International Conference
on
Bioinformatics and Biostatistics for Agriculture Health and Environment

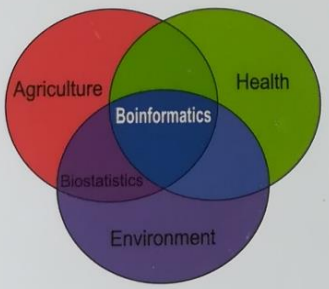
20-23 January 2017

Proceedings

ISBN : 978-984-34-0996-6







Jointly Organized by

Department of Statistics, University of Rajshahi, Bangladesh

Bangladesh Bioinformatics and Computational Biology Association (BBCBA)

Courtesy

Higher Education Quality Enhancement Project (HEQEP), CP-3603, W2, R3

Access to Information (a2i), Prime Minister's Office, Bangladesh

Development of artificial limbs using 3D printer

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Abstract. In the context of Bangladesh, disability prevails at a higher rate caused by a variety of reasons like lack of awareness, medical care, illiteracy, poverty, etc. These disabled people are not accounted with proper data. To minimize the loss, people need to look for prosthetic replacement treatments, but those are not available to everyone in the country and as a result, people have to come to Dhaka for better treatment. This study titled 'Development of Artificial Limb Using 3D Printer' aims to analyze the current scenario of people with disabilities and the problem of taking prosthesis based treatment and the possibilities of modern technology to cover up the problem respectively. Besides this broad aim, this study also has the specific objectives to assess the current situation of people with disabilities, understand the current scenario of receiving prosthetic treatment and identify the problem of prosthesis based treatment of people with disabilities. This study was done using relevant secondary data by reviewing and analyzing them along with the in-depth interviews of the project focal and NITOR. The traditional process of producing artificial parts or limbs is very slow and very costly, but the functionality and durability of those are questionable. Availing the service also requires time and money. Only 59% of male, 39% of female and 2% of children patients in Bangladesh take the prosthetic treatment. The lower limbs are very expensive and take a long time to get prosthetic treatment. For upper limb related problems, there is no replacement system. On the other hand, 3D printers can provide artificial parts at an affordable price. It can be used to create durable artificial limbs with accuracy and flexibility that helps them to lead better life.
Keywords: 3D Printer, Prosthetic Treatment, Disable people, Artificial Limb,

1. Introduction

In the world, disability is a very complex, dynamic, multidimensional and contested issues for any society like Bangladesh. It should be remembered that, the generalization on disability or individuals with disabilities can be misled as well as an individual with disability can have numerous influential factor that may vary the meaning in terms of gender, age, socioeconomic status, sexuality, ethnicity or race or cultural heritages, etc. The present context analysis is on the possibilities of the "Development of artificial limbs using 3D printer".

In the context of Bangladesh over population, poverty, illiteracy, lack of self or collective awareness, lack of medical care and service system and so on are the core reasons for the high prevalence of disability. It is one of the major social and economic phenomenons in Bangladesh but it is true that there is very little reliable data available on this issue due to the lack of proper combination of national survey on persons with disabilities. The Government of Bangladesh (GOB) surveys in 1982, 1986 and 1998 estimated a national prevalence rate of disability at 0.64%, 0.5% and 1.60% respectively. Action Aid-Bangladesh and Social Assistance and Rehabilitation for the Physically Vulnerable (SARPV) put the disabled population at 8.8% of the total population. Bangladesh Protibandi Kalayan Samiti records 7.8%. Dr. Julian Francis, in a report prepared for the Aid Management Office (AMOD) of the Overseas Development Administration (ODA) of the British Government in 1995, estimated the Person with Disabilities population to be 9 million, of which no less than 7 million live in rural areas (Action Aid, 1995). Most of the estimates generally appear to be underrated, sometimes exaggerated. In addition, the persons with disabilities encounter numerous problems to live their lives. When they go to hospitals for treatments, they again encounter different types of problems to get those treatments. The high cost lack of institutional knowledge,

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infrastructure and so on play a crucial role to demotivate them to take that treatment that ultimately affecting their entire life respectively.

2. Discussion

In the context of Bangladesh, the people with disabilities are often among the poorest of the poor and around 15-20% of the poor population in developing countries are disabled (WB, 2004). In Bangladesh, the accuracy of national data on the people with disabilities are questionable and no national representative data are available on types, severity and cause of impairments or on service availability and equity issues. A survey on prevalence of disability from 1994 by the Bangladesh Bureau of Statistics shows a rate of 10.62% disabilities per 1000 population (Ann Elwan, 2002).

2.1 The Prosthetic Treatment in Bangladesh

In the context of Bangladesh, the users of artificial limbs has been increased due to the high percentage of road accidents and other factors, but the prosthetic replacement treatment is not available or accessible for every one of the country and most of the time people rather come to Dhaka for better treatment. The trend of coming to Dhaka for getting services has been increased the total cost of the treatment and it has also created barrier for them for their daily activities. Most of the time, their families face numerous problems when they come here for treatment. In addition, the lack of infrastructure, lack of service provider and specialist are also creating the worst situation for them who need those prosthetic treatments. The quality and quantity of artificial limbs are not sufficient in contrast to their actual demand. According to the service provider, it has been noted that a large number of patients go back without receiving that prosthetic replacement treatment (NITOR, 2015).

There is insufficient treatment for the people with disabilities and the traditional process of producing artificial parts or limbs are also very slow. Besides, its manufacturing process is also very difficult and there is need of more time and cost for getting those services. The functionality and durability are not very good and there is a lack of efficiency. Most of the time, the available service system has failed to fulfill the patients' demands and it has not improved the safety levels nor it has increased an individual's self-confidence, rather it has decreased the safety level and self-confidence of the patients who need them for living their lives once again (NITOR, 2015).

2.2 The Present scenario of NITOR about Prosthetic treatment

In the context of Bangladesh, about 59% of male, 39% of female and only 2% of children patient takes the prosthetic treatment. The ratio of treatment taking is very low to compare with the actual incidents. A large number of people takes their surgical prosthetic treatments from their own district hospitals and rest of them are coming to NITOR and CRP for those prosthetic treatments. In the context of NITOR (National Institution of Traumatology and Orthopedic Rehabilitation), there is no upper limbs prosthetic treatment service and the lower limbs supports are available from the NITOR limbs center. The lower limbs are very expensive and it takes a long time to get the prosthetic treatment. According to the NITOR, it takes 10 to 12 days for a person to get that treatment and in CRP, it takes 9 to 10 days to get that treatment (NITOR, 2015).

There are few private hospitals that provide the surgical prosthetic treatment service, but those are few to compare with the demand of that treatment. In addition, the cost of surgical prosthetic treatment in a private hospital is very high and expensive and only the higher class citizens have the capability and accessibility to get that treatment.

According to the NITOR, about 300 to 350 patients come here for limbs related treatments and the number of patients is almost double at CRP, as well as about 9000 to 10000 patients take treatments from their local district hospitals. In CRP and NITOR, there is mainly surgery based operation and there is only one measurement system for the patients. If a person comes for his or her upper limbs related problem then his/her upper limbs (finger, wrist) are cut down and there is no replacement system for them who need them for a better life. For that reason, there is no satisfaction on replacing the upper fingers and limbs respectively (NITOR, 2015).

The Disadvantages of availing prosthetic Treatment: Surgical or Replacement?

According to the NITOR, there is lack of infrastructure to provide the replacement prosthetic treatment, but they just only provide the surgery prosthesis based treatment for the patient, for example, if a patient have an injury to his or her hand or leg, then the NITOR giving him/her a surgical treatment and as a part of this treatment, they do a surgery and cut down his or her hand or leg if necessary, but after the cut down of that patient's hand or leg they didn't give him/her prosthesis based replacement treatment. They rather help them to get that treatment outside the NITOR. In NITOR, there are two surgery doctors and one technician for surgical prosthetic treatment. There is no technical unit to support them. They rather play as brokers to communicate between the CRP or the BRAC with the patient for prosthesis based replacement treatment. The cost of replacement prosthetic treatment differs with the color, size and the materials that is use to produce the artificial limbs and the cost of that prosthetic replacement treatment is very expensive for the middle class or poor patients in Bangladesh. In any divisional and district city, there is no such opportunity for any replacement based prosthetic treatment for the people with disabilities. It is very sad to say that, in Bangladesh, there is no such government institution that provides the patient of this prosthetic replacement treatment. In the entire country, the BRAC and the CRP are the only two such institutions who provide the entire artificial limbs to the patients (NITOR, 2015).

The current process of prosthetic treatment is only surgery (cut off finger single /multiple and hand) and the average time frame for the treatment is one day surgery and 12 to 15 days to follow up the treatment for quick recovery. The surgery for limbs replacement is free from NITOR, but the bionic finger and hand replacement from private supplier is about 25000 to 45000 BDT respectively. The quality of the prosthetic treatment, in addition surgery based quality is 70% good, 2% is infected for diabetes patients. The surgery based treatment is taken by 97%, but prosthesis based treatment is about 3% to 4% due to the high cost of the prosthesis based treatment. The materials of prosthesis based treatment are available through the private suppliers, but those are very high cost. In the current situation, BRAC limbs center is one of the private limbs material supplier. For all those reasons, the quality of replacement prosthetic treatments is not adequate enough and it needs more development and initiative for making the entire prosthetic treatment more accessible and available for the people with disabilities (NITOR, 2015).

3D Printer is the solution for future prosthesis based treatment in Bangladesh

It is usually known that, the traditional process of prosthetic treatment requires more specialized labor. Usually, the look and feels of those are very mechanical and robotic and that eventually affects negatively on the appearance and psychology of those individuals who need them. In the traditional way, it needs more cost and time as well as the replacement of that body part that they lost by accident or in other way has been unaffordable and sometime malfunction prone or uncomfortable for the patient respectively.

In the context of Bangladesh, there is no such good replacement based prosthetic treatment and in every district and NITOR or CRP center, there is availability of surgical prosthetic treatment, but the prosthetic replacement treatment is quite expensive due to the use of advanced material that has been used to create the new ones and the hospital costs. It is often noted that the lack of comfort, heavy weight, long delay or wait for getting treatment, feeling embarrassed etc. are the core problems for them who need them for better lives.

Due to the high frequency of road accidents and for other reasons, in orthopedic implants sectors, the most fast growing segments are knee, hip and elbow, but the entire process of prosthetic replacement treatment are old fashion and traditional. The materials they use for creating that artificial part are also hard metals or ceramics that leads to huge amounts of material composition and waste respectively. It is also noted that these prostheses become uncomfortable and even painful for the patients. A large number of patients must have their prosthetic replaced as they become mature. For example, when a child is born without a functional knee would need replacement, but s/he have to wait for a certain period of time for reaching a physical maturity. As a result, many patients have to wait until they grow for getting a prosthetic treatment.

The answer to why prosthetic treatment specialists think that 3D printing technique would be a better solution for the patient would be more explicit after looking at the following section.

2.3 The basic features of 3D printer that built within the country

A. Low cost

The 3D technology is such a technology that is gradually reshaping the entire technical and thinking arena, because through the 3D printer the dreams come true. The cost of 3D printer is cheaper than any other types of printer, because this printer has been produced in Bangladesh with its own technology. Besides, the cost of materials is also cheap to compare with the other processes to create the artificial parts of body and there is no need of any hospital cost that eventually decreases the cost of treatment for them who need them (Atin, 2014).

B. Time saving

To compare with the existing prosthetic treatment, it would be more time saving due to the fast speed of working

and the patient would not need a long time for replacing their needed items. Due to its nature of faster speed, both patients and doctors or technicians get the advantage. The doctors or technicians provide more services to the patients and the patients get their desire services within a very short time (e-NABLE, 2015).

C. Customization size

Another advantage of country made 3D printer is that it can produce any size of artificial item that a patient needs. In the existing system, it is truly difficult and expensive to get any customized size and most of the time they are not fitted with patient bodies and its leads to a malfunctioning of that items and creates an embarrassing situation for the patient. Therefore, it can be said that customization of patient demand would be possible and it takes less time to be fitted with the patients' bodies (e-NABLE, 2015).

D. Accuracy

Accuracy is the core feature of a 3D printer. It has the ability to produce any type of item and the ratio of accuracy is higher than any other type of service. The country made 3D printer has been worked hard on balancing resolution and speed and a system has been found that provides a more accurate or better services (e-NABLE, 2015).

E. Durability

The country made 3D printer is more durable than the others, because it needs a little maintenance and the parts of the 3D printer are both long lusting and exchangeable. Therefore, the complete artificial product that is produced through that printer would be more durable and functional (Atin, 2014).

F. Easy to use

The country made 3D printer is very easy to use and any one can use it, because if a person have a proper software and if he or she is well known with 3D technology, it is very useful and easy for them to create anything that they need just after changing their raw materials with their demands. This makes setup as simple as plugging in any printer and a person is ready to build! Along with the easy-to-use software, a person can start turning their ideas into models and projects in minutes (Matt, 2015).

G. Clean, quit and contained

Another basic feature of the 3D printer is its quality for producing artificial items and often it is also quiet and containable respectively. The amount of waste are very high in the traditional process of prosthetic replacement treatment. Besides, it is not a clean, quiet or contained process in contrast to the 3D printer. Due to the lack of cleanness, quietness and high wastage, this traditional way of producing artificial limbs has not been popular for everyone who needs them, rather they have no alternative option to take another option. In contrast to the availed system, 3D printers would be more clean, quiet and containable and the wastage would also be very low (Travis, 2013).

H. Better quality

In the context of Bangladesh, the quality of traditional prosthetic replacement treatment is low as well as the material they used for producing those parts of bodies are also very low quality. The very heavy weight creates an embarrassing situation for them who need those prosthetic treatments. The nature and outlook of that artificial parts of bodies are also both uncomfortable and robotic that eventually are not very useful for them to overcome that worst situation (Meera, 2014).

I. Accessibility

In the current process of prosthetic replacement treatment, the people with disabilities or their families face a burden to receive the proper treatment. Most of the patients have no such economic condition to get that expensive treatment. For that reason, a large number of patient didn't take such prosthetic treatments. In contrast to traditional prosthetic treatment, this new technical process need less costly materials and it also reduce the time and visit for the treatment that eventually decreased the entire treatment cost and in this way, the prosthetic replacement treatment would be more accessible for the mass population (Laura, 2010).

J. Sustainability

One of the core features of 3D printer is its nature of sustainability. The percentage of sustainability of availed system is not so high, rather the sustainability of traditional prosthetic system is low and less effective. The efficiency and cost effectiveness are also not suitable to every patient. It can be noted that, 3D printer would be more effective and the percentage of efficiency will be higher that will eventually raise the rate of sustainability of 3D printers (Atin, 2014).

3. Conclusion

In the conclusion, it can be articulated that the prosthesis is an artificial extension that replaces a missing body part. Besides, they require prosthetic devices and services which become a life –long event. The artificial limbs

may be needed for different reasons such as for diseases, accidents and congenital defects. In Bangladesh, there is limited data and there are few studies conducted about the people with disabilities, their problems and their needed prosthesis treatments, but it is true that the number of people with disabilities is high enough and many of them live in the rural area.

The vast majority of prosthesis treatment services are located and oriented in the urban area. In addition, in the divisional cities and Dhaka city, these are not strategically coordinated for the welfare of people with disabilities. Prosthetic treatment would be a better solution to overcome that problem, but the inappropriate way of prosthetic treatment, the insufficient of infrastructure, expertise etc. make the entire process worse for them who need the artificial limbs. In the divisional cities or Dhaka city, there is availability of only surgical prosthesis based treatments that may be not so costly for their family and community, but costly enough. There is need for prosthesis replacement based treatments for better rehabilitation in normal lives. In Bangladesh, there is no such opportunity for prosthetic replacement treatment and only the BRAC and CRP are two such institutions that provide the prosthetic replacement treatment, but the time and cost of that treatment are very high expensive for the patients who need them.

The available prosthesis replacement treatment is not enough and well in quality and its function ability and durability is not also enough for the people who needed them to come back to their daily lives. And in the context of Bangladesh, the one of the best and possible solution is 3D printer that can eventually minimize the total cost, time and visit for the patient, as well as the durability, function ability and sustainability of that process would be more visible to compare the availed prosthetic surgical or traditional replacement treatment. Hence, in the context of present context analysis, there is need to formulate further hypothesis for further studies on the problem of people with disabilities and their prosthesis based treatment in Bangladesh that would be helpful to understand the entire scenario more contextually.

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