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Authors:
Nisha Kumar Kulkarni
Usha Ganesh

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In February 2012, Biosense Technologies Co-founder and CEO, Myshkin Ingawale, presented the TouchHb, the Mumbai-based enterprise’s innovative device for detecting anemia, at the annual TED conference. The simplicity and ingenuity of the device was highly praised.

The TouchHb is the brainchild of a group of friends who want to make a clear, positive impact on anemia alleviation in India. While in college, Ingawale and his friends, now part of the leadership team at Biosense, made it their mission to contribute to India’s anemia alleviation efforts, particularly in rural areas. The solution they settled on is a portable, battery-operated, non-invasive device that can be used to detect anemia, as well as monitor its severity. It is easy to use and can be operated by any person in any setting. The device, earlier called Anaemedia, was unveiled in January 2008 at a technology competition and won second prize. After making further improvements to the product over the next four years, the Biosense team rechristened it the ‘TouchHb’ for its 2012 launch. To date, the team has conducted a series of successful pilot trials in Karnataka and Maharashtra to prove their concept.

Anemia is an already severe and growing health concern in India. According to the World Health Organization (WHO), iron deficiency-related anemia is one of the most prevalent nutritional deficiencies in the world, affecting more than 1.5 billion people worldwide. The human body can recycle its stores of iron, but in the event of frequent blood loss (e.g. menstruation) and inadequate nutrition, a person can develop iron deficiency-related anemia. Other diseases that are common challenges in India (i.e., malaria and tuberculosis) further exacerbate cases of anemia, making its treatment essential. The typical symptoms of iron deficiency-related anemia, irrespective of severity, include headaches, fatigue and general physical weakness. In more severe cases of anemia -- usually onset by other serious health conditions -- symptoms can include shortness of breath, abdominal ulcers, weight loss and heavy menstrual bleeding in women. Often, anemia goes untreated due to a lack of healthcare infrastructure, medical personnel and diagnostic facilities, particularly in India’s rural areas.

The blood disorder is of particular concern in women. Severe anemia in a mother leads to high probability that her child will be born underweight and suffer from health complications such as malnutrition. Approximately 30% of all underweight babies born in India contribute to the country’s high neonatal and infant mortality rates. Nearly 40% of neonatal and infant deaths result, directly and indirectly, from anemia.

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2 Anemia is a blood disorder stemming from a deficiency of red blood cells and is indicative of another disease affecting the body. Critically, this lack means that there is a lower concentration of hemoglobin, the iron-containing protein in red blood cells that carries oxygen to various organs in the body via blood. If internal organ systems do not receive enough oxygen, serious health complications such as excessive blood loss, increased cell destruction and impaired red blood cell production may arise.


With the success they have found in unveiling the Touchb and in executing their trials, the Biosense team may soon be able to launch their device in the market. There are, however, some key questions the team seeks to answer. Is the Touchb ready to go to market? Will the device help medical personnel and other health practitioners to identify and treat new and existing anemia cases? To answer these and other pertinent questions, the team is analyzing the outcome of the initial trials in India with the goal of settling on statistically sound results before making the Touchb available to all those working to fight and control India’s anemia challenge.

**Portable Solutions for Anemia Detection and Monitoring**

Since anemia is a blood disorder, the preferred method of detection is by performing a blood test. A doctor, or other medical worker, extracts a sample of blood from a patient, and laboratory tests are conducted to determine the red blood cell count. If the count is below the normal range (less than 11 grams per deciliter), then it is concluded that the patient has anemia. Whether or not the anemia is severe is further determined by the red blood cell count and its other characteristics, such as shape and size. Once a patient is diagnosed with anemia, doctors will administer drug therapy with daily iron supplements until the red blood cell count and iron stores increase.\(^5\)

There are various other medical lab tests that can be conducted to detect anemia, each of which is differently invasive. These tests include evaluating stool hemoglobin, iron levels, vitamin levels (e.g. Folate, Vitamin B12), liver function, kidney function and red blood cell production in bone marrow.

**Figure 1:** Existing Anemia Detection Portable Devices

<table>
<thead>
<tr>
<th>Name of Device</th>
<th>Manufacturer</th>
<th>Price</th>
<th>Cost Per Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>HemoCue (includes 200 strips)</td>
<td>HemoCue</td>
<td>US$700.00</td>
<td>US$0.75</td>
</tr>
<tr>
<td>Hemoglobin Hgb Pro Meter (includes 25 strips)</td>
<td>Fisher Scientific</td>
<td>US$257.00</td>
<td>US$0.70</td>
</tr>
<tr>
<td>HemoPoint H2 (includes 200 strips)</td>
<td>Stanbio Laboratory</td>
<td>US$989.00</td>
<td>US$0.90</td>
</tr>
<tr>
<td>STAT-Site MHgb Hemoglobin Photometer (includes 200 strips)</td>
<td>Stanbio Laboratory</td>
<td>US$375.00</td>
<td>US$0.75</td>
</tr>
</tbody>
</table>

*Source: Company websites*

**Figure 1** describes portable anemia detection devices available in India today. Most of these devices are invasive and require the expertise of licensed doctors or qualified health technicians. Since most popular anemia detection methods are predicated upon a blood test, there are safety concerns around administering such a test. Rural health practitioners may not

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have the appropriate equipment to draw blood hygienically, and there may be risk of infection if the test is not executed correctly.

The degree of invasiveness of anemia detection tests becomes an important issue in low-resource settings where exposure and education of common medical tests are low. A woman in an Indian village may not feel comfortable with her blood being drawn, even if a known, designated health practitioner of her community does it.

The feasibility of existing detection devices must also be considered. In low-resource settings, like rural India, many of these methods are impractical because the price for such detection devices is prohibitively high. For example, HemoCue, a handheld hemoglobin device that is minimally invasive, costs US$ 700 (~INR 40,000), and the cost per blood test is US$ 0.75 (INR 42).

The most promising anemia detection tests in low-resource settings are Sahli’s Method and the WHO color scale.6 Both methods require blood samples. While these methods are helpful tools in the detection arsenal, neither method is 100% accurate or 100% objective. The WHO color scale is a simple technology involving the placement of a drop of blood on color strip paper. Each color on the strip indicates a different hemoglobin level and changes color in accordance to the levels present in the sample of blood. Since color is subjective, the strip is hard to detect and not specific enough for anemia detection.

The Sahli’s Method involves measuring hemoglobin levels. A haemometer, or instrument by which one can measure blood pressure in arteries or veins, is used to convert hemoglobin into an acid. When the acid is diluted in water, it turns brown. The intensity of the brown color is thereby compared to a standard chart and is indicative of the amount of hemoglobin in the blood sample. Like the WHO color scale method, the Sahli’s Method is subjective, albeit more accurate. It does, however, require expert technicians to conduct the test; a layperson or new health practitioner would find it difficult to accurately implement the test continuously.

The WHO color scale and Sahli’s method are too subjective and require more skill than can be reasonably employed in ongoing anemia monitoring efforts. The portable solutions in Figure 1, though, do make monitoring a patient’s anemia condition a distinct possibility. Portable devices allow for “doorstep” diagnostics, but it is critical that such monitoring tests be conducted regularly and that the results and analysis are appropriately recorded for future reference.

**The Competitive Landscape**

In the global market, there are a number of portable solutions for anemia detection. Though there is a slow-growing market for non-invasive solutions, most existing solutions are invasive and require a blood sample. International players, like the manufacturers mentioned in Figure

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1, have developed portable and user-friendly devices. These devices are available in India, but the extent of their market share is unknown.

• For 30 years now, Sweden-based HemoCue has added value to the global health sector by developing, producing and marketing point-of-care medical devices. The company’s value proposition is to facilitate “doorstep” testing with the same accuracy and precision offered by laboratory-grade instruments. HemoCue manufactures six different portable hemoglobin-monitoring systems.

• Based in the U.S. with operations in India, Fisher Scientific offers total laboratory solutions, such as general supplies and chemicals. As part of Thermo Fisher Scientific, the company supports scientists in a variety of fields through their products and services. Fisher Scientific has 12 different clinical diagnostic kits for hemoglobin monitoring.

• For over 50 years, Stanbio Laboratory has manufactured and marketed high-quality clinical diagnostic products. The U.S.-based company has three point-of-care devices that test hemoglobin levels in blood.

Though these devices have already seen success in global markets, they are not perfect fits for the Indian market due to their high cost. The cost of the device and any required accompanying tools may not necessarily fit into the budgets of the typical rural Indian healthcare provider.

Industry Challenges

Given the scale of India’s anemia challenge, there is a clear and present opportunity for diagnostic and monitoring solutions. Still, to operate in this space, industry players must juggle a number of considerations. Healthcare in rural India is erratic: there is a shortage of qualified medical personnel to cater to rural communities. It is therefore critical that industry players deliver anemia detection solutions with technology that anyone can use. A person assisting with anemia detection efforts – be it a healthcare worker or a more skilled technician – should be able to operate such devices easily, allowing for minimal error. There is a higher margin for erroneous readings and misinterpreted analysis of hemoglobin-related data if a device is too complicated to use outside of a laboratory setting.

Simplified device design goes hand-in-hand with changing attitudes towards health. Devices that are simple to use must also be minimally invasive. Already, industry players must overcome traditional notions of health and illness in rural communities; unless a person feels sick, she will not feel compelled to seek medical attention, even if she has access to it. In the case of anemia, the single most experienced – and easily ignored – symptom is fatigue. That

7 HemoCue: http://www.hemocue.com/international/index.php
9 Stanbio Laboratory: http://www.stanbio.com
alone will not convince a person to seek medical treatment, even though it may be indicative of an associated, potentially serious health condition. If a necessary test is invasive, then this further discourages the person from seeking medical attention for routine diagnostic purposes.

Because technology is the vehicle by which such anemia detection solutions are publicly offered, industry players face the challenge of avoiding technology obsolescence. Ease-of-use and accuracy are the most critical components of any solution, and therefore, the onus of understanding how technology can continuously improve upon these components falls onto the device manufacturer. This is especially important when such detection devices are also used for monitoring the severity of a patient’s anemia condition, and results in prescription of appropriate drug therapies.

The last, significant challenge of the industry is to better integrate various on-the-ground efforts being directed towards anemia alleviation. There are numerous private and public players working throughout India to increase awareness of anemia and to decrease the condition’s burden on rural populations. There are more coordinated efforts occurring in the country, but there is scope to scale such programs so that the knowledge, abilities and efforts of various stakeholders are leveraged for greater impact.

**Biosense Technologies**

During pregnancy, a woman’s iron requirement is high, so women and children are more susceptible to anemia. India’s last National Family Health Survey conducted in 2005-2006 reported that there is a strong link between maternal anemia and child anemia, where 55.3% of pregnant women and 69.5% of children under the age of five are anemic.\(^{10}\) Iron deficiency-related anemia is widely prevalent in India, and it is preventable. These facts motivated the Biosense Technologies team to launch their enterprise in 2008 and take on the anemia challenge in India.

**The Leadership Team**

Biosense is led by a team of five college friends: Myshkin Ingawale, Dr. Yogesh Patil, Dr. Abhishek Sen and Aman Midha. They believe that they can address India’s anemia challenge and make direct positive impact.

The leadership team at Biosense variously started as friends. Ingawale and Dr. Darshan Nayak, now a Biosense advisor, grew up together in Thane. Patil and Dr. Abhishek Sen were roommates in medical school, and Nayak already knew Sen separately. Ingawale and Aman Midha were friends in engineering school. Over time, they all connected to one another, and

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united by their desire to impact India’s healthcare scene, decided to engage in a business relationship to combat anemia.

Myshkin Ingawale is the CEO of Biosense. Previously, he was a business consultant at McKinsey & Company and a researcher at MIT, where he was part of the team that developed the Copenhagen Wheel. He earned his Bachelor of Technology in Electrical Engineering from the National Institute of Technology in Bhopal and his PhD in Management Information Systems from the Indian Institute of Management in Kolkata. He was named an Unreasonable Fellow in 2011 and a TED Fellow in 2012.

Aman Midha is the Creative Director at Biosense. He looks after technology design and product development, as well as marketing communications. He has previously worked as an interior designer at Tata Motors. He holds a Bachelor of Technology in Mechanical Engineering from National Institute of Technology in Bhopal and a Master of Design from the Indian Institute of Technology in Delhi. He was named an Echoing Green Fellow in 2010.

Dr. Yogesh Patil is the COO of Biosense. In addition to his operational duties, Patil also coordinates clinical research and patent strategy. He has a management background from the Shailesh J. Mehta School of Management at the Indian Institute of Technology in Mumbai and earned his MBBS in internal medicine from T.N. Hospital in Mumbai.

Dr. Abhishek Sen is the CTO of Biosense. He studied biomedical engineering at the Indian Institute of Technology in Mumbai and earned his MBBS in internal medicine from T.N. Hospital in Mumbai. He is a fellow at the University of Washington, focusing on entrepreneurship and research in medical technology for the developing word. He was named an Echoing Green Fellow in 2010.

The Innovation Journey

The prevalence of iron deficiency-related anemia in India, particularly amongst women, has long been a problem. In the 1980s, the Government of India introduced the Iron & Folic Acid Program, which aims to reduce anemia levels among pregnant and lactating women, and children. Efforts from the government and non-governmental players, such as the United Nations and World Health Organization, have involved preventive measures in India, as well as in other developing countries, whereby iron and other vitamin supplements are supplied to at-risk populations.

At the time of Biosense’s launch in 2008, India’s anemia problem was significant enough to require additional support and the team believed that the problem was simple enough for them to affect a real difference. Patil and Sen gained firsthand experience with anemia during their medical training, when they were posted at a village that was close to 20 kilometers away from the nearest primary health center (PHC). At this village, many women were exhibiting symptoms of severe anemia, but because of inaccessibility to a nearby healthcare facility, they
were unable to have their blood tested. Since these women did not recognize the signs of anemia, they were hard-pressed to justify traveling to the nearest PHC and potentially forfeit a full day’s wages. Conversely, even if a “doorstep” health practitioner came to their homes, the women were unwilling to submit to testing. Fundamentally, these women did not see themselves as being “sick,” and therefore, they did not see a need for any medical testing to be done.

What Patil and Sen witnessed in the village is prototypical of what takes place across rural India. There is an obvious solution then: to distribute nutritional supplements to women and children. Numerous such distribution drives continue to be executed across the country, but they have limited success. These supplements are not a cure and need to be taken as an ongoing therapy. Also, anemia drug therapy needs to be properly monitored because excessive iron levels can also lead to severe medical problems. By understanding the prevalence of the problem and the limited success of preventive solutions, it became clear to the Biosense team that what the field really needed was an affordable device for rural healthcare practitioners – be it government programs, small clinics or NGOs – to detect and monitor anemia cases.

Sen, Patil, Midha and Ingawale started tinkering with ideas to develop an anemia detection device while in college. The first iteration of the device was shortlisted for second prize at the IIT Techfest in 2008. The team then reinvested the prize money to improve upon the original prototype of their device. That same year, the Biosense device was up for the Piramal Prize, and the team was incubated at the Centre for Innovation Incubation and Entrepreneurship at the Indian Institute of Management in Ahmedabad. By December 2008, their organization was rechristened ‘Biosense Technologies Private Limited.’

As the team worked on their anemia detection device, Ingawale notes, “We could have shortened the time to market if we had released versions for early testing in the public.” For instance, one early idea the team had was based on pulse/oxygen science used in popular hospital technology to measure the saturation of oxygen in blood. The Biosense team conjectured if they could use the same technology to measure hemoglobin levels. It was an interesting theory, but Ingawale says that it was “doomed to fail.” The team spent one year researching the idea, but instead, according to Ingawale, should have built a prototype to test and see if the idea was worth further investigation.

Another step in the Biosense team’s innovation journey had to do with mHealth, or mobile health technology that offers healthcare delivery services for patients and practitioners. The idea was to have a mobile-enabled application that allows health practitioners to send health-related data to a central server. This was another interesting theory that was not necessarily practical. A health practitioner may not be comfortable with mobile phone technology and, even with appropriate training, she may face time-related constraints because she has more than 1,000 patients per month: how could she manage this administrative task along with dozens of other duties? For an mHealth solution to work, it would require a holistic approach. Ingawale explains that an mHealth application must standardize and consolidate various responsibilities for a health practitioner to buy into this solution.
The key lesson that the Biosense team learned during their innovation journey towards what would ultimately become the ToucHb is to “fail early,” as Ingawale summarizes. “It is difficult for a technical person to acknowledge failure, but important to do it earlier rather than later. It is important to protect and nurture the idea, but real world data can refute what you believe to be true in theory or in lab settings.”

**The ToucHb**

The ToucHb is a handheld, needle-free, battery-operated device that allows for anemia screening and monitoring in any environment. It is low-cost and non-invasive. Since a probe is attached to a person’s finger, no blood is drawn. The device is low-cost since there are no reagents, chemicals or special pharmaceuticals needed. Also, there are no moving parts, so maintenance of the device is minimal. With the fall in price of electronic parts and easier access to materials from around the world, Biosense is able to negotiate and source material from global suppliers. There are no recurring costs other than rechargeable batteries. The attached probe requires annual maintenance.

Unlike other portable anemia detection devices, the ToucHb does not require specialized skills to operate. It is just the matter of pushing a button and waiting less than a minute for results. To date, Biosense has carried out three pilot trials of the ToucHb: one in Karnataka and two in Maharashtra. Basic feedback during the pilot phase has affirmed the Biosense belief that an accurate screening device is needed. If the device could also be used for easy monitoring of anemia cases, that would be even more valuable to health practitioners.

**The Technology behind the ToucHb**

The ToucHb technology is based on reflectance spectroscopy technology, or the optical principle. If it is known how a substance behaves with respect to different optical properties, or light wavelengths, then a lot can be learned about that substance. An example of this is the color spectrum and how humans see color. The same general principle is being used with the ToucHb device, where the composition of hemoglobin can be determined and thereby lead to a diagnosis of anemia.

Other devices and approaches to non-invasive hemoglobin estimation have also been developed in parallel by a US-based company, Masimo Corporation and an Israel-based company, Orsense.
What has been most surprising in the development of the ToucHb is the tremendous support from the government. Ingawale notes that the team thought that it would take years to gain government buy-in, but that has fortunately not been the case. People are desperate to make a change. Ingawale says, “Our responsibility is to ensure quality and reach out to these people to make their jobs easier.”

Start-Up Challenges

There are some key challenges that Biosense has faced since its 2008 launch. Ingawale cites one challenge as the lack of “first-class research” in India. He says, “To seek advice on technology and R&D-related matters, one must seek expertise outside of India to better understand the technological climate and possibilities.” Another key challenge is the lack of transparency and the role of regulation. Ingawale adds, “This effectively frightens away potential entrepreneurs or forces them to waste time on non-productive activities.”

For Biosense, the most important ingredient for the enterprise’s success has been the team. “The core team is essential and has the right skill sets,” says Ingawale. Funding is also important, but “overestimated,” in Ingawale’s opinion. From its launch, Biosense received funding from strong partners like the Villgro Innovations Foundation, Echoing Green and IIM-Ahmedabad.

The Business Model

Biosense has a clear vision regarding how the product should be unveiled and whom it should target. Since the ToucHb is filling a critical gap as an accurate, non-invasive diagnostic tool, the business model will take shape and adapt to the various business opportunities that open up as the healthcare industry takes notice of the affordable and accurate Biosense solution.

The potential customer base that stands to reap the most benefit from the ToucHb is the rural clinic. The Biosense team recognizes that the cost of the device must be kept low – without compromising on its accuracy – so that the rural healthcare practitioner can afford to make it a part of her diagnostic toolkit. Lower cost will only be achieved by higher demand, but until the team is satisfied that the ToucHb is ready for market, manufacturing volumes are deliberately being kept low.

Biosense Technologies and Villgro

Biosense’s drive to make a positive social impact through free market mechanisms is an example of social entrepreneurship. Social enterprises are organizations that have the dual aims of financial sustainability and social impact.

Biosense is an incubatee of the Villgro Innovations Foundation, a Chennai-based NGO that provides seed funding, mentoring and networking opportunities to social enterprises that have the potential to scale up and transform rural India.

In Biosense, Villgro saw an enterprise working at the crossroads between a holistic approach to a critical health problem in India, anemia, and a simple, easy-to-use technology.
Manufacturing

The ToucHb is assembled in Mumbai. Each component comes from specific vendors from around the world, each offering the best quality at the best cost.

The estimated cost of a ToucHb unit is the same as an affordable mobile phone for a rural healthcare practitioner, but scale will play a huge role in driving this cost down. The final price that will be offered when the ToucHb enters the wider market will ultimately depend on demand volume.

Marketing, Sales and Distribution

In order to achieve maximum impact, it is essential for Biosense to work with the many stakeholders already working in India to alleviate the country’s anemia challenge. Partnerships with international agencies as well as with domestic authorities will help Biosense to inform protocol and policy in the future.

There are many possible customer channels that can be penetrated, but primary customers for TouchHb will likely be rural clinics. After the TouchHb is made widely available, the Biosense team recognizes that other channels, such as pharmaceutical companies with vast health networks, could be an invaluable target segment.

In terms of after sales services, Biosense is working on a service manual based on the feedback it has received from its initial trials. It will offer a replacement scheme, as well as servicing for faulty devices.

The Road Ahead

Currently, the challenges faced by the Biosense team involve issues faced by all entrepreneurs before they launch their product. Examples of the types of questions the Biosense team is resolving before delivering the ToucHb to market pertain to establishing relationships with the best suppliers it can afford and making further improvements to the manufacturing process to drive down costs. The team is also reviewing its marketing plan to ensure it appropriately supports their vision for launching the ToucHb and scaling its impact. Other elements of the TouchHb that are being closely scrutinized include hidden costs (i.e., overhead, shipping, regulatory) that need to be accounted for so that they are captured in its eventual pricing; and further technology improvements to make the TouchHb easy to use and accurate.

While the Biosense team further tailors the ToucHb to meet market needs, an important lesson on product use comes from the fact that portable anemia-related technology can be used not just to detect new cases of the condition, but also to monitor ongoing cases. Like all diseases,
preventive and curative measures must be part of overall alleviation efforts. The ToucHb is a device that makes these dual goals a possibility going forward.

Over the next five years, the Biosense team does not have complex plans. They simply want to make it as easy as possible to enable healthcare practitioners to do their jobs and make an impact on India’s anemia problem. In terms of scale, Ingawale believes that volume will drive impact in healthcare, especially in India. Therefore, Biosense must strive for volume to achieve scale: “The Indian market is, by definition, for impact when you’re looking at volumes,” he explains.

Feedback from pilot trials and soft launches of the ToucHb in various forums has been very positive. The Biosense team’s dedication to furthering anemia alleviation efforts clearly has merit, and the success of an affordable, accurate, easy-to-use device will be an unmistakable healthcare winner for anyone driving to make impact in underserved communities around the world.

As Biosense reviews statistical data to ensure that the best possible product is launched, it must build a strong business model to support the ToucHb, including understanding how the market will value the device enough to continuously make it an affordable option for stakeholders working in the healthcare field.

Once the ToucHb is launched, a new host of questions and field experience will further build the device’s business, and technological, case. Upon launch, the key questions the Biosense team must ask are: Can any further technological improvements be made to the ToucHb? Is the ToucHb easily accessible to its target customer segments? Does the Biosense business model continue to support scale thereby affecting substantial impact on anemia alleviation efforts? Until then, it is promising that Biosense is garnering accolades for its focused mission to provide the right tools for impact on anemia alleviation.