Virtual Presentia (VIP) and Virtual Absentia (VIA) Hospitals

A Novel Approach Based on Virtual Presence and Absence

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Abstract—Medical robots are moving from the benches of laboratories to the bedside of patients rapidly. With advancements in information and communication technology (ICT), these are being used for diagnostic as well as therapeutic purposes. They can assist but cannot replace the doctors. Evolution of new terminologies like tele-presence, tele-medicine, tele-referral, tele-consultation, tele-rounding, tele-diagnosis, telerounding, tele-health centers, tele-doctors, tele-nurses are overwhelming and required to be readdressed. Mostly these terms are overlapping. Definitions of triad of telediagnosis, different ways of communication (real and virtual) and medical robots (Roboscope and Roboop) are given. There is increase demand of teleclinics or telehospitals to absorb these terms to avoid confusion. Our focus here is to review the literature related to telemedicine and discuss new concept of Virtually Presentable or Virtual Presentia (VIP) and Virtually Accessible or Virtual Absentia (VIA) Specialist Hospitals leading to Absolute Virtual Hospitals. Classification of virtual hospitals, identification of available resources (computers), manpower (virtual specialists) and modes of communication (absent or present) will lay down foundation of new aspects for telediagnosis as well as medical educational system.

Keywords-telemedicine; remote presence; telepresence; telehospital; virtual hospitals; teleconsultation; telerounding; telereferral; telediagnosis;

I. INTRODUCTION

A new concept of Virtual Specialist Hospital is promising and required to promote field of telemedicine, medical education and confidence of patients [1-3]. Telemedicine may be as simple as two health professionals discussing a case over the telephone or as complex as using ICT (Information and Communication Technology) to conduct a real-time teleconsultation or telerounding between medical specialists in two different countries. In telemedicine typical scenario, two doctors are involved with the patient i.e., a local attending doctor and a remote tele-doctor who is engaged to do variety of services ranging from tele-consultation to tele-surgery, as well as tele-diagnosis where a doctor diagnoses a sickness [4]. Local attending doctors mostly are medical officers or nurses. Remote tele-doctors are specialists from different disciplines of medicine with in the boundaries of any country but across the borders generally both are specialists to exchange their views. Care at a distan*ce* (in absentia care) is evolved from an old times practice of sending prescription through postal letters to current modern telemedicine by using information and communication technology. Use of whistle, smoke signals, drum beating, loud speakers and two-ways radio powered by dynamo of bicycle to warn about diseases from a distance are established facts [5]. Telemedicine tends to be taken for granted in developed countries but lacking in developing and underdeveloped countries because of shortage of facilities and awareness. Even critics are there to declare it responsible for overburdening of already overburdened doctors in urban areas. Proponents are over-enthusiastic and happy even with only one e-Health specialist in countries like Rwanda [6]. Interrupted and slow internet services with availability of one computer will not stop them from declaring their clinics as tele-clinics. A comparative study is available regarding urban and rural doctors indicating good physicians' perception of usefulness of telemedicine in both groups and is positively related to their intention to adopt this technology [7]. Telemedicine improves the delivery of healthcare to rural and under-served communities as well as reduces the sense of professional isolation often reported by practitioners in these types of communities [8].Telemedicine is a helpful tool to reach people whose voices are not being heard as much us as the peoples in the main cities. Patients from rural areas are in great need of health services without the need of traveling long distances and in a much shorter time, that could mean a matter of life or death [9]. Its role in urban and rural areas is well established fact but commonly focused on rural areas due to lack of proper hospital facilities. Urbanization is directly related to development of infra-structure including hospitals therefore, its significance in cities is comparatively less than remote areas. Telemedicine may be considered as branch of rural medicine. It may turn out to be the cheapest, as well as the fastest, way to bridge the rural–urban health divide [10]. Its role in disastrous situation like Tsunami may be more helpful [11-12] Telemedicine is not well placed speciality, because it is equally shared by electronic and software engineers and medical doctors. It is also considered as branch of engineering in which, knowledge and skills are developed and applied to define and solve problems in biology and medicine [13]. In fact, it is a marriage of convenience between medicine and information and communication technology. Telemedicine system consists of a personal computer with customized medical software

connected to a few medical diagnostic instruments (ECG, X-ray machine or X-rays scanner) [14]. Through this computer, digitized versions of patients' medical images and diagnostic details (such as X-ray images and blood test reports) are dispatched to specialist doctors through the satellite-based communication link. Retrieved information's are analyzed by specialist to reach on diagnosis and therapeutics. The entire system is relatively user-friendly. Dr Devi Shetty an Indian cardiac surgeon with special interest in telemedicine said "99% of non surgical patients are not required to be touched by physicians. Therefore, no need to be there too in terms of disease management and can be managed by telemedicine [10].Another study conducted by Iftikhar and Muralindran suggest that more than 75% acute cases of orthopaedic can be diagnosed by Otorob (orthopaedic robot) through telerounding or teleconsultation[2-3]. On the other side a tele-doctor is sentenced to 9-months in jail after prescribing Prozac to a teen who later committed suicide in Colorado [15]. When it comes to diagnosing and treating new problems, a physical examination and face-to-face meeting is imperative especially when you are un-known to the patient [16]. Once you remove the hotel component from the hospital, you erase 60% of the cost [17]. Therefore, telemedicine is a better alternative to remove hotel component from medical field to make it cost effective. Remote presence, telepresence, distant presence and virtual presence are being used in literature interchangeably [18]. Virtual reality is often used when "actual reality" is expensive to create, dangerous to inhabit, or simply does not exist. Thomas B. Sheridan is one of the first scholars to investigate the concept of presence and let alone a theory of telepresence or virtual presence [19]. The RP2W (Remote Presence 2-Way) is a one of the remote presence robot which, allows professionals in different geographical locations to teleconference and establish a remote presence via a mobile robot [20]. With novel applications of mobile robots in the field of medicine, new terminologies are emerging rapidly too. Telepresence or Remote Presence (RP) is the ability to project yourself to another location (without leaving your current location) and to move, see, hear and talk as though you were actually there [21]. Virtual means the quality of affecting something without actually being that something [22]. In prevailing situation when most of the studies in the field of Telerobotics and Telemedicine are designed by non-doctors, confusions, overlapping and multiple notions for same option are possible. Telerounding [23], telereferral [24], teleconsultation [25], and telediagnosis [26-27] are being used synonymously too. Teleconsultation and telerounding are considered as more effective and efficient by ensuring diagnostic information is gained in advance [28]. Researchers are working without concentrating on model of real hospitals. Presently, there are no concepts of Tele, Remote or Virtual Presence Hospital in literature in their true spirit on the basis of absent presence concept given in this paper.

TABLE I.   DEFINATIONS OF TRIAD OF TELEDIAGNOSIS

Terms	Definitions
Teleconsultation	Dynamic real time examination of patient in clinic
Telerounding	Dynamic real time examination of patient in ward
Telereferral/ Tele-consolation	Static (Store and Forward) type of medical consultations

Similarly it is not possible to know whether study is based on virtual synchronous presence (telerounding in wards and teleconsultation in clinics) or asynchronous presence (telereferral) without going in details of study design. Definitions of triad of telediagnosis are given in Table I and can be further clarified by following description. In telerounding mobile robot is controlled by remote physician and drove to the bed of a patient by him for real time (hard or soft) communication depending upon speed of internet. But teleconsultation is being used here for real time tele-examination of patient in clinic. In "Telediagnosis" as practiced by SICOT (international society dealing in orthopaedic and trauma) patient data is collected from 29 countries interlinked to each other [26]. Later experts review the patient data and give their expert opinions regarding diagnosis and management. Data is reviewed by experts depending on their availability and later suggestions are stored for members to enhance their professional expertise. It is better to use tele-referral rather than telediagnosis in this situation. Target of tele-referral, consultation or rounding is to reach on telediagnosis by different means. Telediagnosis is defined as "Determination of the nature of a disease at a site remote from the patient on the basis of transmitted tele-monitoring data or closed-circuit television consultation" [27]. This definition of telediagnosis is mainly emphasizing on telereferral by using transmitted data and teleconsultation but tele-rounding is not being fully corporated. The term absent presence describes individuals who use information and communication technologies (ICT's), while in the physical presence of others, who may or may not be engaged in the same [29]. This can be explained by usage of laptop in a parks or social gatherings. This scenario explained physical presence in the park but his involvement in virtual word. Virtual presence and absence are proper words to explain these situations respectively. It is our common experience while chatting suddenly someone has to logout because of certain work or disruption in connection. Person who is waiting for him is Virtually Present (VP) or Complete Virtual Presence and other is said to be Virtually Absent Presence (VAP) or Partial Virtual Presence. Therefore, it seems meaningful to mention which, organization, hospital, department, facility, doctor and staff is virtually absent or present to avail facilities and giving full benefits to ailing humanity. Here we are using these terms in different context. If internet connection lines are disturbed, then we signed in and out alternatively. In other words we are jumping from real to virtual world alternatively. During this time we are not serving any

purpose for virtual or real worlds. It is better to name it as Virtual Absent Presence or Partial Virtual Absence. In case of Virtual Absence or Complete Virtual Absence, although person is not sitting on internet at all but retrieves data when required. But in reverse situation, i.e., virtual presence, person is lively enjoying with internet in real time. Sometimes, it is part of our duty to sit on computer and reply immediately by internet when required i.e., on-call duty. Although we are not using internet in this situation but with a click of mouse, it is possible to enter in virtual world as a part of duty. This we can label as Virtual Present Absence (VPA). Practically VPA user is just away from click of mouse, i.e., equivalent to Virtual Present (VP). These both (VP and VPA) are grouped under VIP (Virtually Presentable or Presentia). Similarly VA and VAP are grouped as VIA (Virtually Accessible or Absentia). Additionally, we aimed to review literature related to terminologies of telemedicine and to fit them on a hospital model. Re-definition of tele-referral to distinguish it from tele-consultation and tele-rounding will enhance more understanding of these terms for their applications in telemedicine. We commonly send the data of patient only (tele-referral) and wait for physician to reply depending upon his or her convenience (asynchronous). But in reverse situation, remote doctor not only receives data from hospital lively but can see his remote patient too. If the patient is in clinic, we termed it as teleconsultation but in case of ward patient, it becomes telerounding, location of the doctor does not matter except his distant presence. Tele-consultation for out-door and tele-rounding for indoor ward's patients are better choices respectively. Data (patient medical record) is available in the clinic or hospital and accessible to physician easily during video-conferencing (synchronous) to reach on final diagnosis (telediagnosis) with the help of investigations (tele-echocardiography, ECG, X-rays, blood reports and others, etc.).

Similarly in our medical practice, doctors used 2 common words, non-interventional (X-rays, ultrasound, etc) and interventional procedures (intravenous cannulation, endoscopy, etc.). Therefore, it is better to use Roboscope for non-interventional and Roboop ("op" from operation) for interventional medical robots to understand their rule. Active (first) and passive (second) on-call terms are commonly used in hospitals. First or active on-call doctor suppose to stay at duty location and whereas, second or passive on-call doctor can stay outside hospital. Passive on-call doctor will replace or give him support if and when required. Virtually Present Absence (VPA) is equivalent to passive on-call doctor in real practice. If a doctor just receives data of a patient, analyzes it, and sends it back after review, is not actively involved in virtual word and considered as Virtually Absent Presence (VAP). We targeted at following aims and objectives for this study

- To search commonly used medical terminologies in field of telemedicine and review of literature.

- To differentiate between Teleconsultation, Telerounding, Telereferral, and Telediagnosis.
- To rationalize new terms like VIP/VIA Specialist Hospital, Roboscope and Roboop
- To define different ways of virtual communication and their application to new concept of virtual hospitals.
- To rationalize possible role of Virtual Hospitals in web based medical education.
- To prepare algorithm by following web designs of ten state level hospitals to accommodate different terms related to telemedicine .

We explored three different search engines (Yahoo, MSN, and Goggle) during May 2009, to know frequencies of different terms, e.g., tele-medicine, tele-presence, tele-rounding, tele-diagnosis, teleclinics and tele-doctors, etc. IEEE Xplore [30-33] was taken as professional web explorer to search work on telemedicine. IEEE Xplore was selected as a search engine because of its proven contribution for enginers, who are valuable researchers in the field of telemedicine. Review of literature and personnel experience of main author leads us to define new concept of VIP or VIA Hospitals and other terms. Web designs of 10 state level hospitals were taken as a role model to define these terminologies and to prepare algorithm for our virtual hospital. Literature is not available regarding any effort to prepare such classification and algorithm for virtual hospitals. Currently our project is onging under title of SAKIT (Sikuati And Kota Kinabalu Informatics & Teleclinic). Sikuati (village of district of Kudat, Sabah) and Kota Kinabalu (capital of state of Sabah)are representing rural and urban areas of Malaysia. SAKIT is Malay equivalent of pain, representing ailing humanity.

Review of literature is followed by aims and objectives and methodology in Section I . Proposal, discussion and conclusion, consitute Sections II to IV. Discussion section emphasis on clarification and rationalization of our new terminologies in the field of telemedicine. Possible future pivotal role of virtual hospitals for the field of medical education is given too. This concept article will provide basic foundation to researchers for catagorization and standradization of tele or virtual hospitals.

II.   PROPOSAL

A. Frequencies of Terminologies

Telehospitals enteries are less than teleclinics but telehealth centre is more frequent than both of telehospital and teleclinic.Telenurse and teledoctor is equally famous in health sector, representing active participation from both professionals (Table II).Telehealth centres are more in numbers, even by sum of both telehospitals and teleclinics. There were about 2263 search entries on telemedicine and 413 on telepresence out of 2,061,238 online documents on IEEE Xplore digital library [33]. Numbers of search varies by same terminologies in different ways, like telemedicine,

tele medicine (spaced) or tele-medicine (dashed), especially numbers become very high if tele and medicine are written with spacing and should be avoided. One way of writing should be practiced for scientific terms. Most of work in field of medicine is data processing, i.e., telereferral according to our perception but all the search engines showed little literature on it. Although telerounding, teleclinics and other terms are present in IEEE Xplore but only telediagnosis, telepresence and telemedicine can be searched by its engine therefore, search criteria should be revised. Other terms either cannot be explored or their frequency on search engine is negligible. Yahoo, MSN and Google search engines are giving higher numbers of search entries but relevance is limited and non-scientific terms appeared more than scientific e.g., beautician are using teleclinic term quite often. Doctors, nurses and paramedical staff are three actors around patient in a hospital (Figure 2) and search entrees related to them are more than the hospitals, where they are working (Table II). If we summed up all terminologies searched by four engines, telemedicine (90.13%), telepresence (7.69%) and tele-health centers (1.18%) represent about 98%. Other remaining terms are less than 2% and none of them is more than one percent. Therefore, their percentages are not given in Table II. Our data suggests that only telemedicine and telepresence are acceptable but others terms are not well recognized yet. Even telemedicine is still not established speciality in well known medical institutes. Its fate lies between medical and engineering faculties because of multidisciplinary involvement.

B. .New Concept of Virtual Hospitals or Teleclinics

We tried to define six ways of communication in telemedicine based on literature, clinical experience of 18 years of main author in the field of medicine, day to day observations while video-conferencing and comparing six ways of communication in real life (Table III). Simply virtual presence and absence are divided into absolute, complete and partial sub-divisions like that of real, making it 6 in numbers. These terms laid down the foundation of our concept of VIP and VIA Specialist Hospitals. Figures 1and 3, represent the pathway to telediagnosis by referral, consultation or rounding. It also explains our concept of Virtual Hospital through synchronous and asynchronous ways of communication.

1) Types of Absolute virtuality

a) Absolute Virtual Presence

It is possible in near future when "Simulated Virtual Doctors" would advise theirs patients by automated software programs and Virtual Mr. Bob may work like Real Mr. Bob [22]. Katherine Hayles described a new idea of simulation in her book titled "How we became post-human". According to her, "In future human simulation and its corporeal existence may look similar" [34]. This philosophy may open new chapter in telemedicine by Absolute Virtual Present Hospitals (AVIP Hospitals). How

TABLE II.   FRQUENY OF MEDICAL TERMINOLOGIES IN TELEMEDICINE

Terms (%)	Web Search			
	Yahoo	Google	Msn	IEEE Xplore
Telepresence (7.69%)	5,490,000	1,090,000	366,000	413
Telemedicine (90.13%)	80,090,000	1,900,00	1,080,000	2263
Telemedicine *Def.	715,00	219,00	228	0
Teleround	1,970	4,230	315	0
Telerounding	1,120	3,410	606	0
Telerounding *Def.	120	143	0	0
Teleconsultation	224,000	68,700	51,600	0
Telerefferal	250	472	184	0
Telediagnosis	47,400	25,800	13,100	40
Telediagnosis *Def.	29	3,210	0	0
Telehealth centre (1.18%)	599,000	178,000	311,000	1
Teleclinic	52,800	109,000	7,110	0
Telehospital	227	396	111	0
Telenurse	15,300	37,000	4,610	0
Teledoctor	22,600	9,570	12,300	0
Teleparamedical	1	0	0	0
Telemedical Staff	33,400	12,300	17,200	0

Terms (not given in Table II) are less than 1% each.
*Def. stands for Definitions

far away we are from this era is difficult to predict or impossible to achieve. But desires and dreams are endless to reach on destination of absolute virtual presence hospitals.

b) Absolute Virtual Absence

It is applicable to remote areas of the world where, ICT'S facilities are not available yet [35]. A unique way of communication is documented in spiritual religious books especially QURAN [36] where Prophets can talk to the God (Allah) and even communication between remotely present Holy Peoples (Prophets and Their Friend) is documented without any mediating ICT's. These Holy Peoples may have strong auditory and visual God given brain cortices to perceive such signals which, common peoples could not. This type of communication is not possible to fit on real or virtual criteria's. It is for the researchers to decide, how they take it? Currently we are unable to define AVIA Hospitals because of ambiguous definition of AVIA way of communication (Figures 1and 3). In Table III and Figure 1 our six types of communication leading to concept of virtual hospital are given. But AVIA terminology should be re-defined to make it practical for hospitals. In future neuro-signals enhancement may be possible by exploration of new techniques to improve brain activities especially for visual

and auditory function. In this situation, weak communicating signals may be intercepted by strong auditory and visual cortices of brain. In certain diseases, human beings perceive visual and auditory hallucinations that are non-existing. These may be because of more enhancements of respective brain cortices. Once these methods will be well established transmission of auditory and visual images may be transmitted and perceived without any intervening ICT facilities. There is another established fact that positive feed back to brain leads to establishment of neural interconnections to enhance brain abilities. This is possible area of research in future to make our dream of Absolute Virtual Absence Hospital true. Although theoretically these things look promising but how many decades or centuries are required to reach on this destination is not known. If it becomes true reality then people at distances can talk to each other with out any mediator like Mobile technology, P.C's or Laptops and even doctors can give consultation to their patients from distances.

2) Analysis of Some Current Virtual Hospitals

There is no unified structure available regarding types of teleclinics/hospitals in literature. It is difficult to know types of services available in such clinics due to misnomer or confusing terminologies. From skin care clinics to well establish telehospitals are misleading e.g., skin care is domain of beauticians whereas telehospitals are dealt by medical doctors and telediagnosis is phenomenon to reach on diagnosis in a teleclinic/hospital [37-38]. Different services factors in terms of internet speed, static/dynamic way of communication, GP/Specialist consultation, active or passive on call (availability of doctor with in or out side hospital) are the issues to be considered to design telehospitals. Therefore, we will analyze few available teleclinic on the basis of our new concept of virtual hospital and above factors for better understanding. Results are summarized in Table IV.

a) SICOT Telediagnosis [26]

Telediagnosis [26] is store and forward type of teleclinic where doctors (GP's/Specialist) report clinical issues to remote doctors, by emails. Data is reviewed, diagnosis are made and available for further referencing. Telediagnosis is a misnomer in a sense that it reflect outcome of any clinical issue but not explain the types of services in terms of static or dynamic modes etc. This project is linking 29 European countries. Therefore, it represents our Virtual Absentia Hospital (VIA).

b) Virgin Airlines Telemedicine [39]

The Virgin airline has just announced a deal with Remote Diagnostic Technologies (RDT) that will result in each of Virgin's planes being outfitted with the Tempus telemedicine system which, contains blood pressure and pulse monitors along with an integrated video cam, and transmits data down to medical personnel via the on-board telephone system. This system is based on dynamic video teleconsultation.

TABLE III.   TYPES OF COMMUNICATIONS

NO'S	TERMS		DEFINATIONS
1	Real Presence (RP)	Active	If doctor is within the hospital and available to patient
2	Real Absence (RA)	On leave	If doctor is absent from the hospital, e.g., on leave or off-hours.
3	Real Absent Present (RAP)	Active but deviated	If doctor is in the hospital but not available to his patients, i.e., busy in meeting or using laptop etc.
4	Real Present Absence (RPA)	Passive	If doctor is on duty but not present in the hospital. He will be available when required
5	Absolute Presence	x	Difficult to define
6	Absolute Absence	x	Difficult to define
7	Complete Virtual Presence Virtual Presence (VP) Tele Presence Synchronous	*VIP Hospital	If doctor is virtually present and communicating with his patients in Real Time (Hard or Soft), i.e., online
8	Complete Virtual Absence Virtual Absence (VA) Tele Absence Asynchronous	*VIA Hospital	If doctor is virtually absent and can analyze data only when he is free. He is not connected to virtual world at all, i.e., offline
9	Partial Virtual Presence Virtual Absent Presence (VAP) Tele Absent Presence Synchronous Asynchronous	*VIA Hospital	Doctor is available but server is down or internet is very slow. This will not serve the purpose, i.e., disturbed online
10	Partial Virtual Absence Virtual Present Absence (VPA) Tele Present Absence Asynchronous Synchronous	*VIP Hospital	If doctor is virtually absent and can see his virtual patients when required, i.e., offline but available anytime to come online
11	Absolute Virtual Presence (AVIP)	*AVIP Hospital	When virtually simulated doctor reply to the patients
12	Absolute Virtual Absence (AVIA)	*AVIA Hospital	Possible in remote areas of the world where there is no ICT access.

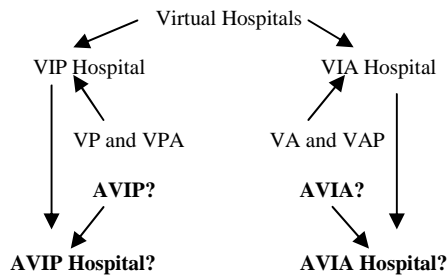. "X" difficult to define and "V" / "VI" stand for Virtual

Figure 1. Six types of virtual communication

c) IHS Telehealth System [40]

It provides a comprehensive health service delivery system for approximately 1.9 million out of 3.3 million American Indians and Alaska Natives. It comprises of approximately 2,600 nurses, 930 physicians, 390 engineers, 500 pharmacists, 300 dentists, and 170 sanitarians. This provides both dynamic as well as static tele-services along with home care. Its focus is on clinical, educational including public telehealth program too. It represents our Comprehensia Virtual Hospital (VIC). It is not possible to compare Rwanda e-health system where only one tele-specialist is available with such a huge system [6]. Therefore, it is irrational too compare both systems under same category although both are dynamic in nature. It is reasonably good to put later type of hospital under Virtual Absentia Hospital due to shortage of specialists there. It is self-explanatory to declare any hospital as virtual presence hospital dynamic mode of communication, infrastructure, internet speed as well as human resources must be enough to handle the patients. In summary, if dynamic hospitals lack sufficient staff or facilities should be considered as Virtual Absentia Hospital.

C. Triad of Telediagnosis

Doctors are responsible for diagnosis of different diseases through 3 different ways of communication. We labeled them as Triad of Telediagnosis i.e., Teleconsultation, Telerounding and Telereferral. Theirs definitions are given in Table I. First two are grouped under dynamic and third is considered as static type of communication. Most of the projects having dynamic type also have static component too but it is better to be considered as Hybrid or Combined variety. We tried to isolate different telemedicine projects on this basis in Table IV and pathway to tele-diagnosis is given in Figure 3.
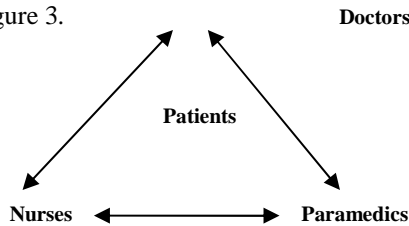
Figure 2. Three actors around patients

TABLE IV.   TYPES OF TELEMEDICINE SYSTEM   (DYNAMIC, STATIC AND HYBRID)

| System	Clinical Applications
Teleconsultation/ Telerounding (Dynamic) [1-4]	1. For Medical Images in China 2. For Instant Treatment, Taipei 3. Teleconsultation, Taiwan 4. For Self Breast Examination, Malaysia
Telereferral (Static) [5-8]	1. SICOT Telediagnosis 2. SWEAT, Egypt 3. Telemedical System, Germany 4. ImageNet Telepathology
Both (Hybrid/Combined) [9-12]	1. Teleworks, Greece 2. Teleconsultation, UK 3. Medical Teleconsultation System, UK 4. Teleconsultation for CVS, UK
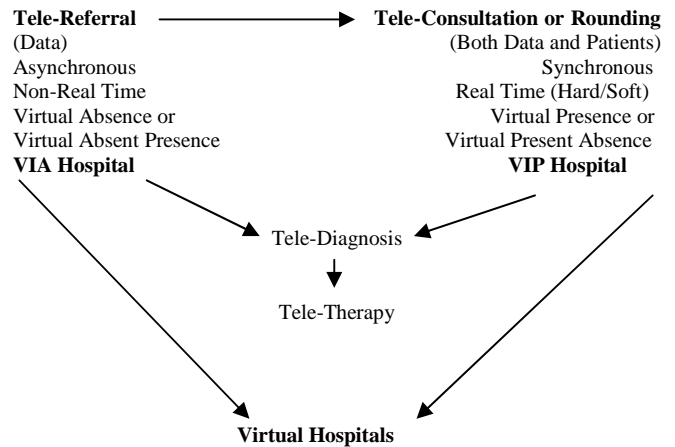
Figure 3. Pathway to telediagnosos

D. Types of Medical Robots

Medical robots are classified in different ways and one classification is given below [41].

1) Robot to assist doctors (physicians and surgeons)

These are helpful for surgery, exploration, diagnosis and therapy.

a) Surgical robots

These are commonly used in orthopaedics, neurosurgery and general surgery etc.

b) Non-surgical robots

These are popular in tele-echocardiography, tele-ultrasonography and tele X-rays etc.

2) Robots to assist peoples

a) Assistive robotics

Robots and machines that improve the quality of life of disabled and elderly people, mainly by increasing personal

independence e.g., orthopaedic devices (exoskeletons), robotics aids, smart living spaces and personal assistants.

b) Rehabilitative robotics

These are robotics mechatronic tools for clinical therapy in neuro-motor rehabilitation and training etc. These are temporarily used therapeutic tools. Our concept of division of robot for doctors is based on their direct interference to the patient i.e., interventional and non interventional. It is justified below along with definitions in Tables VI and VII.

E. Roboscope and Roboop (Medical Robots)

It is based on two types of procedures in the hospitals, i.e., interventional (endoscopy, arthroscopy, angioplasty and venous or arterial catheterization etc.) and non-interventional (echocardiography, ultrasonography, CT Scans and MRI etc.). Field of medical telerobotics is also following the same tract, i.e., interventional (Telesurgery [42], Doc at a Distance for tele-operations [43]) and non-interventional (RP-7 or RoboDoc [21], and Tele-Echography [44]). Therefore, it is better to use Roboop and Roboscope respectively (Figure 4 and Tables VI and VII). This way ultimate user, i.e., health professionals also can explains to their patients that this robot has no business in direct management of the patient in case of Roboscope. Therefore, robot is an assistant but not the replacement or master of a doctor. In Table VII different medical robot are divided into 2 groups depending upon their applications e.g., Otorob with Docmata is robot only meant for telerounding or teleconsultation but da Vinci is an operating robot and directly involved in surgery by hands-on technique. Therefore, these are considered as interventional robot.

F. Algorithm for Virtual Hospitals Web

Our work related to design a web algorithm for Virtual Hospital is in progress so that different terminologies (Table V) can be adjusted on a standard protocol. Our target is to evaluate web sites of 10 different state level hospitals to design a model for Virtual Hospitals. Due to work in progress, wider applications and lengthy web designing process, it is not possible to cover this objective in this paper. We are progressively moving towards it and will present our results in its second part soon. It is an empty field of telemedicine and will open a new era for researchers and web designers to establish novel websites.
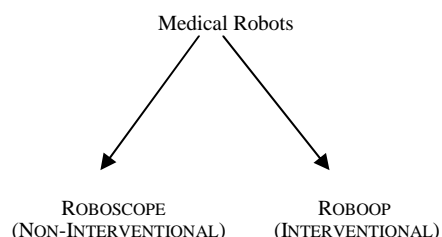
Medical Robots

ROBOSCOPE
(NON-INTERVENTIONAL)

ROBOOP
(INTERVENTIONAL)

Figure 4.   Types of medical robots

TABLE V.   TELEMEDICINE AND ITS SUBDIVISIONS

NO'S	TERMS	SUBDIVISIONS
1	Tele-Medicine	Tele-Paeds. Tele-Cardiology Tele-Neuro
2	Tele-Surgery	Tele-Ortho Tele-Obs. and Gynae. Tele-Neurosurgery
3	Tele-Radiology	Tele-Ultrasonology Tele-Imaging Tele-X-rays
4	Tele-Nonclinical(Basic)	Tele-Pathology Tele-Biochemistry Tele-Anatomy Tele-Physiology
5	Tele-OT	Tele-Recovery Tele- Assistant Tele-OT Nurse
6	Tele-Clinic	Tele-Consultation Tele-Referral Tele-Follow up
7	Tele-ICU	Tele-PICU Tele-NICU Tele-HDU
8	Tele-Wards	Tele-Rounding Tele-Nursing Tele-Teaching
9	Tele-Staff	Tele-Doctor Tele-Nurse Tele-Patient
10	Tele-Education	Tele-teaching Tele-mentoring Tele-monitoring

TABLE VI.   DEFINATIONS OF ROBOSCOPE AND ROBOOP

Terms	Definitions
Roboscope	Non-interventional medical robots for doctors
Roboop	Interventional medical robots for doctors

TABLE VII.   DIFFERENT ROBOSCOPE AND ROBOOP

No	Roboscope	Roboop
1	Otorob	ARTHROBOT
2	Docmata	da Vinci
3	RP-7	Probot
4	X-ray Robot	Palmbot
5	SYRTECH (Tele Echocardiography)	Neurobot,
6	Ultrasound Robot (UBC)	NeuroMate
7	Robosoft	CASPAR
8	Telepathology	ACROBOT
9	Tele-Sonography	MARS
10	Tele-ECG	BRIGIT

III.   DISCUSSION

A.   Telemedicine Terminologies

If we look at Table II and V, it is self evident that telemedicine is a branch of medicine and repetition of "tele" is not appealing. Therefore, it is better to bold the 1st letter of terminology rather putting "tele" every time, e.g., **R**eferral for tele-referral and **C**linic for tele-clinic. Another option is encircling of the first alphabet of the word but this way typing options are limited. Encircled letters are only available for R and C on a key board like **®eferral or ©linic.** Other options can be explored like usage of Italic words. With invention of mobile robots telerounding [45-50] is getting popularity in literature as compared to telereferral although, most of the work in telemedince is data processing, i.e., tele-referral. But term telereferral itself is not famous in literature (Table II). In surgical wards telerounding is of two types, i.e., pre and post operative tele-rounding. Pre-operative telerounding is mainly concerned for diagnosis and planning for surgical procedures but post-operative telerounding [51] is concerned with patient care after surgery. In medical wards initially it is concerned with diagnosis by history, physical examination and investigations like pre-operative telerounding but its later part is more focused on the management. Any patient seen in clinic is commonly considered as consultation. In real practice medical record is available near bed side of patient but in clinics, staff nurse provides medical record to the doctor for further management. Therefore for tele-rounding and tele-consultation both data availability and patient presence are pre-requisite. But for referral cases, referring doctor sends a written or verbal requisition to another doctor to see his patient. Appointment for consultation depends upon availability of doctor and severity of disease. Same is the case with Tele-Referral. Once tele-referred case is seen by any doctor should be termed as teleconsultation.

B.   Virtual hospitals

In most of the studies tele-medicine is helpful for the mankind [52-53] but opponents are also there. Maurice Mars at the University of KwaZulu-Natal in the South African coastal city of Durban said, "We may be transferring the problem (of diagnosis and care) from one overburdened doctor to another overburdened doctor by telemedicine" [54]. Therefore, specialists with minor physical ailments for virtual hospitals can be considered as an alternative. This way we will not overburden the already overburdened doctors by using relatively inactive doctors from medical community. Catharine Omaswa of the Ugandan National eHealth Committee noted that her country might only have a modern ICT infrastructure by 2025 but Rwanda's only e-Health Specialist, Richard Gakuba is happy with telemedicine in his country [54]. VIP OR VIA Hospital should be the specialist hospitals. It is pointless to establish virtual hospitals without specialist support because patient may not be satisfied by remotely present medical officers. It is better to name them as VIA rather VIP Hospital if shortage of specialist is there to avoid misleading to the patients. Similarly, where internet services are of poor qualities should be categorizes as VIA hospital. The Philippine health care system is crippled by shortage of doctors and telehealth centres are seen as a tool to bridge this gap [55]. Pakistan, Bangladesh and Tunisia are on the tract of telemedicine too [56-58]. Virgin's Airline is starting telemedicine system in their planes [59]. Even telemedicine has opened the doors in battle fields [60]. Communication may be mediated (telephonic call) or unmediated (face to face). Technology (ICT's) mediated communication is of two types asynchronous (fax, beeper, voicemail, e-mail, or an electronic discussion group) or synchronous (telephone call, videoconference, or electronic chat room) [22]. All these possibilities can be explored from country to country for telemedicine application too.

1)   VIP (Virtual Presentia) Hospitals

Virtual Presence (VP) is better term for real-time activity, e.g., tele-consultation or tele-rounding. The on-call doctor, who is off-line but available to his remotely present patient with a click of mouse, is considered as Virtually Present Absence (VPA). He will serve the same role as passive on-call doctor in real practice, therefore should be considered as same functional unit, i.e., VIP.

2)   VIA (Virtual Absentia) Hospitals

Virtual Absence (VA) or Virtual Absent Presence (VAP) are responsible for delayed responses, e.g., tele-referral and better to be discussed in another functional unit, i.e., VIA Hospital. Good patient health care system is targeted to reach on Telediagnosis either by VIP or VIA mode of communications followed by treatment. The treatment is either given by the locally available staff or sending support at patient's own location or calling patient to real hospital depending upon circumstances under the guidance of tele-doctor. With better understanding of these terms we can categorize different set-up available in the world, e.g., Remote Diagnostic Technologies based on telerounding and teleconsultation [61] is VIP Hospital and SICOT Telediagnosis project is VIA Hospital based on virtual Absence. This VIP or VIA Hospitals will allow client (patient and their families) to know about facilities available in hospital pre-hand. Establishment of VIP Hospitals in true spirit will become important like VIP peoples too in future. But in VIA Hospitals, patients have to wait for their data analysis first (tele-referral) to consult their doctors (teleconsultation). In other way, patient wills get telediagnosis via data analysis by static or slower path. Therefore, VIA Hospital is preferable term. IHS Telehealth System in U.S.A. divided their clinical services menu as Real-time (mental health, cardiology and rheumatology etc.), Store and Forwarded (cardiology, dermatology and radiology etc.), and Home Care (heart failure and diabetes care) [62]. Its first two terms are comparable to our VIP or VIA Hospitals and third term mimics home care like real practice. Therefore, this systems is combination of all three

VIP, VIA and Real Home care services. In literature, remote presence is used for real things and virtual presence for simulation. Similarly dynamic (synchronous) and static (asynchronous) terms are used for off and online transmission respectively. In this study we used virtual and remote presence interchangeably. In addition to off and online, we also considered the some issues of slow internet and disturbed line to make it more meaningful. Similarly, shortage of specialists and inadequate internet facilities were considered equivalent to offline transmission. These changes will build the confidence of ultimate user (patient and their families) regarding available facilities in Virtual Hospital. Clients (patients) will be in a position to choose VIP or VIA Hospitals depending upon their requirements. If urgent attention is required then VIP Hospital will be better option compared to VIA Hospital. These two broader categories of virtual hospital will also prevent community from cheating (labeling of telehospital by availability of only one computer or one doctor) by further legislation and standardization. In our opinion cell, mobile and hand phones are different names for same product and function. But this paper focused on the matter because same name is being utilized for different modalities or vice a versa. For example in Africa tele-hospital having one computer or one specialist and in USA having 100's of specialists are being placed under same category of telehospital or clinic. Therefore, these should to be standardized for proper understanding.

Role of Virtual Hospital in Medical Education: Developing countries are trying to establish educational hubs because of high expenses in developed countries [63]. Medical education is one way to attract overseas students; even USA is trying to attract foreign students [64]. Medical schools and universities are increasing in numbers but proportionate increase in the hospital number is not there. This disproportion is jeopardizing the quality of education [65]. Our concept of VIP Hospital can be extended to non-teaching hospital to use them for teaching purpose to overcome the shortage of hospitals. Similarly VIA Hospitals can be utilized for examination (MCQ'S, MEQ'S and OSCE) and continuous medical education, i.e., CME'S. Simulated dynamic (virtual) and hybrid dynamic (virtual plus real) transmission is commonly used for tele-education and real dynamic (remote) and off-line (static) transmission is for tele-diagnosis. Similarly this new concept of virtual hospital will help us to define utilization of absent and present services in its true spirit for medical education too. Absent services will be used only for information purposes while present services will be better option for live real time teaching and demonstrations.

C. Roboscope and Roboop

Similarly term Roboscope for non interventional robot will enhance confidence in patients because of familiarity of word "scope" as well as their minimal interference. Their approval from health authorities will be easy compared to interventional robots (Roboop). Safety issues in Roboop

will be questioned in more detail by relevant health authorities before their approval compared to Roboscope.

IV. CONCLUSION

Telemedicine and telepresence are growing fast in their popularity in the field of medicine but medical terminologies are misleading for tele-experts especially telerounding, teleconsultation, telereferral and telediagnosis. Therefore, should be used cautiously, otherwise conflicting situation may arise. VIP and VIA Hospitals are promising terms and required to promote field of telemedicine, medical education and confidence of patients. Although virtual or remote presence terms are commonly used but still wider applications are possible after its proper understanding. Roboscope and Roboop are new terms to differentiate between non-interventional and interventional medical robots. Work is in the progress for model website for virtual hospitals and relevant results will be presented later.

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