Telemedicine Facilities on Ambulance for a Patient Pre-Hospitalized - A Raised Model

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Abstract - *Telemedicine is nothing new in medicine. However, many branches and sub-branches have been created, are being and will be in the future. And in the field of health, getting acquainted with such new topics become very challenging. With such an invention of telemedicine in mind in the future, we need to acquire a lot of knowledge on that subject with planning. Our proposed model uses a high-speed wireless network system (up to 100 Mbps). There are also monitors, webcams and all the necessary arrangements that will play a role in telecommunications with doctors and experts or technicians. There are also agency services and smart device base health services such as Mobile Applications, Websites and Calling services. As a result, the patient or client will be able to receive the necessary healthcare very quickly. So that the mortality rate of the patient or service recipient will be reduced. If the use of robotics in the next model is confirmed, the model will go a few steps further. This will allow the patient or the client to receive more advanced treatment.*

Key Words: **Ambulance, Emergency Health Care, Mobile Based Health Service, Pre-Hospitalized, Robotics, Tele- Ambulance, Telehealth, Telemedicine.**

1. INTRODUCTION

Reportedly, in 1967, Massachusetts General Hospital provided the first clinical emergency health service [1].The service is provided primarily to employees and travelers at Logan International Airport, about three miles from the hospital. Two-way audio visual microwave circuits were used there [1]. "The prefix 'tele' derives from the Greek meaning 'far' or 'at a distance' or 'remote'. Hence, the word telemedicine signifies: medicine delivered at a distance"[2]. Over time, different geniuses have defined telemedicine in different ways. "The transfer of electronic medical data from one location to another"[3]. "Telemedicine is the use of telecommunications to provide medical information and services" [4]. "Telemedicine utilizes information and telecommunications technology to transfer medical information for diagnosis, therapy and education"[5]. According to Medscape "Telemedicine is also known as 'video visit', 'online doctor visits' and ' doctors on demand' and its can be implemented via smartphone, tablate or computer" [6]. From google dictionary, "The remote diagnosis and treatment of patients by means of telecommunications technology is called telemedicine"[7].

According to evisit.com, "Telemedicine is the exchange of medical information from one location to another using electronic communication, which improves patient's health status" [8]. By definition of News Medical Life Science, "Telemedicine refers to the provision of remote clinical services via real time two-way communication between the patient and the health care provider, using the electronic audio and visual means" [9].

As a result of this continuous advancement in technology, many sectors of telemedicine are being created and will continue to be created in the future. And "all these telemedicine systems are generally divided into teleconsultation, tele-education, telemonitoring and telesurgery" [2]. Teleconsultation is usually the communication base [2]. The communication here may be between two or more doctors or physicians without the patient or between two or more doctors and the patient or maybe between the physicians or expert and the doctor who is with the patient. For example, the expert or physician present at the patient side contacts the doctor for help and that doctor contacts one or more other doctors to seek their advice. After all, the Internet is a source of information at this time. This online source of information is one of the main tools of education. It is an open and common place for everyone. Many educational materials are available here at very low cost and easily. All these health related educational material delivery routes are called tele-education. And the purpose of this transmission is:-"From teleconsultation to clinical education and providing clinical education, academic education and public education through a internet" [2]. Here, "Telemonitoring is the use of a telecommunications link to gather routine or repeated data on a patient's condition" [2].It's defined as "the use of information technology to monitor patients at a distance" [10]. It also refers to "the transmission of symptom scores, physiological data including heart rate, blood pressure, oxygen saturation and weight directly to care providers either via automated electronic means or by web-based or phone-based data entry" [11]. And, "Telesurgery also known as Remote Surgery and it's the ability for a doctor to perform surgery on a patient even though they are not physically in the same location"[12]."It uses wireless networking and robotic technology to allow surgeons to cooperate on patients who are distantly located and it also eliminates geographical barriers that prevent timely and high-quality surgical invention, financial burden,

complications and often risky long-distance travel" [13]. And "It's a surgical procedure that carried out at a distance thanks to advances in robotic and computer technology and their applications to surgery" [14].

"Future priorities for telemedicine include moving telemedicine into the mainstream, developing health policy, telecare, exploiting the Internet, and expanding healthcare in underdeveloped countries" [2]. In this golden age of technology, our goal is to take this telemedicine service one step further and bring that service to the doorsteps of the people. In this context, the main goal of our research is to discuss the overall development of telemedicine in the ambulance service.

2. METHODOLOGY:

2.1 Telemedicine and Ambulance

"Telemedicine is a remote clinical service that allows for simultaneous diagnosis and monitoring of the patient"[15].On the other hand, "An ambulance is a vehicle used to transport a patient to a hospital and provide first aid to a patient" [16].There is a lot of research on telemedicine in the world today. Many researchers have already done research on the use of this telemedicine in various diseases including stroke, diabetes etc. Again some papers have spoken about ambulance-base or facilities of ambulance telemedicine. The main goal of our paper is the overall use of telemedicine in this ambulance service. Basically, today we discuss some ideas with how to make further improvements in this field. We will publish "Telemedicine on Ambulance" as "Tele-Ambulance". These are basically for the sweetness of writing.

2.2 Ambulance and Tele-Communication System

The world is moving forward through the promotion and dissemination of information and communication technology. IT is the short form of information and communication technology. "It is an integrated communication system made up of telecommunications, computer networking, software, middleware, etc" [17]. The current world is running by the fourth generation. And 4G is the technology of wireless telecommunication[18]. Through 4G network, from mobile web services to video conferencing, three-dimensional television and cloud computing are possible [18].The data rate of this 4G networking is up to 100 Mbps[18]. A telecommunication system is a telegraphic or telephonic communication[19]. "Which carries video, audio or digital messages remotely via radio waves, optical signals, satellites or cables" [20]. Tele-ambulance is required to provide real time service. It requires a video conferencing system, which requires a data rate of 128 kbps to 20 Mbps [21]. 128 kbps data rate is required for low quality video conferencing and up to 20 Mbps is required for three screen video conferencing [21]. Moreover, more than 16 kbps [22] data is required to transmit audio one to

another place. By making all these arrangements, telemedicine services can be provided in ambulances. In this way, the ambulance can be converted into a tele-ambulance.

2.3 Doctor and Technician or Experts and Tele-Ambulance

Proper management of tele-ambulance services requires the combined leadership of doctors and technicians or experts. It is also important for doctors and technicians or experts to have an idea about the medical equipments and technological devices (Table-1) used in telemedicine. All of them must be caring and active at work. Technicians or experts need to know how to do blood grouping, pressure measurement, diabetes testing, digital ECG monitoring and have experience and proper training in the use of all Medical equipment (Table-2) used in tele-ambulance. Moreover, they must have the ability to do telecommunication. Through which the doctor stationed in the hospital and the technician or expert present in the tele-ambulance can communicate with each other and the technician or expert can provide the necessary health services to the patient through proper advice according to the patient's condition. Tele-ambulance drivers must also have training in this regard. So that they can help the technician or expert when needed.

2.4 Installation of Telemedicine facilities in Ambulance

The most important part of a tele-ambulance is to make all the arrangements for the installation of telemedicine services in the ambulance. Text and data, audio, still or single image and video [2] are required to provide telemedicine services. If these four facilities are provided, it will be possible to eliminate the technological problems of telemedicine. And for that we have to install some telecommunication devices in the ambulance (Table-1). In addition, the ambulance must have the necessary medical equipment to provide the real time health services (Table-2). Only then can the ambulance be called a tele-ambulance. And through this device or equipment, the technician or expert will be able to provide the necessary health care to the patient.

Table-1: Some Telecommunication devices in the Tele-Ambulance (with use and cost).

Devices for Telecommunication	Use	Cost* (MOQ)
Display Monitor (15.6" Open Frame LCD)	To review imaging results (wide angle view) [23]	$120-450
Webcam (USB FHD 1080p)	To see patients real time image and video [24]	$12-15
Hand Free	To talk patient/ technician	$4-5

Speaker Phone	clearly (easy to carry) [25]	
External Ports	To connect devices properly and consistently [26]	$60-200
Wireless Network Facilities (set)	To establish network connection	$4,000-10,000
USB Macro Camera	To view patients close image	$40-100

*from online website [27]

MOQ - Minimum Order Quantity

Table-2: Necessary medical equipment for real time health services (with use and cost).

Equipment's for Telecare	Use	Cost* (MOQ)
Digital Blood Pressure Cuff (with monitor)	To get patients systolic and diastolic Blood Pressure through digital screen [28]	$8-80
Glucose Meter	To measure patients blood glucose level [29]	$4-20
Digital Thermometer	To record body temperature through electronic heart sensors [30]	$4-800
Digital Electrocardiogram (monitor)	To detect abnormal heart rhythm [31]	$200-1,000
Pulse Oximeter	To check how well patients heart is pumping oxygen in the body [32]	$3-15
Electronic Stethoscope	To convert the acoustic sound into electrical sound (chest) [33]	$50-200
USB Otoscope (Digital)	To investigate patients ear symptoms [34]	$100-800
Oxygen Supply Units	To support patients respiration [35]	$25-150
Sphygmomanometer (electronic)	For measure blood pressure without training [36]	$5-100
Nebulizer	To administer medication in the form of a mist inhaled into the lungs [37]	$9-115
Digital X-ray	To directly capture data during the patients examination [38]	$2,000 - 10,000
Medical Assessment Guide	To identify the patients problem and medical needs [39]	-

*from online website [27]

MOQ - Minimum Order Quantity

2.5 Tele-Ambulance Service Agency

In order to provide a tele-ambulance service, its overall management needs to be streamlined. As a result, tele-ambulance service is easily accessible to the public. In this case, the agency can be a very good solution. This service will reach the public through this agency. Below are some of the agencies discussed -

- **Government Agency (GA)**: These GA can play a role in providing tele-ambulance services very easily and at low cost. Whose overall control will be with the government or administration? And all its activities will be controlled by government or administration. Thus, all the responsibility of the GA is on the government or administration.

- **Private Agency (PA):** Private Organizations and NGOs will continue to run such agencies. Usually, it is not possible to do everything in government and it will take more time. In this case, if the non-governmental organizations and NGOs come forward, it is possible to deliver tele-ambulance service to the local level very easily and quickly.

- **Voluntary Organizations(VO):** These VO can be a major tool in managing tele-ambulance services. As a result, it is possible to provide these services to the public at a very low cost and quickly.

2.6 Device Based Tele-Health Service

As of July 2020, 59% of the world's population is actively using the Internet, which is about 4.57~4.78 billion [40][41]. Where 4.17 billion unique mobile users [40]. Of that, 3.5 billion [40] are smartphone users. Smartphones are now one of the necessities of life. People are now using smartphones for everything from communicating with certain people. People have become so addicted to smartphones that they wake up in the morning and now look for the smartphone first instead of coffee or tea. We can easily use this smartphone for telehealth or telecare services. It is basically a three-way service provider. And those services are -

> **1.** Mobile Application and Health care service
>
> **2.** Web Service and Telehealth
>
> **3.** Calling Service and Tele-Ambulance

2.6.1 Mobile Application and Health care service

There are currently several mobile applications available that offer access to many telemedicine services. However, different applications are needed to receive all these

services. At the very least, we want to bring almost all telemedicine services into a single platform or application.
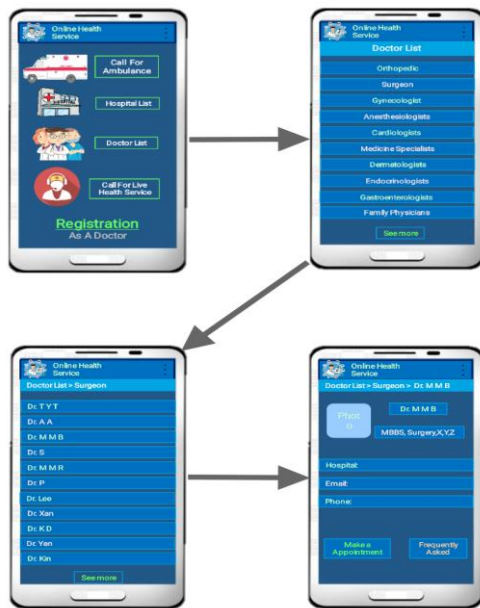

Figure-1:Mobile Application and Health care service

That's why we have this little effort. It is just like a normal mobile application. Which will use very little space on the mobile? First of all, this application will be an online healthcare provider. From online ambulance services to a list of city-based hospitals. There will be a list of doctors according to the type of doctor. There will be online patient services to provide all health services online. There will be an opportunity to make an appointment for a specific doctor. From joining as a new doctor to the opportunity to register as an ambulance service provider or as a patient. And there will be a list of top-rated doctors. Which are made by giving ratings to patients? And this application will be free for everyone. Use also requires very little data. It can be controlled by the government or a social organization or an NGO. Those who will try to provide the highest service (Figure -1).

2.6.2 Web service and Health care

Researching over 50 health care websites, we found that almost every website provides a City or State or Country-based service. However, there is no website that provides health care globally or internationally. Moreover, there are very few of those websites that are easily usable. Since the world is moving very fast now, we want a platform or website that will be easily usable and will have easy access to global or international health services. Where, the patient can receive local, national and international services. The site will have a specific home page with healthcare related recent news, which will be constantly updated. There will be an opportunity to receive services from the local health care center according to the location. There will be a list of city-based hospitals and doctors

according to schedule or rating. There will also be a list of country-based hospitals and doctors. All lists will be based on patient reviews. This will help to understand new patients about this doctor and also hospital. And as a result, new patients will be able to easily find a good hospital and seek primary advice from a good doctor and
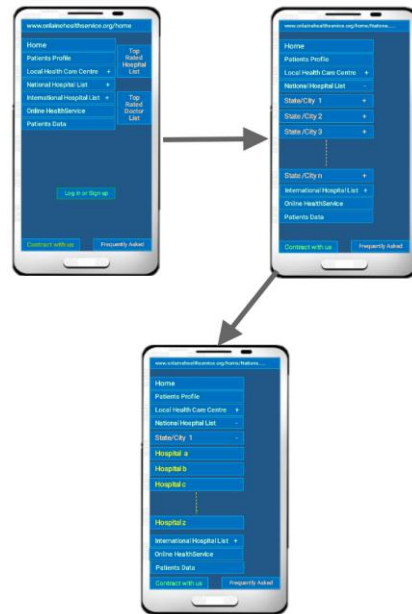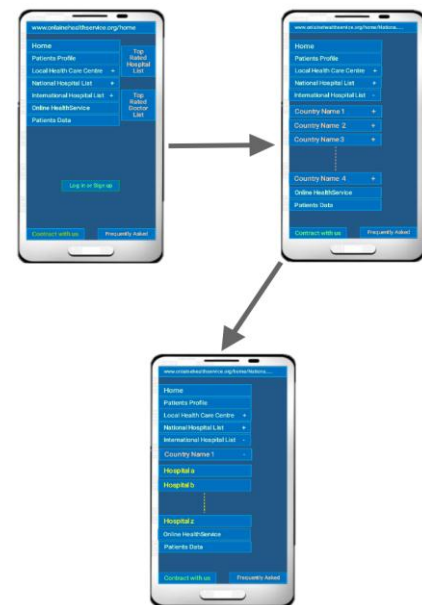

Figure - 2a

Figure -2b

paying a little fee. They will also be able to make an appointment with the doctor. In this way doctors and patients from all over the world will come together on one platform. Moreover, doctors will be able to create collaboration among themselves which is very important for telemedicine. And it will only be in the service of

humanity. For this purpose we have given a demo design of a website (Figure-2).

2.6.3 Calling Service and Tele-Ambulance

There are 1.3~ billion [40] normal phone users in the world today. Basically, this service will be launched considering them. However, smartphone users will also be able to enjoy this service. The other two services are globally possible but the calling-service will be local or national level. This service will usually be an ambulance or tele-ambulance service provider. There will be a specific hot-line number. Which will provide country based services. And through this the patient or the client will contact to get the service. That can be local or national or separately hotline service at local and national level. In this case the patient or service recipient can contact the National Health Care Centre (NHCC) directly for the service and then the NHCC will contact the Local Health Care Centre (LHCC). Again the patient or client can contact the LHCC for services. Because there will be different hotline arrangements for LHCC and NHCC. And this hotline service will be open to everyone. In this way a patient or service recipient can easily take tele-ambulance service from Tele-Ambulance Center (Diagram-1).

Diagram - 1: Calling Service and Tele-Ambulance
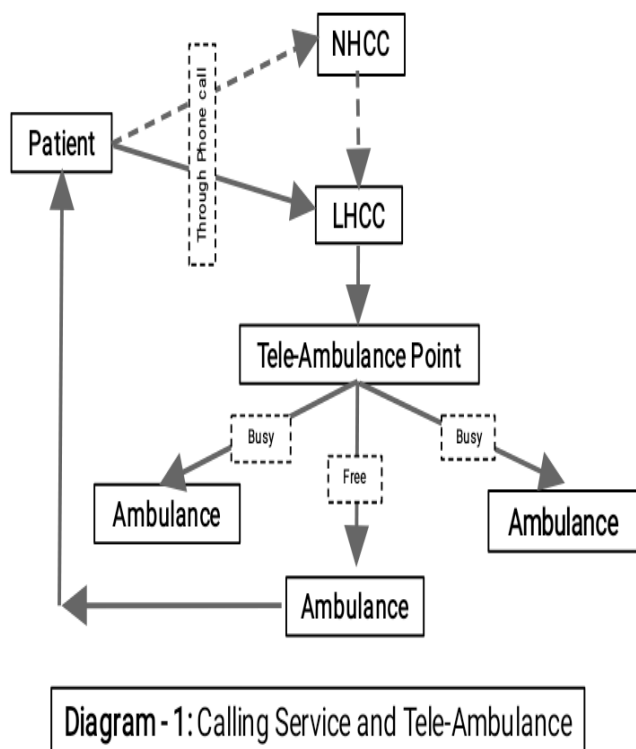
2.7 Literature review

Even from a distance, telemedicine is about serving the patient by standing next to the patient[42]. Some papers have talked about treating many diseases through telemedicine[43][44][45]. In most cases, telemedicine services have been mentioned for stroke, diabetes, cardiovascular diseases[46]. Due to telemedicine services,

the rate of loss while receiving patient services has been greatly reduced[47][48].In this golden age of technology, the use of digital ECGs in telemedicine services has become possible[49]. Also, the technician connects and provides services to the doctor through video conferencing in real time[46].For this, technicians or nurses need to have good knowledge and experience about telemedicine and telecommunications[50].

In this case, we want to give a new look in telemedicine service. The telemedicine service that the patient could not get without going to the hospital. We have come up with the issue of tele-ambulance to further improve that service.

2.8 Our Strategy

Our strategy will basically follow four phases. In the first phase there will be patients (who need help) and in the 2nd, 3rd and 4th phase there will be Local Hospitals (LH) or LHCC, NHCC and the latest International Health Care Centre (IHCC). Here the patient will contact LH or LHCC for help. All LHs will have two automatic systems, one is Automatic Massage Alert (AMA) and the other is Automatic Location Sharing (ALS).When a patient will contact the LH for help. Only then will the AMA move to the rest of the LH, asking for help from the specified LH.
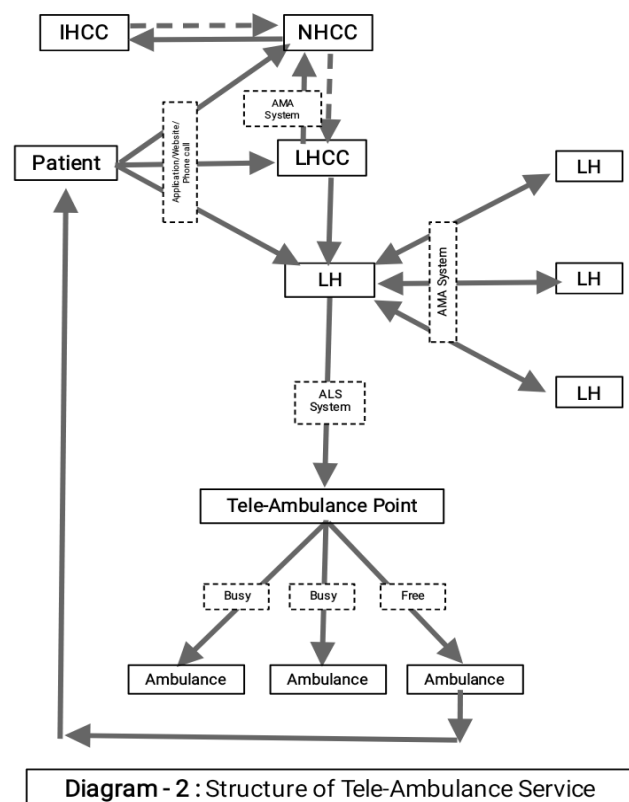

Diagram - 2 : Structure of Tele-Ambulance Service

Figure-2: Web service and Health care

Immediately another message with ALS will be sent to LH's tele-ambulance center. Who will send a tele-ambulance to the location without any delay. Another

AMA from the specified LH or LHCC will go to the NHCC and the latest from the NHCC to the IHCC will be contacted for emergency assistance. If necessary, the patient or client can contact the NHCC directly for help. There will be all arrangements for providing and receiving telemedicine services in all cases. This will be done mainly at the local and national level to discuss the patient's condition while providing services to the patient and to get a clear idea. And if telesurgery is needed. It is a system capable of providing point-to-points well as multi-point services (Diagram-2).

3. RESULT

This proposed model is designed to provide medical care to the patient at his doorstep. In that model, the patient or client will be able to receive telemedicine services using their mobile phone, as well as the necessary health services using tele-ambulance in critical times. The applications and websites used in this model will help the patient or the client to receive health services at home. Also the patient or the client will be able to receive the telemedicine service of the tele-ambulance very easily and in a very short time.

Patients in tele-ambulance will be able to receive point-to-point or multipoint services if required through the telemedicine system installed in the hospital and ambulance. The patient or client will get the service of this tele-ambulance through technician or expert. The technician will send all the data of the patient to the data base of the hospital. The doctor will guide the technician considering the overall condition of the patient and the technician will provide the service as per the direction of the doctor. This will allow the patient to receive the right services and reduce patient mortality.

4. DISCUSSION AND LIMITATION

When, there is an emergency and the hospital is far away from the patient's position. Patients fell to their deaths as ambulances rushed to the hospital. Tele-ambulances play an important role in dealing with such situations. Where the ambulance has almost all the arrangements for providing telemedicine services. Which is able to provide all the basic services of the patient. "Chronic disease, Medication management (birth control, chronic illness),Non-emergency urgent care, minor injuries, respiratory illness, urinary tract infections, Pregnancy emergency, digestive issue, stroke, diabetes, pandemic situations are one of the services"[46][51]. Along with tele-ambulance, LHCC will also have all the arrangements to provide telemedicine services. These telemedicine services are easily accessible to the patient or the client through the application or website. In order to receive such services, the patient has to access the application or website. The value of which will be within the reach of the patient or the client. And this access will be of two types. One of which is private access and the other is general access. With private access, the patient will be able to get services from the doctor through the application or website using their own device from their own location. However, for this, the patient or the client has to get a schedule from the doctor in advance. Also through general access the patient or client will be able to receive all primary health care services at any time through the application or website from the service providers. This will reduce the time and extra cost of the patient or the client.

Tele-education can also be arranged. Since almost every person is connected to the internet or mobile in one way or another, so it is possible to do this very easily. And at least one person from each family will receive this training. By doing this, the trained person will be able to provide the necessary basic health services to his family members when needed. In addition, the person will be able to assist the technician or expert in the tele-ambulance as needed. As a result, the patient's risk of death will be reduced.

There are some limitations to provide this service. First, the lack of adequate tele-ambulance, Considering the cost of installation of telemedicine facilities in the ambulance, it will not be possible to provide adequate tele-ambulance in the beginning. However, it is possible to solve this problem gradually. For that, governmental and non-governmental organizations have to come forward. Second, lack of adequate technicians or experts, this is not a big problem. LHCC and NHCC can solve this problem very easily if they want. The LHCC or NHCC can solve this problem by hiring or appointing technicians or experts and arranging the necessary training for them. Third, the lack of doctors. However it can be solved by proper recruitment. And all these problems can be solved through the participation of all of us. In particular, the governmental and non-governmental organizations, NGOs or businessmen need to intervene. In this way tele-ambulance service can be extended to all.

5. CONCLUSION AND IN FUTURE

It is possible to provide very fast and effective service to the patient through tele-ambulance. This will reduce patient mortality, those who do not receive treatment on time or cannot reach the hospital. Through this, the doctor of the hospital and the technician of the tele-ambulance will be able to provide treatment to the patient considering the condition of the patient. Also, if tele-ambulance arrangement of telesurgery is possible, this service can also be provided to the critical patient. Which will help the patient to get better service.

In the future we can take this telemedicine and tele-ambulance one step further by using robotics. Robotics is now being used across an important part of medicine. If these robotics can be combined with telemedicine, basically tele-ambulance, the medical field will go a few

steps further. Robots can easily reach where humans have trouble reaching. It is possible to provide services even when there is a risk to human health through these robotics and that's without any health risks (Example: Epidemic like COVID-19).

AUTHOR'S CONTRIBUTION

The authors have all made equal contributions to this work. And all the credit for this work goes to them.

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BIOGRAPHIES

As an engineering student, I always like to do challenging work, think about innovation and value my time. By using engineering education and practice to do something new and innovative for our world.

Currently working as a Research Assistant. I always like to think innovatively. I am interested in learning new skills and love to move on to new challenges with an open mind.

As a student of biomedical engineering, I want to bring revolution in human organ replacement with artificial devices.

Combining human qualities and the knowledge gained as an engineering student, want to do something beneficial and timely that will lead mankind to prosperity, not destruction.

I prefer to take all the work of life as enjoyable. Being able to do something from a tension free mood has a special charm.