items have typical reflected around $1.5 million per quarter and from $3.5 to $4.0 million respectively. While we have projected 2020 in that range, we also suspect SG&A could see some added selling expense as commercialization accelerates. That may include expenses related to the installations, which we alluded to above. Again, while in the case of expenses we do have some reliable historic perspective, we think this portion of the ledger could also be fluid as commercialization launches and accelerates.

On the balance sheet, the Company ended fiscal/calendar 2019 with cash of $12.1 million and subsequently completed a secondary through Laidlaw & Company selling 2.5 million shares and raising an additional $9.2 million (net) at $4.00. We would add one additional item from the balance sheet that we find telling. The Company ended the year with Inventory totaling $577,690. Unless we are mistaken, we think this is the first filing they have made that reflects this line item, which consists of "finished goods". Clearly, the Company is positioning to demo and/or sell a measurable number of units. That is, we are assuming they have a good sense of what they are going to do with $577,690 worth of inventory.

Lastly, the Company has noted that they believe they will develop additional adjunct pieces of business around PURE EP. These may include the sale of data and or add-ons that incorporate AI functionality around the system. Those seem like logical potential additions to us, although we do not have any particular visibility in terms of the scope or the timing of these. We mention them because we can envision them making contributions at points in the future that would be additive, although we have certainly have not attempted to model such additions.

## Management

We generally provide some management color here, but in the case of BioSig, they have an extensive management overview on their website, which included biographies of the C-Suite, the Board of Directors and their Advisory Board. For the sake of brevity, we would refer readers to that portion of their website:

https://www.biosig.com/about-biosig/leadership

## Risks and Caveats

With an FDA approval in hand, a collaboration with one of the premier healthcare providers in the world and cash in the bank, BioSig has many of the typical risks associated with a small medical device company behind them. On the other hand, they must now transition the business to commercialization of those efforts and success in that regard is certainly not a forgone conclusion. While we believe the Company has demonstrated and through additional trials will continue to demonstrate that PURE EP provides several advantages for EPs performing ablations, there is no guarantee that EP labs (and those who have to pay for them) will be willing to pay for that marginal benefit. Further, the greater likelihood is that some will, and some will not. Further, while we have provided some ranges that we feel are reasonable in terms of price points, they may find that the price they are able to garner for the system is considerably lower than our estimates. That sort of variable would negatively impact our assumptions.

Along the same lines as the above, the healthcare industry is a difficult environment for small emerging device players even when their devices include superior attributes. It is dominated by large well entrenched companies with a host of advantages over smaller upstarts and they vigorously protect their market share. While we believe BioSig's system is unique, there is no assurance that similar competitive offerings won't emerge.

In our experience, many healthcare providers are averse to change. That will create challenges for BioSig's sales efforts.

The healthcare industry is facing a myriad of pressures especially with respect to rising costs. Any of those pressures that impact reimbursements could in turn impact vendors to the industry. Obviously, that is specifically true in the case of ablation procedures. As we understand it, ablation has not been the subject of reimbursement pressures and in fact it may not. However, if it *does* that would likely make Biosig's sales efforts more challenging.

The current Covid-19 pandemic is negatively impacting the global economic environment and could lengthen the Company's sales cycle. While we believe the Company has made considerable progress via a variety of marketing approaches to increase industry awareness and interest in PURE EP, the pandemic could mitigate some of that momentum at least temporarily. Here again, we have no insights into how to handicap that at this time.

As we noted, the Company continues to conduct trials to establish the efficacy of PURE EP relative to existing ablation standards. If those trials do not support the added efficacy of PURE EP, it could have a negative impact on their sales processes.

If the Company can place units in new facilities as we anticipate, it will be necessary to hire appropriately skilled personnel to install these systems and properly train customers. If they are unable to hire these skilled personnel, it could impact their ability scale the business.

If our analysis is accurate, the Company currently has more cash in the bank than it ever has. However, they will likely continue to burn cash through the next several quarters. Moreover, if our models prove reasonably accurate, they will need to raise additional capital before they reach profitability. There is no guarantee that they will be able to raise additional capital in the future, as that will likely depend in part on the progress they make on the sales front. Additional capital acquisition will likely be dilutive.

Like many small enterprises, BioSig is dependent on a handful of individuals to advance their opportunities. The loss of key employees could negatively impact the Company.

BioSig's share price is often quite volatile so investors should consider that in the context of their own financial risk tolerances, liquidity needs and investment horizons.

These are just a few of the more obvious risk in the story there are likely others we may have overlooked and/or perhaps some that are not visible just yet.

## Summary and Conclusion

BioSig was incorporated in 2009 so they have been at this for quite some time. While making an ECG signal clearer may seem simple enough, it is quite complex. If it weren't, they would have made them clearer from the start. Recognize, the *interpretation* of the heart's electrical signals is the cornerstone of electrophysiology, and it requires specific dedicated discipline. For instance, electrophysiology generally requires a year or two of additional study beyond any other core discipline. That is, not all cardiologists are electrophysiologists. While many electrophysiologists are also cardiologists, others may be anesthesiologists or others. The point is, electrophysiology is complex, so tools that can reduce the complexity can provide marked value.

As we suggested above, as medical devices go, BioSig has several of the more difficult hurdles behind them. First, they have an FDA approval. Anyone who spends time in the biopharmaceutical and/or medical device space know that is a *big* hurdle. Getting to this point takes considerable time, money, effort and other resources and many that try fail to get to this point. As microcap analysts, we can attest, we have followed many small companies that failed because they could not get over this hurdle. The fact that BioSig has FDA approval is a considerable milestone and a substantial risk mitigator. Further, the FDA approval should help their pursuit of a CE mark for other international markets. In addition, they have been able raise money recently, which given the subsequent pandemic was probably good fortune, so they should have the capital necessary to begin executing the marketing and commercialization phase of the business. Granted, they will likely require additional capital, but getting that in the bank prior to the onset of COVID-19 was clearly fortuitous.

While they have some of the bigger challenges behind them, others remain. FDA approvals do not always translate into sales. We are all too familiar with the rising costs of healthcare and those costs have drawn scrutiny regarding what procedures and protocols people (payors) are willing to pay for and how much they are willing to pay. We know of several examples of companies with FDA approvals that are having difficulties selling their devices. Clearly, an FDA approval is not a guarantee of success but that brings us to our next point.

Maybe we are overstating this, but we believe BioSig's collaboration with and investment from the Mayo Clinic is a marked validation of the technology. Mayo is one of the premier medical groups in the world and as we alluded to above with respect to some of the presentations their doctors have made on behalf of PURE EP they are clearly supportive of the platform's efficacy. We submit, much like the FDA approval, Mayo's collaboration and endorsement does not necessarily mean they are going to be successful selling units, but we think it certainly helps. Maybe our memory eludes us with respect to this, but we can't recall any small device companies with a similar arrangement. We believe this will positively impact their sales efforts.

As an extension of the prior paragraph, the Company is also collaborating with other notable healthcare institutions on the conduction of a clinical trial aimed a clearly demonstrating *"the clinical value proposition"* of PURE EP. Those trials commenced late last year, and we believe they are continuing to enroll patients at both the Texas Cardiac Arrhythmia Institute at St. David's Medical Center and Mayo Clinic's Florida campus. We think it is fair to suggest that the Company feels good about their ability to demonstrate that "*clinical value proposition"* or they likely would not go through the time and expense to do them. Recall, they already have an FDA approval. On the other hand, we believe, much as they do, that positive clinical results could provide a major boost to their marketing efforts.

We Consider the current "generation" of PURE EP to be BioSig's "core business", and certainly their success over the foreseeable future will depend on their ability to market that core business. However, they have announced further initiatives with Mayo to develop new innovations around the core platform. We have not attempted to model any impact from those initiatives, but we believe they hold the potential for additional valuation legs in the future. As we move forward, we suspect they may forge additional relationships to leverage the core platform as well. For instance, in December (2019) they announced a collaboration with *"Cambridge, Massachusetts-based Reified which will focus on developing a foundational artificial intelligence platform on the basis of integrated healthcare datasets, beginning with ECG and EEG data acquired by BioSig's PURE EP(tm) System".* Here again, while we have not attempted to model or value this arrangement, we believe it could also provide a basis for future valuation catalysts.

Speaking of future valuation catalysts, we also touched on the Company's relatively new division NeuroClear Technologies, Inc. ("NCTI"). NCTI was established to pursue the potential use of the Company's core signal processing technology in other healthcare related applications. The first of those looks to be neurostimulation, which is an emerging discipline looking to treat neurological disorders like Parkinson's Disease and a *long* list of others. Here again, the Company was successful in forming (another) collaboration with Mayo on the NTCI business and they were also successful in completing a separate funding for the entity. As we said, the list of neurological disorders is extensive so we would envision a successful product in neurostimulation as potentially larger **and collectively perhaps much larger**, than BioSig's opportunity in arrhythmia. Granted there is no visibility with respect to that sort of offering, but we are comfortable suggesting that they have identified issues in the neurostimulation theatre they believe they can help solve with iterations of the core technology platform. Again, we have not modeled that and have provide only a modest input to our valuation for this piece of the business and that number is considerably less than the valuation implied by the raise they did for NTCI in September 2019. That brings us to ViralClear Pharmaceuticals, Inc. ("VCPI").

On March 25, 2020 BioSig announced that *"its majority-owned subsidiary NeuroClear Technologies, Inc. acquired the rights to develop a novel pharmaceutical to treat Coronavirus Disease 2019 (COVID-19)"*. NeuroClear has in turn formed a new subsidiary company called ViralClear Pharmaceuticals, Inc. to manage the license/technology.

An excerpt from the release goes on to say: *"In a preliminary internal review, the orally administered, broad-spectrum anti-viral agent Vicromax(tm) demonstrated strong activity against COVID-19 in cell cultures in laboratory testing. In this analysis, Vicromax(tm) was added to a tissue culture assay for SARS-CO-2 coronavirus (the causative agent for COVID-19) and an anti-viral effect was observed, which led to a reduction of over 90% of infectious viruses. The Company intends to pursue development of this agent for the treatment of COVID-19 through FDA-approved clinical trials. The product candidate already completed Phase I and three Phase II trials in other indications and underwent extensive animal testing and human clinical experience. The Company expects that Vicromax(tm) could be used alone or in a combination with other anti-viral agents or immune modulators…".*

We didn't see that coming…

The following is the time line the Company has laid out for advancing the drug. As many will recognize, this is an aggressive timeline for a drug of this nature although it has been through phase II, so it is not starting from the drawing board. On the other hand, these are strange times, so typical timelines probably don't apply especially when it comes to addressing COVID-19.


As we noted above, we have no idea how to handicap this, so we are not going to try. Further, as far as we know, the Company has not released details of the license either, so as of this writing, there are some pieces to the puzzle we still need to understand. With that said, here is the point from our perspective. Over the past few weeks, we have seen some small companies with *potential* pieces of the COVID puzzle trade multiples higher because of those prospects. Those include some with diagnostic candidates as well as some other pieces. That may suggest that the *prospect* of having a potential piece of the COVID puzzle is worth *something*. At the same time, we are also quite confident suggesting that this is going to be a crowded field over the coming weeks/months. Again, we have no intention of trying to value this. With that in mind, we have spent the preponderance of this report laying out a case for why BioSig should attract a significantly higher valuation over the next 12-24 months, and those conclusions *having nothing to do with the current pandemic*. From that perspective, **we don't think purchasers of BioSig today are paying *anything* for ViralClear and its prospective opportunity**. We submit, if ViralClear ends up being a part of the COVID treatment solution, it will likely be worth considerably more than the current market cap of BioSig. Obviously, that would be a watershed event for the Company and the stock.

We believe that BioSig has made marked progress towards their goal of becoming part of the standard of care in every EP ablation procedure. Granted, their success in achieving that will depend on their marketing efforts as well as the culmination of some of the other things we laid out above, but we like their chances. Further, we think they have also planted a handful of other seeds that could provide additional legs in the valuation going forward. We are initiating our coverage of BioSig Technologies, Inc. with an allocation of 4 and a 12-24 month price target of $10.50 per share. We will revisit each of those conclusions as visibility improves.

# Projected Operating Overview

| BioSig Technologies, Inc. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Projected Operating Overview** | | | | | | | | |
| **By: Trickle Research LLC** | | | | | | | | |
| | | | | | | | | |
| CONDENSED CONSOLIDATED STATEMENTS OF OPERATIONS | | | | | | | | |
| | **Fiscal 2019** | **3/31/2020** | **6/30/2020** | **9/30/2020** | **12/31/2020** | **Fiscal 2020** | **Fiscal 2021** | **Fiscal 2022** |
| | | | | | | | | |
| **Revenues:** | | | | | | | | |
| | | | | | | | | |
| **Unit Sales** | | $ - | $ 760,000 | $ 950,000 | $ 1,520,000 | $ 3,230,000 | $ 9,600,000 | $ 32,880,000 |
| **Recurring Maintenance and Service Fees** | | $ - | $ - | $ - | $ - | $ - | $ 900,000 | $ 2,900,000 |
| **Other Revenue** | | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| | | $ - | $ - | $ - | $ - | | | |
| **Total Revenue** | | $ - | $ 760,000 | $ 950,000 | $ 1,520,000 | **$ 3,230,000** | **$ 10,500,000** | **$ 35,780,000** |
| **Cost of Goods** | | $ - | $ 160,000 | $ 200,000 | $ 320,000 | **$ 680,000** | **$ 1,600,000** | **$ 5,069,000** |
| **Gross Profit (Loss)** | | $ - | $ 600,000 | $ 750,000 | $ 1,200,000 | **$ 2,550,000** | **$ 8,900,000** | **$ 30,711,000** |
| | | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| **Operating expenses:** | | $ - | $ - | $ - | $ - | $ - | | |
| Research and development | $ 9,738,819 | $ 1,700,000 | $ 1,722,800 | $ 1,728,500 | $ 1,745,600 | $ 6,896,900 | $ 7,115,000 | $ 7,873,400 |
| General and administrative | $ 24,810,712 | $ 5,010,000 | $ 4,255,200 | $ 4,269,000 | $ 4,310,400 | $ 17,844,600 | $ 17,410,000 | $ 18,885,600 |
| Depreciation and amortization | $ 54,349 | $ 17,961 | $ 17,997 | $ 18,033 | $ 18,069 | $ 72,059 | $ 72,637 | $ 73,220 |
| **Total operating expenses** | **$ 34,603,880** | $ 6,727,961 | $ 5,995,997 | $ 6,015,533 | $ 6,074,069 | **$ 24,813,559** | **$ 24,597,637** | **$ 26,832,220** |
| **Loss from operations** | **$ (34,603,880)** | $ (6,727,961) | $ (5,395,997) | $ (5,265,533) | $ (4,874,069) | **$ (22,263,559)** | **$ (15,697,637)** | **$ 3,878,780** |
| **Other income (expense):** | **$ -** | $ - | $ - | $ - | $ - | **$ -** | **$ -** | **$ -** |
| Gain on change in fair value of derivatives | $ 452 | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Interest income | $ 132,751 | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Loss before income taxes | $ (34,470,677) | $ (6,727,961) | $ (5,395,997) | $ (5,265,533) | $ (4,874,069) | $ (22,263,559) | $ (15,697,637) | $ 3,878,780 |
| Income taxes (benefit) | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| Net loss | $ (34,470,677) | $ (6,727,961) | $ (5,395,997) | $ (5,265,533) | $ (4,874,069) | $ (22,263,559) | $ (15,697,637) | $ 3,878,780 |
| Preferred stock dividend | $ (25,163) | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| NET LOSS AVAILABLE TO COMMON STOCKHOLDERS | $ (34,495,840) | $ (6,727,961) | $ (5,395,997) | $ (5,265,533) | $ (4,874,069) | $ (22,263,559) | $ (15,697,637) | $ 3,878,780 |
| Non-controlling interest | $ 415,849 | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| NET LOSS ATTRIBUTABLE TO BIOSIG TECHNOLOGIES, INC. | $ (34,079,991) | $ (6,727,961) | $ (5,395,997) | $ (5,265,533) | $ (4,874,069) | $ (22,263,559) | $ (15,697,637) | $ 3,878,780 |
| Net loss per common share, basic (in Dollars per share) | $ (1.68) | $ (0.27) | $ (0.21) | $ (0.20) | $ (0.19) | $ (0.87) | $ (0.55) | $ 0.14 |
| | $ - | $ (0.27) | $ (0.21) | $ (0.20) | $ (0.18) | $ (0.86) | $ (0.54) | $ 0.13 |
| Weighted average number of common shares outstanding, basic (in Shares) | 20,256,023 | 24,873,087 | 25,923,087 | 25,966,565 | 26,005,027 | 25,691,942 | 28,583,812 | 28,688,185 |
| Weighted average number of common shares outstanding, diluted (in Shares) | 25,966,565 | 26,760,264 | 29,138,491 | 29,057,432 | 29,002,574 | 28,965,220 | 28,831,101 | 28,881,163 |

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**Rating System Overview:**

There are no letters in the rating system (Buy, Sell Hold), only numbers. The numbers range from 1 to 10, with 1 representing 1 "investment unit" (for my performance purposes, 1 "investment unit" equals $250) and 10 representing 10 investment units or $2,500. Obviously, a rating of 10 would suggest that I favor the stock (at respective/current levels) more than a stock with a rating of 1. As a guideline, here is a suggestion on how to use the allocation system.

Our belief at Trickle is that the best way to participate in the micro-cap/small cap space is by employing a diversified strategy. In simple terms, that means you are generally best off owning a number of issues rather than just two or three. To that point, our goal is to have at least 20 companies under coverage at any point in time, so let's use that as a guideline. Hypothetically, if you think you would like to commit $25,000 to buying micro-cap stocks, that would assume an investment of $1000 per stock (using the diversification approach we just mentioned, and the 20-stock coverage list we suggested and leaving some room to add to positions around allocation upgrades. We generally start initial coverage stocks with an allocation of 4. Thus, at $1000 invested per stock and a typical starting allocation of 4, your "investment unit" would be the same $250 we used in the example above. Thus, if we initiate a stock at a 4, you might consider putting $1000 into the position ($250 * 4). If we later raise the allocation to 6, you might consider adding two additional units or $500 to the position. If we then reduce the allocation from 6 to 4 you might consider selling whatever number of shares you purchased with 2 of the original 4 investment units. Again, this is just a suggestion as to how you might be able to use the allocation system to manage your portfolio.

**For those attached to more traditional rating systems (Buy, Sell, Hold) we would submit the following guidelines.**

**A Trickle rating of 1 thru 3 would best correspond to a "Speculative Buy" although we would caution that a rating in that range should not assume that the stock is necessarily riskier than a stock with a higher rating. It may carry a lower rating because the stock is trading closer to a price target we are unwilling to raise at that point. This by the way applies to all of our ratings.**

**A Trickle rating of 4 thru 6 might best (although not perfectly) correspond to a standard "Buy" rating.**

**A Trickle rating of 7 thru 10 would best correspond to a "Strong Buy" however, ratings at the higher end of that range would indicate something that we deem as quite extraordinary an "Extreme Buy" if you will. You will not see a lot of these.**