International Healthcare Vision 2037. New Technologies, Educational Goals and Entrepreneurial Challenges

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- What kind of effect will new technologies have on healthcare delivery in the next decades?
- Will we finally develop systems to prevent people from becoming patients?
- Will healthcare become more and more expensive?
- What kind of role will developing nations play?
- Do we need all these expensive and complex systems?
- Will artificial intelligence, gene therapy, robotics help to tackle the future healthcare issues or will they create additional problems?
- … and how can we foster entrepreneurship to identify new unmet clinical needs and subsequently introduce new systems, devices or services?

As a university, we will additionally need to ask on whether the current research setup and the educational programs are in line with the anticipated changes?

The BME-IDEA (Biomedical Engineering - Innovation, Design and Entrepreneurship Alliance) was started in 2003 by a group of professors, who were teaching design in a Biomedical Engineering department or program and realized that there were common needs among them that were not being met by current conference offerings. In 2013, the first European BME-IDEA meeting was held and in 2017, the 5th European meeting found its way to the Otto-von-Guericke University in Magdeburg, Germany. The goals of the Alliance are to review the experiences of different university programs to discuss objectives/challenges/opportunities for further development of these programs and to explore the potential for sharing resources.
Healthcare delivery is one of the - if not the - most important topics for many people and also comes with a lot of future worries. The current systems in just about any country in the word are complex, inefficient, expensive and are mainly focusing on treating people that have become sick.
There is also a huge economy around everything that has to do with care and treatment. New Technologies, dedicated healthcare innovation training/education and entrepreneurial activities could be the key to improve healthcare in general, make it more affordable, efficient and equal.
The **INTRODUCTION** provides an overview of the importance of exponential Technologies and reverse innovation opportunities to help solve the future healthcare issues that we are challenged with. This is followed by the **CONFERENCE SUMMARY** including some of the ideas that were developed in the workshops.
The individual paper contributions of the conference from 15 nations and 4 continents were categorized in **HEALTHCARE VISION AND CLINICAL INNOVATION, HEALTHCARE DIGITISATION, EXPONENTIAL TECHNOLOGIES, REGIONAL HEALTHCARE and DEDICATED HEALTHCARE TECHNOLOGIES**.
We hope that you enjoy the contributions and use some of the concepts for your own research or as additional input for an entrepreneurial venture.

Magdeburg, Germany, July 2017

Michael Friebe, PhD
Professor of Image Guided Therapies
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INTRODUCTION

Exponential Technologies + Reverse Innovation = Solution for future healthcare issues? What does it mean for university education and entrepreneurial opportunities?

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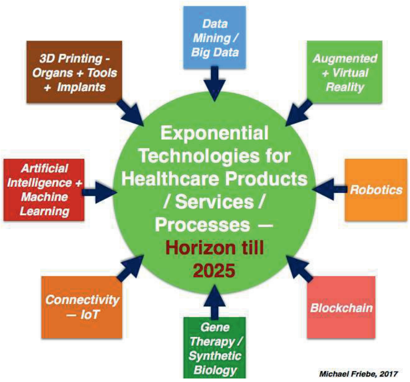

Figure 1: Exponential Technologies will potentially introduce dramatic changes in the coming decades, moving to a value based and patient centric healthcare system that will have a pro-active focus on preventing people from becoming sick rather than to reactively treat the ones that become sick.

1. Abstract

Exponential technologies are generally described as something that will - in a given time period - double data generation/evaluation and/or half the associated cost with it.

The terminology is actually only proven for the Information and communication technology (ICT) segment at the moment, where according to Moore's law the complexity of processors and the cost per transistor follow that path for many decades now.

An example from Medical technology is the cost of genome sequencing that has dropped from millions to thousands and now to under USD 100 within a little more than a decade.

In many other areas there is a potential and hope that certain technologies (see Figure 1) could lead to significant clinical knowledge gains and procedure improvements combined with cost reductions.

But is this just a hype or something that in combination with other emerging technologies could really provide solutions for the problems that we will face in present and future healthcare delivery?

Specifically the increasing life expectancy and the ageing societies in combination with less and less available healthcare staff, ever increasing cost associated with healthcare delivery / products and services, or the inequalities between rural and urban areas particularly in developing nations that need to be addressed urgently.

This paper will present the potential impact of some exponential technologies - in selected areas - on the future challenges of healthcare delivery with a particular focus on reverse innovation, where new technologies and delivery approaches will be first implemented in developing nations before being accepted and adopted by the developed world.

It will also point out some changes that need to be implemented by universities for the education of future medical technology developers and the effect that could have on entrepreneurial opportunities.

2. Introduction

The global healthcare market is currently greater than US$ 3 trillion and growing. It is expected, that in the United States one quarter of the total gross domestic product will be spend on healthcare within the next two decades.

In the developed world healthcare is - with very few exceptions - dealing mainly with sick people however, within a complex, expensive, and overly bureaucratic environment. There is very little focus and money spend on preventing people from getting sick.

Avoiding medical problems potentially has a huge negative financial impact for healthcare companies, clinical service providers, and everyone involved in healthcare delivery. [1]

On the other hand, staying healthy comes with a huge positive impact for the personal quality of live and on the total cost of healthcare for the society.

Many procedures currently performed for example are not clinically necessary and done just to avoid malpractice and liability issues. [2]

At the same time there is a growing concern that the healthcare industry's focus is, at the moment, mainly on developing advanced technologies that only help the relatively small population of the developed world, rather than to invest money into providing products and services that would simplify the complexity of healthcare.

Simplification could potentially lead to truly innovative technologies that benefit most patients on this planet and provide preventive and personalised solutions.

What are the requirements to open healthcare for these technologies so they can have a huge and positive impact (Figure. 1)?

3. Digital Transformation

Systems that combine advanced hardware with Artificial Intelligence (AI) will - in the next two decades - be able to provide diagnostic information that should be equally available to the poorest and wealthiest on Earth.

The patients genomic sequence and machine learning will allow us to understand the root cause of many non-communicable diseases like cancer, cardiovascular and neurodegenerative problems, and also provide information and advise on what to do about it.

Robotic systems are currently tele-manipulated devices operated directly or via remote connections through surgeons. That will expand and also make advanced surgeries possible at remote locations, but eventually AI will help to create robotic surgeons that will be able to carry out excellent surgical interventions for very little cost and on a 24 hour basis.

3D printing is already able to provide 3D cell models of organ tissue. It is therefore quite likely that we will eventually be able to regrow a heart, liver, lung or kidney when we need it instead of waiting for a donor to die. Even more realistic is a personalised 3D print of a bone implant produced either pre-operatively or during the surgery with a fast printer that is directly fed with the data from the surgical table.

One of the pre-requirements for all these technologies is digitisation. Processes and services that cannot be digitised will - for the time being - be impossible to grow or improve exponentially.

The associated digital data content is key to analysis, evaluation, learning, drawing conclusions, and subsequently providing the required information for personalised and individualised therapy decisions and outcome improvements. It will also be essential for a transformation from a reactive to a proactive healthcare delivery.

We have already started that process with the large number of healthcare apps that are available and by recording all kinds of personal data with the support of wearable sensors. While most of these sensors and apps are for personal use only at the moment and are not used in the official clinical diagnosis yet, that will change for sure.

Healthcare participants (so everyone) will use sensor systems for blood pressure -, glucose -, behaviour - monitoring and many other applications (Figure. 2).

They will use their Internet of Things (IoT) devices to connect directly or via smartphone to cloud servers that make the data available for researchers, regulatory offices and also healthcare providers (doctors, hospitals, …).

These home-based and personally used technologies and the data generated by them will eventually lead to providing fast, and personalised healthcare status information directly to the patient.

The patient does not have to go in person to see a doctor for a majority of causes, but instead gets detailed feedback and even a prescription digitally. In case of urgent or immediate clinical intervention a clinical expert would be contacted and an appointment made or an ambulance dispatched.

Healthcare prevention is currently mainly limited to exercise and nutrition and only complemented by a voluntary clinical feedback every other years.

In the near future home-based or personally worn sensors and other technologies would give much more detailed, fast, and regular feedback on the current healthcare status. Improvements or situation worsening could be monitored and combined with follow-up clinical treatments were needed and indicated (Figure 3).

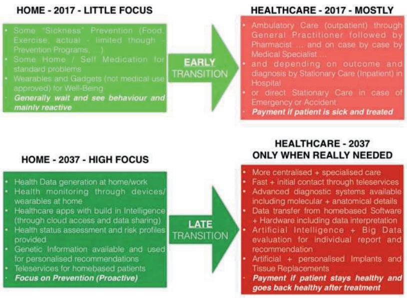

Figure 2: In the very near future wearable sensors, healthcare apps and the smartphone will provide data for researchers, healthcare providers, and regulatory offices that are actually used for making personalised decisions and that will provide some of the needed datasets to potentially solve the non-communicable disease problems proactively.

So instead of an early and reactive transition from home to the healthcare system, as is typical for today, a future healthcare system will stimulate pro-active prevention, provide personalised healthcare status and recommendation, and transfer the patient relatively late to become a real patient.

Many challenges and issues remain, like regulatory permissions, reimbursement and payment, data privacy and of course general adoption of such a setup. It can already be safely forecasted though, that some home-based diagnostic platforms will soon arrive and with that start to establish medical care at home. [3]

Interpretation of diagnostic images, an essential and very important part of analysing a patient's health and to subsequently provide information for a treatment / surgery, is believed to be one of the first disciplines to be dramatically effected by AI and Machine Learning.

A pre-requirement is however that the images provided by the radiology systems are standardised and that the obtained results are comparable to each other. These could then be shared and combined with additional information to create a multi-dimensional data set. This subsequent data set can be analysed by computers most likely better than by human radiologists, who will be "freed from many repetitive and mind-numbingly tedious tasks", but will shift the work to added value in image interpretation. So, while it is likely that the standard image interpretation will disappear for the radiologist (and for that matter clinicians in other segments that my be affected by the new technologies) there will be other responsibilities and opportunities for the human radiologists. [4, 5]

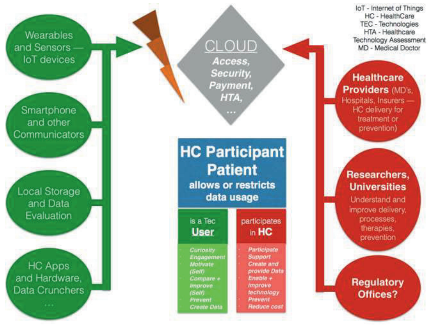

Figure 3: The current healthcare system is based on being reactive to treat a patient when he/she becomes sick. The clinical providers receive payment for that. In the future the transition from a home-based prevention and information based system is relatively late to an actual clinical treatment. Healthcare providers should be paid if the patient leaves healthy and subsequently stays healthy.

New technologies will not only change the diagnostics, but will also have a huge effect on the treatment of for example cancers. We will there see new imaging systems that are combined with robotics and radiation therapy systems. These systems will be able to distinguish between the cancerous and healthy cells and only selectively kill, which will result in a very personalised treatment with minimum side-effects. However, for that a fast on-site digital pathology is also needed. [6]

Even surgery, while being a manual discipline, will be digitised. Modern surgery has to be concerned about outcome of the surgery, associated cost of surgery and rehab measures, as well as about the inflicted surgical trauma. E-health and IoT connection of all surgery devices and associated systems (lighting, diagnostic imaging, monitoring equipment, surgical table, …) will be a key for improving efficiency and accountability. The captured data and subsequent analysis of the patient specific data (genetic, pre-diagnostic, histology, …) with the surgical procedure and outcome will provide optimised surgical models with the help of machine learning and AI approaches. Complicated cases could also be supported by experts through advanced telesurgery procedures from anywhere in the world. [7]

And many other applications from prevention to treatment, subsequent rehabilitation, and elder care or home-care will be influenced by the digitisation promising a faster, more efficient, and cheaper healthcare delivery in the coming decades. [8]

But will these technologies also be able to address unequal delivery of healthcare in developing nations? Or will the developing nations be providing solutions that are also applicable for use in developed nations?

4. Reverse Healthcare Innovation

One of the major problems for the implementation and acceptance of new technologies in the healthcare systems of the developed world is the current setup and associated adoption issues. Also, the regulatory environment in Europe, Northern America and Japan is already very complicated and slow … and, it will probably get even more complicated and slower in the near future.

While it is obvious that health care providers will receive less revenue in the future there is no real interest to rethink the current healthcare delivery and to start thinking about more cost-efficient solutions. Some of these solutions have been developed by the developed world for developing nations and a few others are directly originating there that address vital local problems.

Reverse Innovation - the introduction of these solutions originally meant for developing nations by developed nations - may be one way that healthcare systems can decrease per-capita costs and increase quality at the same time. [9]

High-priced and complicated medical equipment is normally produced by developed nations for developed nations and is typically installed and used for 5-15 years. After that it is exchanged by a Next Generation Product that more or less does the same task, but better, faster, with more features - something called sustaining innovation. The old equipment is then often sold as used or refurbished to emerging or developing nations, but may still be too complicated to install / operate or may only be useful / accessible to a very small part of the population there.

An alternative is to build a lower specified system that more closely fits the requirements of the healthcare system and clinical needs in these nations.

What we will see more often in the future is that these nations actually will build dedicated systems for the needs of their population that are typically quite simple, very efficient, and can be manufactured for a fraction of the cost of the advanced technologies that are produced by the developed nations.

Yes, these products most likely do not provide the same features, and may be slower, or lower specified … but they may be applicable for a majority of the cases even in the developed world and/or when used in rural areas. These point of care and local technologies could therefore have a valuable use in our healthcare systems as well. This process of adopting low-cost, efficient, and easier solutions from developing nations is called Reverse Innovation and highlighted in Figure 4.

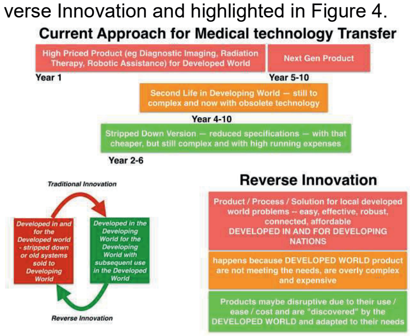

Figure 4: The traditional and current innovation process for medical technology is an either stripped down or used product that comes from a developed nation to a developing nation. Reverse Innovation - developing a product in a developing nation that is subsequently transferred for use to a developed nation - could be a way to reduce inequalities and also help to reduce the healthcare cost in the developed world

It has been proven that developing nations can come up with and subsequently develop and produce extremely efficient products addressing local problems that could substitute expensive products in the developed world and therefore could easily be transferred. [10]

Companies located in the developed world have a hard time accepting that however, as it would stipulate a complete rethinking and reorganisation process of their operation. Only very few companies have therefore invested in reverse innovation. But the ones that did were rather successful. [11]

A solution could be a combined learning process between organisations/companies in developing and developed nations specifically looking at creating cost-effective, easy, small and with that valuable products and processes that are helpful for a global health systems. [12]

And there is plenty of data supporting such joint activities and the value of a development focus on creating less expensive devices. While only 13% of the medical technology manufacturers are located in lower income countries almost two third of the incremental health care spending is used for affordable technologies. The products that come from these low income nations very often are quite disruptive and creative, with a technology basis that is significantly simpler that competing technologies from developed nations.

A recipe for joint developments between Low Income (LIN) and High Income nations (HIN) could be:

1. What medical needs are common to LIN and HIN.
2. Start the innovation process in the LIN
3. Initiate the Reverse Innovation process and introduce to HIN with proven concept in LIN
4. Implement and establish the technology in HIN

But this process and the focus on disruptive value based clinical innovation can also be initiated and managed by entrepreneurs through dedicated start-up companies in LIN or HIN. [13, 14]

5. Importance of Entrepreneurship for the HC transition

Without entrepreneurs that challenge the current setup and that come-up with alternative and new systems, methods and processes a healthcare change as outlined will not happen soon.

The large medical device companies and healthcare providers do not have a large enough incentive to start a rethinking process immediately and to a full extend. Part of this slow and little radical innovation process are regulatory issues and high cost of entry.

But, we are now on the way to a late transition from home-care to the healthcare providers and from a reactive healthcare delivery process to a more prevention oriented and personalised pro-active one.

There will for sure be entrepreneurs that will tackle and address the opportunities that come with such a transition and that will nevertheless put the patient in the midst of their thinking, while maintaining the regulatory rules that come with new healthcare products and services. [15]

These entrepreneurs (and the more progressive established medical technology suppliers and healthcare providers) will also learn that valuable products and services can be developed and introduced adapted to the local needs with key value propositions like inexpensive and easy to use.

These local needs include special diagnostic and/or therapy systems to address different disease patterns, dedicated and simple technical support and training, availability of inexpensive spare parts, affordability of system and related medical service for all not just a minority, and fulfilment of all applicable regulatory issues. These systems could also open opportunities for local manufacturing, servicing, and support companies with that creating employment and tax income. [16]

Entrepreneurs in that segment will understand that success is predominantly based on the knowledge of the local markets and customer needs. These needs are locally different and may require completely different product features when HIN and LIN are compared to each other (Figure 5).

Finding these differences and designing the product / service that fits to the local market, requires dedicated need finding in a combination between technical and clinical innovators. And, it also requires a different skill set that is commonly not provided as part of a university based training.

To address the mentioned healthcare innovation, reverse innovation and entrepreneurial opportunities, a special skill set and dedicated knowledge is required that can only be taught in a university within a new degree program

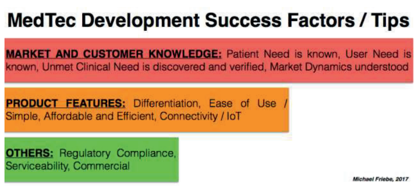

Figure 5: Successful local healthcare products and services are predominantly related to how well the market and customer needs are known. This then determines the local features and regulatory compliance issues.

6. University based HC Innovation Education - Changes needed

University education will make you a good doctor or an excellent engineer or possibly a great economist — depending on your choice of subject. But it does not prepare the student for being a future leader in healthcare innovation. The skill set needed for that — in an interdisciplinary triangle environment between technical possibilities, medical needs and economic realities — is quite different from the either technical / clinical / or economic foundation that is provided as part of a university training (see Figure 6).

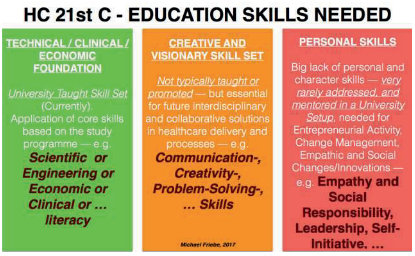

Figure 6: 21st century healthcare innovation requires a special set of skills that are typically not part of a university based education. While the technical / clinical / economical foundation is standard for a dedicated university education the creative, visionary, and personal skills are generally not taught especially not in the context of healthcare innovation.

You need to be creative and visionary and also be trained in personal skills, like leadership, social responsibility and in an empathic understanding of problems and concerns of any participant in the healthcare system including (but not limited to) patients, doctors, and other clinical staff.

Entrepreneurial basics with a focus on healthcare need to be addressed and taught. Future entrepreneurs that can collaborate with the medical device or healthcare provider industry, researchers, clinical staff and public organisations, will have a distinct advantage and be able to more easily identify real innovations solving medical needs. [18]

And that not limited to just incremental innovations. These are of of course needed, but they will not solve the problems with healthcare cost constraints, availability of treatment options for everyone and everywhere, personalised approach to cancer treatment, …, and many others.

Disruptive ideas and concepts are needed that could potentially solve a lot of these problems and at the same time provide large business opportunities, which are however hard to implement in modern healthcare systems. [17]

A new study program (Bachelor or Master or Post-Graduate) incorporating knowledge of healthcare system and provision, innovation challenges and strategies, basic knowledge of clinical problems and future oriented technical possibilities, interdisciplinary and international team work, combined with management and entrepreneurial skills should be initiated.

7. Discussion & Conclusion

Exponential technologies could lead to a dramatic change in the way that healthcare is delivered. Currently, almost all of the national healthcare systems treat sick patients rather than to prevent people from becoming patients. The future will be a pro-active predominantly data based healthcare that will collect, process, and analyse information providing a personalised report that would also allow preventive measures. [1]

Digitisation is a key requirement for these developments. With that real disruptive medical technologies could be developed that would change diagnosis, treatment, billing, financing, and many other aspects of healthcare delivery. [2, 19]

These disruptions may very likely come with easier to use, less complex, and much more affordable solutions - some of them originating from low income nations that are subsequently adapted by the developed world as they have proven to provide adequate or even superior solutions for a fraction of cost.

Entrepreneurs will play a vital role in the future change of healthcare, as they will develop and introduce solutions that are based on addressing local clinical needs. Entrepreneurship education is still not seen as a core responsibility of universities however.

But these changes in technology, leading to completely new business models, will require innovation leaders that have a skill set that fits the 21st century healthcare challenges, that are not taught in conventional university based study programs.

For that we would need a new type of lecture - Bachelor or Master program - that combines basics of economical, technical and clinical knowledge with management skills, innovation techniques, entrepreneurship, and social skills for working as a leader of interdisciplinary and international development teams. Healthcare is a global problem and therefore these future programs should be very international with respect to the student population and the teaching faculty.

Aknowledgements

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Biography

Prof. Michael Friebe, PhD, has been involved in diagnostic imaging and image guided therapeutic products and services, as founder / innovator / CEO investor, and scientist. Dr. Friebe currently is a Board Member of three startup R&D companies, as well as investment partner of a medical technology startup-fund. He is an affiliated professor with the chair for Computer Aided Medical Procedures (CAMP) at TU München, and full professor of Image Guided Therapies at the Otto-von-Guericke-University in Magdeburg, Germany. He is listed inventor of more than 75 patent applications and the author of numerous papers. He is especially interested in entrepreneurial education and opportunities.

CONFERENCE SUMMARY

BME IDEA Biomedical Engineering
Innovation, Design and Entrepreneurship Alliance

5th

BME-IDEA EU

Magdeburg, Germany

SUMMARY MEETING REPORT AND TO DO's 13.06.2017

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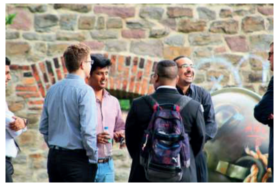
Otto-von-Guericke-Universität Magdeburg

INKA Intelligente Katheter
INNOPROFILE Unternehmen Region Die BMBF-Innovationsinitiative Neue Länder
Otto von Guericke Universität Magdeburg
Gefördert vom Bundesministerium für Bildung und Forschung

Organization committee: *Michael Friebe and the team of the chair for Catheter Technologies + Image Guided Therapies*

GENERAL INFORMATION



- 11.06.-13.06.2017 Lukasklause Magdeburg, Germany
- Approx. 100 individual attendees from 14 nations
- 15 Student Poster Prizes (€100/€75/€50 + 12 x €25) and 4 Student Travel Grants (€500 each)

- Book of abstracts / papers — http://www.healthcare-innovation.de/wp-content/uploads/2017/06/BME-IDEA-Gesamt.pdf
- **Opening words** by Jens Strackeljan, President of the Otto-von-Guericke-University, Magdeburg, Germany; Hans-Joachim Hennings, Ministry State of Sachsen-Anhalt
- **Keynotes** by Michael Dahlweid, GE Healthcare, USA; Sultan Haider, Innovation Think Tank Siemens Healthineers, Erlangen, Germany; Georgios Sakas, MEDCOM GmbH, Darmstadt, Germany; Jan Pietzsch, Stanford University, USA; Franziska Wolf, OVGU, Magdeburg, Germany

- **Discussion Panel Participation** Georg Langs, Medical University of Vienna, Austria; Martin Heinrich Overhoff, Hochschule Vest Gelsenkirchen, Germany; Kumar Rajamani, Robert Bosch Engineering, India; Fei Tian, Vesalius Biocapital, München, Germany; Jörg Traub, Surgiceye GmbH, München; Germany; Martin Schostak (OvGU University Clinic, Magdeburg, Germany); Christoph Arens (OvGU University Clinic, Magdeburg, Germany); Christoph Lohmann (OvGU University Clinic, Magdeburg, Germany); Graham Horton (OvGU University, Magdeburg, Germany).
- **BME IDEA Community Updates**: INNO-X, Aarhus, Denmark; IMPERIAL College, London, UK; EMORY University/Georgia Tech, Atlanta, USA; Otto-von-Guericke University, Magdeburg, Germany; ACIBADEM University, Istanbul, Turkey; BIOCAT, Barcelona, Spain; KTH, Stockholm, Sweden
- **Organising Team:** Axel Boese, Michael Friebe, Holger Fritzsche, Jana Görs, Nadine Tress and the team of the Chair of Catheter Technologies and Image Guided Surgeries Otto-von-Guericke-University, Magdeburg, Germany — www.inka-md.de — with financial support from:

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BME-IDEA Workshop Panel on Digitisation

Participants: *Michael Dahlweid (GE Digital Healthcare, USA), Georg Langs, Med. Universität Wien, Austria), Martin Overhoff (Hochschule Vest, Gelsenkirchen, Germany), Kumar Rajamani (Robert Bosch GmbH, India) moderated by Graham Horton (OVGU, Magdeburg, Germany).*

Keynote Michael Dahlweid

- healthcare organization very backwards in the last years.
- afraid to be unemployed due to robots
- 1 ZetaByte = 95 years "Game of Thrones" will be produced

How is digitization improving healthcare?

- ubiquitous tasks delegated to machines —> cheaper healthcare
- improve personalized treatment
- millennials more likely to accept the digitization
- treatment to patient, not the other way around
- availability of old data to monitor the health related development of the patient
- systems are getting smarter —> self-learning
- people are willing to share data for free
- higher future focus on collection of data by everyone
- nanobots to swallow
- patients will become more self-aware in the next decade —> access to personal health data will be required/demanded
- faster response time by physicians will be needed

How can digitalization contribute to sustainability?

- Machine learning: decision making out of observations, better observations even outside of the clinics

- Easier to analyze by physicians and engineers —> become more and more professional
- Access to more people/physicians
- Smarter devices trough machine learning —> Help to connect people (patient <-> doctor)

Trends?

- consumable robots —> devices travel through patients
- more patients for each doctor due to decentralization
- DIY / selfcontrolled biohacking
- personalized, people more involved into their own health (awareness)
- —> better informed patient, faster response
- appointment prognosis based on personal data
- personalized standard for each one using own data observed by wearables

Favorite example of crazy technology for the next 20 years?

- smart pills like robots for treatment
- smart home US (diagnostic) imaging systems
- miniaturized detection of data collection

BME-IDEA Workshop Panel on Innovation Strategy

<u>**Participants:**</u> *Fei Tian (Vesalius Biomedical Capital, München, Germany), Georgios Sakas (Medcom GmbH, Darmstadt, Germany), Sultan Haider (Siemens Healthineers, Erlangen, Germany), Jörg Traub (Surgiceye GmbH, München, Germany) moderated by Michael Friebe (OVGU, Magdeburg, Germany).*

- **Fei Tian**: Find solutions in existing innovation and build a better ecosystem for start-ups. Make the public aware that these innovations exist

- **Georgios Sakas**: Communicate with customers. Find a connection to the market. There aren't any existing entrepreneurial courses. Invite expert entrepreneurs, which, provides everyone with an opportunity to learn. The will to be an entrepreneur needs to come from within.
- **Sultan Haider**: Find new markets because the products that are built will not fit in everywhere. Improve the quality of life of the people.
- **Jörg Traub**: Quality Basic Education and experience. Customer interaction. Learn by working with smaller companies. High quality healthcare to all.

BME-IDEA Workshop Panel on Clinical Developments

<u>**Participants (all OVGU University Clinic, Magdeburg, Germany):**</u> *Christoph Arens (ENT), Christoph Lohmann (Orthopaedics), Martin Schostack (Urology) moderated by Axel Boese (OVGU, Magdeburg, Germany).*

<u>Christoph Lohmann</u>

- Healing cartilage by anti bodies.
- Self-monitoring technologies are needed along with better diagnostic tools.
- Physicians need to be thought that all the diagnostic tools are not always important for every case. We need to be conscious of our resources.

<u>Martin Schostack</u>

- Cancer is prolonged so long term treatment is difficult to provide. If cancer is not so aggressive less invasive treatments might be employed.
- New technology must have an opportunity to measure the outcome. If it doesn't give measurable results then there is no point.
- There needs to be a good interaction between the doctor and the patient (a two-way street).

<u>Christoph Arens</u>

- Monitoring will be a big part of our lives. This isn't happening in the future- it is right now!!!
- Home based Urinalysis and blood analysis.
- Less costs to patient with more technology. Physicians need to get familiar with the existing technologies (MRI, PET, CT) to understand how they work.
- Family physicians will be a very important aspect of healthcare in the future.

WORKSHOP RESULTS

47 Ideas parked — 26 ideas created in the workshops – 20 partly enriched — 9 fully enriched and listed

BME-IDEA — FULLY ENRICHED IDEAS

NanoTeach - Artificial Immune System

- Self-Learning nanobots to combat infectious diseases.
- Taught in an external environment before introduction into the human body where the learning process continues.

Anti Fall Alarm

- Prevents falling for the geriatric population through the employment of different sensors and vibrations.

Mobile OR - Operating Room on Wheels

- Possible solution to over-crowded hospitals
- Access to basic healthcare on the go.

Exop(l)ants

- Exoskeleton to replace implants
- Can be fitted onto clothes
- Reduce strain on joints

Talk Through - Real-time speech translator

- Break through the language barrier between the physician and patient.
- Facilitate better communication.

Smart EMR - Self-learning Electronic Medical Records

- Paperless Information System
- Avoidance of Data Redundancies.
- Cost-Effectiveness and efficiency
- Data Validation
- Open Access to the Medical records

Health Log

- Collection of personal medical data with a specialised device from birth.
- Enables personalised treatment
- Accessible by the patient only.

GP - App – General Practitioner App

- Accurate and Adequate Diagnosis and Treatment.
- Multi-parameter input for personalised baseline.
- Alerts based on severity of disease.

Predictive Prescription

- Prediction for medication based on patient medical information and past disease history.
- Geriatric home care focus.
- Aimed at cost-effectiveness.

HEALTHCARE VISION

+

CLINICAL INNOVATION

Treatment of prostate disorders – From 'one size fits all' to personalised concepts

Schostak M[1], Fischbach F[2], Pech M[2], Schindele D[1], Wendler JJ[1] and Liehr UB[1]

1) Urology Clinic, University Hospital Magdeburg
2) Radiology Clinic, University Hospital Magdeburg, Germany

1. Introduction

The clinical picture of the prostate organ as an homogeneous gland has barely changed at all. That prostate cancer always develops multifocal growths supports the clinical assumption that the gland can only be considered holistically [1]. Radical prostatectomy or radiotherapy are perfectly appropriate whole-gland treatments, particularly when combined with the highly sensitive tumour marker prostate-specific antigen (PSA).

A single positive (transrectal) prostate biopsy (PBx) is sufficient to detect cancer. Increasing the number of biopsies to the current number of 12 was never aimed at classifying the topography of the cancer within the gland. Taking a 'one size fits all' approach is no longer appropriate, however. Multiparametric magnetic resonance imaging (mp-MRI) has radically changed our view of prostate cancer. Not only can we now avoid superfluous biopsies, we are also able to classify the topography of the prostate cancer and carry out targeted biopsies (e.g. MRI-guided biopsy) of cancer foci. This opens up a large therapeutic spectrum ranging from active surveillance (AS) to focal therapy (FT) right up to standard treatment that largely preserves the organ.

We founded the Centre for Image-Guided Uroradiology Therapy (URBIT) in Magdeburg (Fig. 1).

2. Key URBIT issues

Prostate cancer – Multiparametric magnetic resonance imaging and prostate fusion-guided biopsies

mp-MRI evaluated with PI-RADS v2 opens up a number of options for almost every patient suspected of having prostate cancer or with a confirmed diagnosis of prostate cancer. Patients with benign hyperplasia of the prostate and increased levels of PSA can avoid invasive procedures ('blind' prostate biopsies with no evidence of malignancy) if they have a normal multiparametric MRI. Patients with prostate cancer can be given a more meaningful diagnosis using more targeted biopsies (in-bore or fusion-guided biopsy). For patients with confirmed cancer, the local extent of the tumour can be more precisely determined so that treatment options can be localised.

Targeted prostate biopsies based on mp-MRI achieve more direct diagnostic hits than conventional 12-core TRUS biopsies [2]. Smaller tumours with low malignancy potential tend to be overlooked [3–7]. There is also a negative predictive value for clinically significant tumours of about 90% [8–9]. Standardisation of the procedure has consequently led to mp-MRI being routinely used for almost all those affected in many centres, including ours in Magdeburg. The combination of both procedures in the form of mp-MRI ultrasound fusion-guided biopsy of the prostate is particularly promising.

Prostate cancer (PCa) – Focal therapy (FT)

The standard therapies are increasingly coming under scrutiny because of possible over-treatment in some cases and an associated unnecessary morbidity of those affected. 'Doing nothing' is, however, obviously an alternative that is difficult to tolerate, at least in Germany [10]. Improved imaging has stimulated a demand for highly targeted, focal therapies in this controversial area. Ideally, such a concept should achieve the same oncological effectiveness as a standard therapy but have no or at least considerably fewer adverse effects. Various imaging techniques have been used for several years (e.g. high intensity focused ultrasound or cryotherapy) and the short trends available to date do indicate a very low rate of complications. [11]. The oncological effectiveness cannot be assessed over the long term with any reliability, however. Follow-up biopsies from treated and untreated zones indicate disease-free rates of between 70% and 90% [12].

Prostate cancer – Nuclear medicine procedures

Modern tracers such as Ga68 PSMA increase the sensitivity of PET hybrid imaging to such a degree that masses can now be differentiated on the basis of the cancer activity and can be, where applicable, selectively treated. For the first time, cases with very few (remote) metastases (oligometastatic disease) may even be treated with local therapy alone, allowing systemic treatment to be delayed as a result. On the other hand, unknown, extensive metastases are now occasionally detected which leads directly to the use of a more aggressive systemic therapy [13]. The coupling of therapeutic radionuclides such as radium 223 and lutetium based on imaging procedures are additional instruments in the therapeutic toolbox.

Benign prostatic hyperplasia (BPH):

Modern slice imaging procedures open the door to alternative image-guided non-invasive therapies if the standard therapy is declined. The search by patients for less and less invasive procedures is no longer solely about the reduced risk of bleeding such as that associated with, e.g., transurethral laser therapy, compared to traditional resection. Superselective embolisation can be carried out under local anaesthetic and does not fundamentally alter the internal anatomy of the urethra, providing considerable potential for preserving the ability to ejaculate. Selective embolisation for prostate is currently the subject of a number of studies [14]. Urology and radiology together provide the indication for embolisation if this is this a patient preference. No longitudinal data or large series are yet available, however, and standard therapies are still an option in principle if symptoms cannot be adequately controlled.

3. Summary

URBIT, the recently established interdisciplinary unit in the University Hospital Magdeburg, is a cross-disciplinary, collaborative treatment institute for all types of imaging diagnostics and therapy for urological diseases and opens up new perspectives for patients and clinicians. Unnecessary and invasive diagnostic procedures can be avoided and necessary diagnostics can be carried out sooner and with greater precision. This concerns prostate cancer in particular. This new construct enables alternative and experimental therapies, such as focal therapy, to be administered under highly standardised conditions that are consequently comparable over the long term.

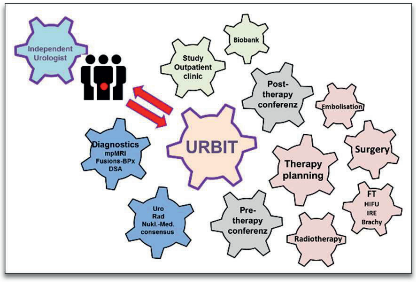

Figure 1: URBIT (Interdisciplinary Urology Radiology Centre for Imaging Diagnostics and Therapies): Linking of various interdisciplinary consulting hours with the diagnostic and therapeutic units in the University Hospital for Urology and Paediatric Urology Magdeburg.

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Biography

Professor Martin Schostak is professor of urology, chairman and director of the Urology departement of the University Hospital Magdeburg. His areas of specialism include surgical procedures to protect organs and function as well as focal therapy for urological cancers. He is president of the Focal Therapy Working Group of the German Society of Urology.

Visions of transoral endoscopic surgery of the upper aerodigestive tract

Christoph Arens

University Hospital Magdeburg

1. Status Quo

Transoral endoscopic surgery has led to a revolutionary change in the treatment of head and neck cancer. The minimal-invasive endoscopic approach reduces the intraoperative trauma. Due to the lower burden for the patient these techniques have gained wide acceptance. Transoral accesses routes allow experienced surgeons reduction of morbidity with save results. This fact advocates an advancement of

the indication spectrum as well as a high potential for these techniques

and equipment in the years to come.

At present surgical robot-systems have the ability to perform minimally invasive surgery in the head and neck. The robotic-systems are made up of a console to be generally placed in the surgery room and equipment with active robotic arms acting directly on the patient, which is controlled by the console. The Robotic-System scales, filters and translates the hand movements of the surgeon in precise micro movements of the driven instruments and avoids the physiological tremor. The ergonomic drawbacks of the transoral endoscopic surgery would be completely avoided by the use of a comfortable console to control the robotic arms that, in addition, do not require the surgeon to be next to the patient. Theoretically the system even permits the surgeon to work outside of the operating theatre. The bleeding-related risks is minimized by the use of electro cautery and other hemostatic instruments as well as the flexible endoscopic CO2-Laser [1].

2. Vision

We will have a new robotic system which works without surgical-arms or handles. The system has manipulators for cutting and hemostasis which are positioned and moved in an electromagnetic field, as well as the light source and high resolution camera. Each tool can be steered separately. It is also imaginable that each manipulator, camera and light is a micro drone. All together build a small drone swarm which acts together under the supervision of the steering and operating surgeon. The surgeon is sitting at a console and steers and/or controls the operation.

The light source produces several different light modes, e.g. white light, autofluorescence light, laser etc. In the different light modes the morphological and metabolic characteristics of the lesion can be scanned completely. Surgical margins are precisely defined. Prior to the surgical removal an optical biopsy is performed to know the exact diagnosis and character of the lesion.

There is also a manipulator with a radiation source, which can apply precise radiation to the tumorous tissue without harming healthy tissue. The manipulators are able to locally apply different medications. Local anesthesia is the standard and allows all kinds of surgical removals in an awake patient. Surgical micro- or even nano-manipulators cut precisely without damaging healthy tissue with absolute hemostasis. Using this technology all kinds of patients can be treated without any risk of bleeding or infection. Healing process is very fast secondary to minimal trauma.

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Will we shift from “Patient inside the hospital” to “hospital beside the patient” in the future?

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1. Background

These days, healthcare domain is experiencing major developments that are going to change many features of it in the near future. This includes not just developments in the quality of procedures that are being done on the patients but also in the method that the healthcare services are delivered to the patients.

Technological developments seem to provide a possibility for patients in the next years to receive their treatments, at least some procedures that currently needs to go to the hospital, at their places or on the road once they need them. This medical-service delivery system will probably be a revolution in emergency medicine that will lead to more lives to survive, than now. Looking to the technologies around us, it is clear that the prerequisites for this infrastructure has already started to be available.

2. On-road hospital concept

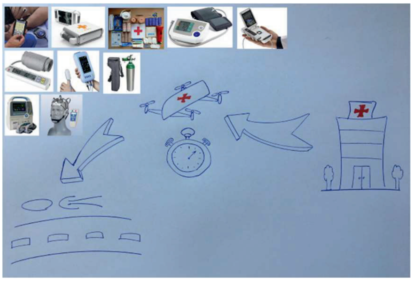
Drones as the aircraft systems that are controlled without a human pilot will be the heart of this on-road hospital system [1]. They will carry first-aid kit to the site of accident beside the patient who needs emergency medical practice. While today drones may be able to carry only small first aid kits including some basic stuff such as adhesive bandages, but in the next years they will be able to transfer several other medical instruments and services as well. Because of a general trend in the design of medical instruments that intends to reduce the size of some of the medical devices [2], it is clear that this will happen very soon. Newly introduced portable ultrasound probe, which can be connected to a tablet is a good example for this miniaturizing trend in medicine that can be easily carried by a drone [3]. This will allow for ultrasound technology to be available not just in clinics and hospitals but also everywhere it is needed to do ultrasound imaging-based procedures. Portable X–ray system is another example that recently a small version of it has been developed [4]. Using drone these kind of medical devices can be considered as everywhere-available instruments. Portable medical instruments are not limited just to these two examples and in the future we will witnessed more miniature tools. Drones will be equipped to medical oxygen tank, defibrillator, pulse rate/temperature/respiration rate/blood pressure measuring system and will be ready to immediately fly to the patient when they need them.

Activation of this drone-based on-road hospitals will be started from the message that is sent from the patient’s smart watch or any his/her other health monitoring gadget. Once this real-time health status checking devices detect a sign of health problem such as heart attack, it well send a message to the nearest drones station or hospital. Using the GPS data of the patient, the drone will fly and be controlled automatically to reach to the patient in a short period of time.

Internet of things (IoT) will allow tens or hundreds of drones to fly in the sky at the same time without any disruption in the task of each other. Using IoT drones will be smart flyers that will sense each other under an internetworking system [5].

It is imaginable when you are near a patient who needs a medical service and a drone immediately comes to you. You have only a basic knowledge about the first aid but you know, at least in the next decade, how to use this drone and what to connect to the body of the patient to measure patient’s condition. As the drone is connected to the health database, acquired data from the patient is analyzed with the help of decision making algorithms, then it decides what procedure should be done on the patient. The whole procedure may also be controlled by a medical doctor or more likely without any human interference.

Figure 1: schematic description of the on-road hospital



3. Discussion & Conclusion

Drone will probably offer more effective form of emergency medicine than cars or helicopters, at least in some basic activities where time is a pivotal factor in surviving of the patient. They will be fast with high maneuver capability, so they will provide the first medical care on the side of the patient in a short time. They can also be a cost effective option when compared with conventional methods of air-based health service delivery. Drone will easily reach to the patients in areas such as crowded streets where demands considerable time for ambulance car to go there and even impossible for helicopters to transfer the services.

Task of drones will not be limited to the elementary emergency medical practices. After a drone on the side of the patient completes its task and realizes that complementary medical activities on the patient is required, using IoT technology it will communicate with a “mother drone” in the hospital or station that is bigger and more equipped drone to come to the side of the patient for more advanced procedures.

Although instruments carried by the drones and the medical services offered by these flying objects will not replace the need for hospitals completely, but miniaturizing the medical devices, which have been conventionally located in the hospitals, and making them portable as well as automatizing technology using machine learning/deep learning and other technologies that are going to reduce the role of physicians on medical activities will probably provide several healthcare services for patient outside of the hospitals that is currently done inside the hospitals.

On-road hospital concept, in one hand will save more lives in the future but on the other hand it will have a negative impact on several physicians/nurses/emergency medicine personnel as their jobs will no longer be required because of the automatized technology used in the on-road hospital system.

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Biography

Ali Mahmoud-Pashazadeh is a PhD candidate at the radiology and nuclear medicine department of the Otto-von-Guericke-University and an R&D engineer at the Chair of Intelligent Catheter and Image Guided Procedures. His main scientific focus is radioguided surgery.

Challenges in Joint Innovation Projects between Start-Ups and Established Cooperates in the MedTec Market

Joerg Traub[1, 2]

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1. Introduction

Over the past 20 years most of the breakthrough medical technology was generated by start-ups and later transferred for a global roll out to established cooperates with a deep market penetration and established sales and service team. In recent years, a great number of cooperates mimic the generation of creativity and innovation with various programs to copy the success in the establishment of new products, services and protocols that was achieved by start-ups. The abstract paper here discusses the challenges in a cooperation between a start-up and a cooperation in which the elephant is hopefully not stepping on the mouse and has mutual interest and benefit in its growth.

2. Essential Difference

About a Start-up: A Start-up is a creative mass of chaos per definition that is trying to find a repeatable business model [1]. The live of a start-up is powered by ideas and creativity and uncertainty is omnipresent in all activities. The everyday activity of an entrepreneur is taking risk with the vision that it can change the world. George B. Shaw writes "The reasonable man adapts himself to the world; the unreasonable one persists in trying to adapt the world to himself. Therefore, all progress depends on the unreasonable man" [2]. In general, there are very few SOPs (standard operating procedures) and a lot of flexibility in the processes and also in the co-founder and early employees. One of the general motto is rather ask for forgiveness than for permission and a failure culture as well as an incentive structure beyond a onetime bonus is established from day zero.

About a Cooperate: Cooperation have a great customer standing and in general a worldwide penetration with application experts, marketing, service and sales infrastructure that is dedicated to the market needs. Furthermore, the internal processes for production and servicing are in general stricter and of higher standards than the regulatory requirement to deliver the best products and the highest quality to the customer. Integrity, quality assurance and compliance as well as cooperate identity are daily activities also in launching new ideas.

The high quality however also required multiple persons and institutes approving projects, discussions, communications etc. and a general zero mistake/failure strategy are established over years. Principles like "fake it until you make it" to have a fast communication with early customers on features and performance is not the working principle of established medical technology cooperation.

3. Discussion & Conclusion

The two worlds are essential difference and in general mimicking structures of the others will fail. Better than learning from the other would be trust the other and start earlier with cooperation of mutual benefits. An investment at a stage, where the market fit is proven is in general too late. Better would be an early cooperation like in many pharmaceutical start-ups by supporting and mentoring the market access for small, creative and technology oriented companies without controlling and slowing down their creativity and innovation engine will be of benefit for both sides. It will bring early access to innovation and cooperation with very limited risk and a route wider market access beyond the initial key opinion leaders for the start-up. The key is to ensure that the elephant (or another) is not stepping too early on the mouse.

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Biography

Dr. Joerg Traub is co-founder and CEO of SurgicEye GmbH a medical device spin-off from TUM Munich. SurgicEye is creating applications in therapy for nuclear medicine. In addition, Dr. Traub is chairman of the board of Piur Imaging GmbH, a Vienna based Cardiovascular Ultrasound Start-Up. He is also a guest lecturer at TUM in Munich for the Healthcare Entrepreneurship Lecture Series, teaching innovation generation and entrepreneurship for engineers and scientists.

Approaches for entrepreneurial thinking for the healthcare sector at Otto-von-Guericke-University Magdeburg

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1. Introduction

Compared to universities in the US or the UK, the potential for innovation generation and subsequent translation in start-up companies at German universities has not been a focus yet and the process is not part of the scientific education. The engineering courses are designed to impart knowledge from the natural sciences in the technical context. Innovation, creation and implementation are rarely part of the curriculum. Now, with the help of the EU funding (EFRE), a research and start-up lab is build up directly at the university hospital to expand this innovation program. In addition to the project processing, and as central point of entry for medical partners, it also serves as lecture room for the new dedicated graduate school "Technology Innovations in Therapy and Imaging- T2I2“.

2. INNOLAB ego.-INKUBATOR IGT (Image Guided Therapies)

The INNOLAB IGT - Image Guided Therapies is a concept in which engineers and doctors work together on new product ideas for clinical application. (Prospective) engineers go to the clinic on site to identify unmet clinical and medical needs during normal operations or surgical procedures performed by the medical users. Based on the Stanford- Biodesign concept (identify, invent, implement), a large number of product and process ideas are developed and subsequently tested in short iterations on their benefits and general feasibility [2]. In addition to the technical implementation, the market potential of such products is of enormous importance. The team of the chair of catheter technologies uses this concept and innovation generation lab to stimulate and motivate engineering students and employees of the university to think about starting a company based on their own verified product ideas. This is especially important since healthcare is of global concern, but every country has a different healthcare system and also different healthcare needs. This opens huge opportunities for entrepreneurial activities [3]. The new INNOLAB ego.-INKUBATOR IGT, located directly at the university clinic, will further intensify the collaboration between the medical doctors and the engineer.

2.1. Creative workshop

The lab encompasses a creative area for idea generation, concept studies and meetings with single and group workstations. A bright and colorful setup invites the creative work. The flexible furniture offers a variety of possibilities to always meet the group requirements. Cork walls, whiteboards and mobile projection beamers offer enough options to find, discuss and develop ideas.

2.2. Prototyping Lab

The attached prototype laboratory is for invention and technical realization. Smaller and larger product ideas are tested for technical feasibility and are built directly as the first prototypes. Various 3D printers, CNC milling and injection molding machines are available for this purpose. A large number of fine tools are available for processing the finished parts and implementing electronic components.

2.3. Simulations OR

The simulation OR is for implementation and verification of the developed prototypes. A minimal invasive surgery setup with patient table, 3D C-arm, Ultrasound tomography system, endoscopy tower with RF generator, ultrasound systems, navigation/tracking equipment and different phantoms give the opportunity to test in a simulated clinical environment with the user.

3. INNOLAB Network

For the mentioned development approach identify, invent, implement, strong partners were found for practical and content support. A clinical and industrial panel was created. The medical and the electrical engineering faculties are currently involved in the innovation processes (identification, invention) and the economics faculty will most likely join soon. The industry board is helping to find and identify technology transfer options (implementation).

3.1. Clinical Panel

Current clinical cooperating partners are the ENT, urology, neuroradiology, radiology, nuclear medicine, dermatology, vascular surgery, orthopedics departments as well as the cardiac surgery at the University Clinic Magdeburg. Interdisciplinary student teams of 3 to 5 members are formed every semester to identify the clinical needs while visiting the actual surgeries and come up with a large number of ideas per problem (Biodesign, Stanford). Ideas are then regularly fed back to the clinicians that come, see, and discuss the developed prototypes.

3.2. Graduate School T2I2

The INNOLAB IGT acts as the central contact point for the Ph.D. program of the Graduate School "Technology Innovations in Therapy and Imaging — T2I2“. Currently 13 Ph.D. students are in a structured doctoral program for innovation generation, technology transfer and business implementation of medical technologies. The training includes technical understanding in the context of the medical application and taking economic factors into account.

3.3. Industry Board

An industry board with several small, medium sized and large companies from Sachsen-Anhalt, and other German locations was also established.

3.4. EU cooperation

An international training network around healthcare products and services for prevention and homecare, based on an adapted BIODESIGN concept. The collaboration of 10 Industry and University-participants from 8 countries provides extensive and complimentary expertise in inpatient and outpatient healthcare services, educational programs, and in applied and relevant technology developments.

3.4. Outlook

The INNOLAB IGT makes it possible to create an innovation and idea generator where clinicians and engineers work closely together in a simulated clinical setup at the campus of the University clinic. The engineer gets an understanding of everyday procedures, as well as identify problems and deficiencies in the clinical workflow or technical products.
Solutions and innovative ideas are developed in constant consultation with the doctors and implemented, altered, or discarded. Test and evaluation by the clinical user, as well as wishes and suggestions from the business partners, are constantly being integrated into the individual development stages of new medical products and ensure a market-oriented product development

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Biography

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For the PhD program, he heads a university-based start-up laboratory for innovation generation and technical transfer of medical technologies in minimal invasive therapies with the aim of creating a network node between industry, medicine and university teach-

A VC's To-do List to Boldly Go Where No Man Has Gone Before

Fei Tian

1. Introduction

'A place where no man has gone before' belongs certainly to the most exciting topic for innovators and explorers, as human behaviour is known to encompass anticipation of the future, which can be the result of a psychological outlook including for example optimism, pessimism, and hope. If the time point of 20 years later is chosen, how to 'live long and prosper' will be one of the most essential issues for the human being. If the Starship is on an exploratory mission to leave the current galaxy of healthcare system, let us pick a life sciences venture capitalist, who is ideally a serious and ambitious entrepreneur-cum-healthcare futurologist, to make the strategy for where and how we are heading to the adventure and eventually financial success by addressing challenges, understanding the cutting edge, and contributing to the future of health and medicine.

2. Discussion & Conclusion

In the future, there will be a paradigm shift of disease focus for therapeutics and medtech technology development and the border between drug and device treatment will be meshed together. For instance cancer will be manageable chronic diseases and patient's life quality and side effect management will be equally important as efficacy for an oncological therapy. With the development genomic diagnostic and personalized medicine, individual preventive cancer vaccine will become realistic. For cancer patients, more life quality friendly therapies will be administrated. There are companies to be watched, who have the potential to become standard of care in the near future. To take prostate cancer as the first example, the Encage™ from Trod Medical is a bipolar radiofrequency device, designed for localized focal ablation. Encage™ is unique in producing a totally predictable ablation volume, with no tissue damage beyond less than 1mm to achieve zero incontinence and incompetence rate after surgery. Another venture is Thermosome, who is developing proprietary thermosensitive liposomal (TSL) delivery technology, biocompatible drug-loaded nanocarriers can be created which release their content upon the influence of mild heat, to increase the local concentration of chemotherapy medication in solid tumor by up to thousand fold. Regenerative medicine with gene modification and cell therapy will overcome the current hurdles and be able to show its full potential in various diseases including cardiovascular, ophthalmology, and orthopedic condition. Inherited genetic metabolic disorders such as haemophilia and urea cycle disorder will be cured for children with gene / cell therapy. Acquired metabolic diseases such diabetes and NASH, will also benefit from cell therapy or gene modified cell therapy. The production of cell therapy will be less depending on donor source due to the advancing development of iPS cell and cell reprogramming, and autologous and allergenic cell therapy will be administrated in the same way as simple as an infusion.

Now we shall move our eyes from the pill tablet to the object standing aside the hospital bed, 'Hello. I am Baymax, your personal healthcare companion.' (Big Hero 6) In the future healthcare system it will be robots working alongside humans, augmenting care to help enhance individuals' experience of later life, and allow people to live independently for longer. There are two types of robots already undergoing development, companion robots and assistive robots, and both are making traffic progress from single application to complex self-learning care-taker and from prototype to household interactive life companion. In the very near future, Echo-like devices will become major healthcare interfaces. As next-generation assistants like Viv (acquired by Samsung in 2016) continue to advance and stay in focus of the consumer and digital industry, these intelligent interfaces will further enable highly personalized and complex services which cross into health and medicine. In Feb. 2017, Virtual nurse app Sense.ly raises $8 million from investors including the Mayo Clinic and venture firms. The company has developed an AI-enhanced virtual assistant "who" acts as a medical companion and monitor. It has demonstrated an ability to reduce hospital readmissions for heart failure patients. Clinical teams assisted by AI will have their productivity increased by more than 10 times, and such advantage will be shown even more prominent in labour-heavy treatments such rehabilitation after stroke and orthopaedic injuries. Not only the encouragingly growing clinical evidence is being generated, but also we will soon be able to happily invite Mabu, the personal healthcare companion from Catalia Health, and years later a real Baymax with a tricorder back home.

In the future 20 years, there will an era for digitally enhanced human beings. This big data revolution has led to the emergence of the Fourth Industrial Revolution, which is about combining connected devices with cloud computing, big data analytics and artificial intelligence. It has been recognized that digital technologies are firmly embedded in our lives – the Internet of Things is becoming a reality, growing from 15 billion smart devices in 2015 to at least 50 billion by 2020. Chronic patients have to live with the condition 24/7, so the diagnostic and treatment efficacy monitoring should reflect that and be able to give a feedback by the care coordinator for real-time individual treatment adjustment. Non-invasive direct blood sugar monitoring by a wearable device instead of the current solution of measuring glucose concentration in the tissue fluid with an electrode will be utilized for diabetes patients, meanwhile real-time continuous monitoring of liver function for patients with liver diseases such as NASH or undergone chemotherapies will become reality. Patients will communicate with the medical Internet of Devices e.g. wearables, scale, blood pressure cuff and glucometer, intraocular pressure implants, meanwhile based on the genomics, microbiome, diet, activity and blood sugar level, suggesting the appropriate meal to have delivered or prepared and type and dose of medication to be taken. Geneticist and Microbiomist will be the new pathologist, and ethical education will be focused on avoiding genoism and defend the belief of 'There is no gene for the human spirit.' (Gattaca)

However, the most fundamental innovations would not only be the stirring medical advances, but rather the technology assets improving how health care is accessed, structured, provided, administrated, and financed. Within 20 years, the healthcare industry will be no longer fragmented but rather interconnected between hospital care and home health, primary and outpatient care, via a data-oriented IT infrastructure with analytical applications and real-time feedback capacity. Hospitals will be used for the highest acuity patients. The focus needs to be on home health, primary care and outpatient care. IT has been seen as "the enabler." Telemedicine, home monitoring systems, point of care testing, EMR, and data management will all impact the infrastructure and physical space. Technology will be integrated into the buildings themselves (smart buildings), and solution providers for such smart hybrid space will be high flyer in the B2B service business.

Ok, now the heart beats have already been raised by imagining that we will be digitalized human beings with all changes in our bodies monitored by smart devices, and robots with AI solutions will make diagnosis with a tricorder and assist us to take the 3D printed pills and move the injured arms with individually designed bone implants and autologous stem cells producing growth factors constantly on demand, according to personalized rehabilitation programs. It is the right moment to finally talk about money and healthcare payment system. Despite of the nature of venture capitalist to be desperately optimistic of technologies and innovations, a fact cannot be ignored is who and how to address the costs of obesity, chronic disease and the health needs of the sheer numbers of aging Baby Boomers and the cost for the high-tech new solutions. Systems have already started to make the changes including value-based payment models, that will make them more competitive and there must be, and there certainly will be, transformative changes over the next 20 years. The payment system should also get patients more involved and be able to measure and creatively reward the right behaviours. Any innovation which facilitates such transformation will be in the frontier to become a successful business and corner stone technology of the new healthcare system.

The stakeholders such as patients, physicians, and insurance companies, should also join force to make the guidelines for the integrated healthcare systems. In the past decades, the industry players, including pharmaceutical companies, medtech companies, IT system builder have placed dots successfully into the healthcare system, the whole healthcare providers are powered by blockbuster drugs and large scale diagnostic imaging devices, all are connect by the IT infrastructure. Starting from these dots, it is time to draw the lines between them and extend the lines to out-patient care and home care market. The dot-makers should also take the initiative to facilitate and invest together with the public and private funding sources in an interconnected health continuum, where the healthcare and consumer worlds integrate to put people at the heart of the evolving matrix system.

At the end of this article, to the Starship crew bravely heading to the resplendent galaxy of healthcare in the future 20 years, 'may the force be with you!'

Biography

Fei Tian holds a MD (Medical Doctor) degree (2008) from Shanghai Tongji University, People's Republic of China. She began her career as a physician in emergency medicine. During her work as a physician, she also performed research in atherosclerosis and immunology. She pursued her interest in pulmonary oncology research for her scientific doctoral degree for a PhD at the Ludwig-Maximilian University and Thoracic Oncology Center, Munich, Germany. She has several publications as author and co-author in international peer-reviewed journals. In addition to her medical and scientific research background, she gained substantial experience of medical communication and life science consulting, including in-licensing of biological products, international market research and communication, and development of business strategies for global medtech companies and pharmaceutical companies. Fei Tian joined Vesalius Biocapital as an analyst in 2012and was promoted to principal in 2017.

An ounce of prevention is worth a pound of cure

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1. Introduction

In this paper, an attempt will be made to extrapolate current trends to envision certain aspects of the healthcare situation two decades hence.

Beginning with a brief statement of motive, areas covered will include genomic technology for prediction and diagnosis, utilization of telecommunications advances, and reduction of invasiveness.

Medical systems which exist in a functioning state at present will be cited to demonstrate progress toward the predicted outcomes.

2. Materials and Methods

The healthcare system of 2036 will fully embrace the adage that an ounce of prevention is worth a pound of cure. The industrialized nations will require strict attention to diagnosis, in order to keep citizens able-bodied and able-minded enough in advanced age to maintain acceptable levels of healthcare. Left to the current model, social systems will be overwhelmed by the healthcare demand increase of the aging population and shortfalls in funding and personnel due to retirement and dropping fertility rates.

Inexpensive DNA sequencing and a better understanding of the human genome will amplify predictive power. System-wide databases anonymously combining medical histories and patient DNA sequences [1] will permit optimization of diagnostic testing regimes driven by statistical analysis instead of painstaking clinical research, so that healthcare systems will have a good idea of what to look for and how often.

Diagnostic methods will, when possible, rely on the identification of molecular biomarkers, both for infectious agents and for disorders indicated by metabolic abnormalities. Continuing miniaturization of biosensors via the thin-film and printed circuit approaches will allow

Figure 1: Atlas Genetics io® genomic diagnostic platform [atlasgenetics.com].

higher sensitivities, lower costs, and reduced scanning times, with more common tests becoming point-of-care. A hybrid thick film electrochemical nucleic acid assay in development by Atlas Genetics (Fig. 1) is potentially capable of 24-fold multiplexing with a single blood sample and point-of-care diagnosis speed.

The most common tests will rely on sensors integrated into either smartphones or plug-in modules thereof. The latter approach (Fig. 2) is demonstrated by the Dynamical Biomarkers Group, which shared a win in Qualcomm's Tricorder XPRIZE in 2017.

Surgery will evolve to take advantage of the modern digital environment. Problems of sterility, surgeon availability, and radiation doses will be partially obviated by extensive migration to telesurgery. Medical schools will begin to replace traditional surgical training programs with more robot-centric ones, with hyperspeforization (i.e., individual surgeons performing only a narrow range of surgical approaches and targets) becoming common to maximize both throughput and positive outcomes, a trend mirrored by diagnostic medicine as AI becomes capable of outperforming doctors for general diagnosis. Nurses and technicians will experience job growth to help manage and oversee these new systems.

Figure 2: DBG Tricorder, utilizing smartphone for digital processing [tricorder.xprize.org].

Another direction in surgical evolution will involve reduction in invasiveness, especially important given the frailty and slowed recovery of aged patients. Even modern laparoscopic surgery may seem excessively traumatic compared to future approaches, which may utilize injectable surgical means such as magnetically-directed nanoparticle ablation [2] in addition to the increase in the proportion of catheter-based procedures where feasible.

Improvements in imaging and beam targeting will allow more extensive use of radiosurgery, with minimized side effects. Precision delivery will make use of techniques such as Intensity-Modulated Radiation Therapy (IMRT) and (if expenses can be reduced by means such as replacing cyclo- and synchrotrons with laser ion accelerators) proton therapy, due to the technical superiority of the Bragg peak over photon depth distribution profile [3].

3. Discussion & Conclusion

The immediate future of medicine is centered around a number of trends explored in depth hereinbefore: an aging population, use of genomic technology, and integration of telecommunications in medical technology.

The increasing average age of patients means that less traumatic approaches will become more common, the least traumatic approaches requiring that diseases are detected well before they can cause serious symptoms or require a major interventional effort to combat.

Modern familiarity with genetics can be put to use not only to detect disease markers in the bloodstream, but also to predict the incidence of diseases.

Advances in processing power and communications mean that diagnosis can be moved away from the traditional doctor's office paradigm, and treatment can be conducted from afar.

Of course, given the rapid nature of technology these days, it is certainly possible that innovations could arrive completely unpredicted and achieve market dominance within the space of 20 years. It is likely that regulation will prove a much steeper hurdle than innovation.

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Biography

Alan Guthrie, B.Sc., is a student of Medical Systems Engineering at Otto von Guericke Universität Magdeburg, where he edits papers for the Computer-Assisted Surgery group. He previously studied Mechanical Engineering (focusing on alternative energy and emerging technologies) at the University of Washington, where he also performed research in the NanoManufacturing Laboratory. In between, he was employed as a design engineer at a printed electronics company, where he was responsible for all medical electrodes and diagnostic circuits, as well as a number of user interfaces for the medical and defense industries.

Convergence of fast paced emergent technologies for continuous, proactive and value based care

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1. Introduction

Healthcare is at the center of convergence of a number of current fast-paced emergent technologies that could dramatically change the face the healthcare forever. Some of the fast paced emergent technologies to name a few are Artificial Intelligence, Machine Learning, Robotics, Virtual Reality, Crowd Sourcing, 3D Printing, Material Science, Synthetic Biology, Apps and Mobile computing. However, the wave of dynamic change is not limited to technology only, but healthcare is in midst of a socio-economic reformatting, which might well change our present approach towards healthcare delivery.

2. The new frontiers in technology

Healthcare is currently profiting from the advances of all the diverse fields. This is making healthcare from a sickness, reactive care to a continuous, proactive and participatory care[1]. The role of the healthcare provider is no longer going to be a cure for a single episode, but towards a care continuum where there is value created for the individual through preventive and predictive techniques. The individual and no longer the patient is the center stage of Healthcare. This changes the care cycle from a hospital only mode of 'acute' care to a three stage care approach of Home care (Health Independent Living), Mid-Level care (Assisted Living), to finally Acute Care. The quality of life is going to become a major determining factor and not the mundane increase of life span expectancy.

The understanding that genetics only play a small role in the overall health aspects in now getting better established. This would become even more well accepted in the decades to come. Individuals would hold more responsibility for their own health and well-being. It is already determined that the costs from behavior for an economy are far larger than costs from genetics.

A large percentage of Individuals have already started to monitor their health and vital parameters. This is set to grow exponentially. The stage is set to change from quantified self to quantified health, where the individuals have all the health data that they want to know about themselves. The coming decades would have shift from wearables to insideables (that which is ingested or tattooed onto the skin) and to trainables (patch that can recommend the right body postures) to 'shockables' – (that which trigger a shock when there is inappropriate conditions)

The community and ecosystem are playing a vital role already in the behavior changes of the individuals. It is proven that just by having large amount of wearables would not by themselves lead to behavioral changes [1]. The quantified health would be connected to the trained specialists, therapists to help, guide and mentor slowly the behavioral changes. This would lead to large ecosystems play in healthcare, from social platforms to self-help groups. The data collected from all these diverse sensors and behavior patterns would become a rich mine of information. These would be analyzed by machine learning algorithms to predict onset of any ailment much in advance. The artificial intelligence systems would be able to proactively intervene before the calamity onset. Robotics and immersive virtual reality systems would help engage with individuals in unprecedented ways bridging the gap between machines and humans. Smarter AI systems would understand each individual minutely and be able to offer personalized solutions.

3. The new socio-economic frontiers in healthcare

The generic narrative in health-tech innovation is multiplicity of technology and fast emergence of state-of–the art instrumentation and cloud based services. But, beyond such developments there lies the fast opening up of the (so called) resource limited regions, specially China and India, followed by parts of African continent. This emergent market will rely less on the professional and high-cost diagnostics workflows and move more towards low-cost pre-screening based methodologies and shift towards healthcare economy of scale. The effects of such a shift is manifold : (i) Inspite of the long standing belief that personalized medicine is the future, there will be a new market where bulk medical products with thrive and grow at a rampant pace – ushering in an era of much production of low cost connected medical devices [3]. (ii) Since the bulk of available data increases (many of the emerging countries has less stringent rules for patient data) and more individuals are connected to a global system, accuracy of artificially intelligent systems will improve – further promoting its growth. Several reports has indicated the medical devices market in India alone will cross 20 billion in 2026, thus creating a healthcare ecomony seldom envisaged by many global players. Moreover, it will allow healthcare services to reach far and wide, thus encouraging tertiary healthcare providers to extend value based care as opposed to the small cohort of service based delivery of care. The Yashwaswini scheme for providing health insurance for rural dwellers in Karnataka, India and the Narayana Hrudayalaya stand testimony to the emerging world order.

4. Discussion and conclusion

There are lots of opportunity areas in this convergence–

Easier Three Dimensional models for entire anatomy, Machine Learning and Deep Learning to help Radiologists, Reduced dose while imaging, Hospitals/Doctor move to houses, Smarter Appointment booking systems, Robotics assisting surgeons tasks, AI making smart hospitals.

There are lots of challenges that this would pose –Spiraling Costs could force business/governments to come up with alternative Business Models, Governments to pay money for people to stay healthy, Larger divide between healthy and Non healthy people, Newer diseases that get generated, Increasing Life Span versus Increasing Quality of Life

The geographical variations and opportunities in the emerging markets, coupled with its challenges in implementation, will be an equally important factor as the technical developments. Developed economies will see an emergence of precision medicine and automation of diagnosis, but on the contrary, the emerging economies will have a fresh and vibrant model of pervasive and accessible healthcare. Though evolution of healthcare technologies and pathways for its delivery is one of the most difficult aspects to predict, we can be optimistic of technology driven framework to emerge. Though some regions are still laggards in terms of infrastructure, it allows them an option of a jump starting a revolution (reminiscent of the telecom revolution of India). Finally, we should also spare a thought about the wonderful frugal innovations taking place around the globe, which can not only create local well-being, but some ideas can potentially revolutionize and disrupt the presence status quo between the stakeholders [4].

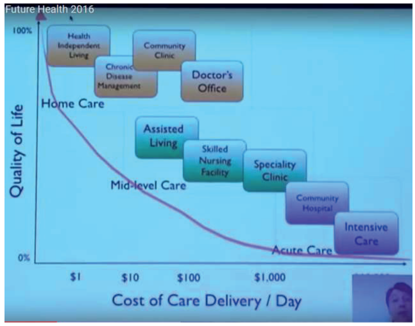

Figure 1: Cost versus Quality of Life

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Biography

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How could a novel outcome-based Healthcare Payment System look like in the future?

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1. Introduction

The average life expectancy of the population in industrial countries was never as high as now [1]. Despite the fact that improved healthcare is one of the reasons for this positive change, it contains also new challenges which have to be solved.

Fitting to the higher average age of the population, there are more age dependent diseases, accidents and other health problems which need an appropriate healthcare. This is resulting in a higher number of patients who want to get a therapy for their health problems by visiting a physician or a hospital. While these huge number of patients want to get an optimal treatment, the physicians have to care about their limited time in which they have to satisfy the medical need of the patients.

In the current healthcare system, the physicians are paid based on procedures and number of patients they have treated. The following example depicts the problem of current healthcare systems: A medical doctor “A” works with a lot of effort and spends a lot of time in comprehensive individual differential diagnosis for finding the cause of some unclear symptoms. This results in a maximum medical outcome for the patient. Another medical doctor “B” divides his patients very quickly into standard categories and applies therefore mainly typical non individual procedures which results in less patient satisfaction. At the end Doctor “B” can get the same or a better payment than Doctor “A”. The injustice in this example could demotivate doctor “A” and may reduce also his diagnostic and therapeutic quality. This conventional payment concept carries the risk that the patients don’t get individual and specific treatment.

This paper will present a novel healthcare payment method and how it could be implemented in the future giving the physicians new motivations and supporting the patients to get a better medical care.

2. General Concept

The main purpose of the new healthcare payment system is improving the quality of healthcare by motivating the physicians to achieve maximum medical outcome. That would mean that physicians will get paid for their medical performance instead of their amount of realised procedures. In general, the patient has to get any kind of medical benefits out of the treatment that the physician gets paid.

3. Special Regulations

<u>Regulation for measurement of success:</u>

This system needs a measurement method which measures the medical performance of the physician. To evaluate if the treatment was successful, the first choice is using objective methods like laboratory testing (blood tests, urine tests and other), imaging modalities and many other available objective testing methods. For example, a patient with hypothyroidism (underactive thyroid) visits a doctor for treatment and gets medication to lower the increased TSH (thyroid stimulating hormone) level of the patient. For measuring if the chosen drug therapy was successful, the TSH level of the patient is analysed again and if a lowering to a healthy level is achieved, the doctor gets paid after a confirmation of the laboratory is done.

<u>Regulation for diseases with low scientific success rate:</u>

If the payment is based on medical outcome, physicians with focus on diseases with poor success rate like Cancer would not get their deserved salary. Therefore, the payment is not only based on positive medical outcome. It is based on a so called scientific success rate (SSR) of a certain disease. The SSR describes a scientifically proven average success rate under medical treatment. Based on this SSR, all known diseases are staggered into categories. Bowel Cancer for example has an survival rate of 57 %, that the patient will survive for at least 10 more years [2]. For this kind of diseases, the treating physician gets 43% of the treatment cost immediately. The remaining 57% are paid after successful treatment is proved.

<u>Regulation for incurable diseases:</u>

The success of the medical doctor treating incurable diseases like Parkinson's disease is assessed in a different way. Parkinson treatment is based on symptom reduction and slowing the progression of the disease. The success in both aspects can only be evaluated by the patient. Therefore, the patient plays a central role in the salary process of the physician in this kind of diseases. The physician will be only paid if the patient can confirm the success of the treatment by an evaluation done by the patient or a family member. It is done by family members if the patient is not able to. For this purpose, every patient has an CE certified medical mobile application on their mobile devices provided by the health insurance (see Fig. 1). This application contains patient data, diseases, treating physicians, past procedures, sample results and treatment outcome evaluation, which is in direct contact with the health insurance and treating physician.

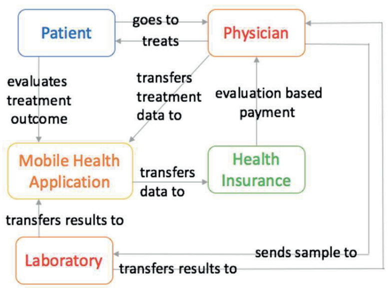

Fig. 1: Association between different involved parties for successful treatment outcome evaluation

4. Discussion

Like every other concept there are also disadvantages like delayed payment for the physicians and more expense for the patient because of involvement in salary process.

Nevertheless, it motivates the physician to put more effort in medical treatment and improve the quality of healthcare in general. The unequal dealing with doctors who spend more time and trying to get a more individual therapy for the patient is also repealed.

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Biography

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The Effect of New Technologies on Healthcare Future Vision

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1. Introduction

Globally, all healthcare systems are facing similar challenges. Rising costs, changing demographics, accessibility of medical services, quality of medical cares and ... have increased the need to manage healthcare plans for the future. Multiple solutions are being put into play to help determine the future of healthcare. As a popular solution, application of different forms of technology is becoming a major factor in healthcare settings around the world. Across all health care sectors, there is a demand for creative and thoughtful uses of new technologies to make high-quality health care accessible and affordable for everyone. From the other point of view, using new technologies bring changes in to each area, for instance the movement from public healthcare systems to more personalized medicine in the past few years.

Considering all important points, here a short overview on how new technologies will change the picture of healthcare systems in the future is provided.

2. Materials and Methods

How will healthcare look like in a few decades from now? Multiple factors should be considered to answer this question. There are many countries around the world that have differences in the case of healthcare infrastructures, payment systems, medical requirements, medical equipment and resources. However the main point is that all countries try to apply the various types of technology to meet their needs. How will these technologies change the healthcare in the future?

2.1. Artificial Intelligence (AI)

AI in healthcare and medicine could organize the patient routes or treatment plans better, and offer physicians with literally all the information they need to make a good decision. Clinical Decision Support systems (CDSS) and AI systems for medical image, and lab test analytics are the current examples of using AI in the healthcare settings. Future directions for AI including mining medical records, designing treatment plans, genetics and genomics programs, drug creation and … will provide a complete, accurate and acceptable computer-based treatment path for the patient-individual which can be observed by the physicians in special cases. Some companies are working on different projects in this area and will introduce a wide application of AI in healthcare settings in the future [1].

2.2. Health Information Technology (HIT)

HIT will alter the focus of healthcare providers from curing illness to able the person to improve their personal health. Cloud computing will store big data for secure and easy access by people, mobile devices will be used to enter data during health events, wearable sensors discover changes in our bodies like physical changes, and social media will provide sharing our health information to support communities. These four pillars generate the big data that could fuel a learning health system (LHS). The LHS continuously analysis this data as well as the data from electronic health records (EHRs) and other healthcare entities. Subsequently, patients and their healthcare providers will use HIT to get access to this learned knowledge to improve health conditions [2].

2.3. Robotics

Robotics has the ability to scale down a surgeon's motions so that, in cooperation with the computer, surgical manipulations at a sub micro scale would be possible. Also, the advancement in miniaturization to have micro-robots is not as far off as one might think. So following imagination is possible: „a robot doctor has replaced its human predecessor, using a super-computer brain to calculate drug doses in seconds with no risk of fatigue-induced errors“ [3].

Figure 1: Technologies and future of medicine

3. Discussion & Conclusion

The healthcare systems are concentrating on prevention and aftercare, instead of providing medical care in acute phase. Based on this new movement, what we can see in the future of healthcare is the presence of new technologies in different medical settings.

Family history, current health condition, and genetic prediction will gather to assess the patient, with the help of wearable devices. Additional information will collect with the portable ultra-fast scanning systems. All this integrated information in the EHR will be analyzed by the support of AI to offer an accurate and efficient personalized treatment plan. The revolution in the field of pharmaceutical treatment will provide more rapid effective drugs that hit the target fast and have long-lasting performances, which is based on molecular structure of each patient. In the case of surgical treatment, we can see fully equipped operation rooms which can easily be modified for each procedure. Hybrid and fast imaging modalities, navigation setups, different processing units and computers will be placed inside the operation rooms (ORs). Robots will handle all surgical procedures and surgeons and nurses will only observe the process, either from the next room or thousand miles away. Aftercare and follow-up process will take place at home and all information regarding patient condition will be transfer to the healthcare center. Then next step will be applied with the help of automated machines and robots.
Thinking and talking about all these workflows in the future is easy. But there are some critical properties that need more attention. For instance:

1. Every new change in healthcare settings should pass the standardization filter (FDA and …) which takes long time.
2. We have countries with different requirements and resources in the healthcare system. Hence, what we will see in a developed country is not similar to the poor developing one.
3. How insurance companies and payment systems will deal with new changes?
4. How the security, confidentiality and privacy of patient and its information will be protected in this new workflow?
5. What kind of cultural, ethical and religious issues will come to the scenario?
6. Will the governments, patients, physicians, clinical staffs, managers and … cooperate with these changes?

These are only a few examples of what we will face with in the future of healthcare systems. More discussion and scientific researches is crucial to prepare each society for what they will meet.

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Biography

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Ultrasound Image Guided Minimally-Invasive Interventions

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3. Introduction

Ultrasound reflection imaging is a real-time modality which is widely used to guide minimally-invasive clinical interventions, where the instrument path is essentially straight forward and a few centimeters in length.

Image reconstruction: The technical realization of wave excitation, measurement of the reflected wave and image reconstruction in clinical routine equipment is nowadays based on the so-called synthetic aperture focusing (SAFT) or similar techniques. In SAFT, some neighbored piezo crystals (synthetic aperture, SA) are excited to generate an emission wave focused to a point (A-line), and thus improves the signal-to-noise ratio of the reflected waves. The reflected waves are measured at some neighboring piezo crystals, and their signals are delayed-and-summed up (DAS) phase-coherently to form a receive-focused signal. Numerous of such emit-receive procedures are processed, and this number is roughly inversely proportional to the image repetition frequency.

SAFT has some inherent drawbacks:

1. A high number of A-lines improves lateral image resolution, but decreases image repetition frequency and thus real-time ability.
2. Parallel A-lines often cannot circumvent structures acting as perfect wave energy absorbers or reflectors, thus provoking incomplete visualization of target and structures at risk (e.g. vessels, nerves).
3. A-lines directed into the same tissue under different orientations, improves image quality, but decreases image repetition frequency.
4. Focusing causes inhomogeneous iso-pressure wave envelopes and thus a physical resolution that decreases typically from axial (sub-millimeter) to lateral to elevational (millimeter) wave propagation direction. It should be noted, that data discretization is finer than physical resolution in many devices.
5. For emit-receive focusing a constant wave propagation velocity must be assumed. Because wave propagation velocity depends on tissue properties (e.g. mass density, compressibility), this assumption represents real properties only poorly. Therefore, DAS is performed over phase-incoherent signals.

Obviously, SA focusing and DAS techniques can result in poor image contrast, high noise levels as well as in mis-placement, incomplete visualization and erroneous measures of target and structures at risk (e.g. vessels, nerves). These problems become relevant especially for small structures and hinder the usage of ultrasound guided interventions.

Dynamic image guidance: In the recent years, 2-D ultrasound imaging has been extended to volumetric 3-D techniques. Frame and volume rates > 10/sec are technically realizable and sufficient for most interventions. Because anatomical relations are spatial, from a visualization point-of-view, 3-D+t image acquisition techniques seem to be preferable. At present, transducers for 3-D+t imaging are bulky in most cases. Thus, in typically small transcutaneous access windows, instrument and transducer must be placed and restrain each other. In some cases, ultrasound guided interventions can become non-ergonomic. Smaller 2-D transducers would still be utilizable, but at the first glance spatial information gets lost.

4. Materials and Methods

Image reconstruction: A mathematical linear wave propagation forward model can be derived allowing for in-homogeneous tissue parameters (e.g. elasticity and mass density) [1]. It relates the amplitudes of emitted waves to the measured signals of received reflected waves. In plane wave imaging, several waves are transmitted under different angles into the same tissue. Combined with the associated receive waves, an - ill-posed – source (tissue parameters) problem can be solved to determine the tissue parameters [2]. For appropriate algorithms, this procedure not only improves geometric correctness of ultrasound images, but in addition yields two discrete material parameters instead of one B-mode image.

Dynamic image guidance: Spatial alignment of 2-D images is performed by trained physicists, e.g. radiologists, in clinical routine. Not only this observation encourages algorithmic approaches of plane-to-volume registration [3]. The term plane-to-volume registration underestimates the potential of such an approach, because it even allows to fit smooth, non-flat areas into a volume. Thus, it enables to handle registration of at least small tissue deformations that occur between intra-interventional 2-D imaging vs. pre-interventional volume imaging.

3. Discussion & Conclusion

At present, the computational time for the determination of tissue parameters is far from real-time demands (s. above: 10/sec). Additionally, the slice-to-volume registration is only feasible for small regions of interest, and a reliable initialization of registration must be available. This demands proper transducer todling skills of physicians. If the computational and algorithmic challenges can be met, 2-D ultrasound imaging is assumed to be a valuable tool for 3-D image guided interventions where transducer tracking is not feasible. It then avoids the usage of 3-D transducers, and smaller 2-D transducers can be employed instead. Additional advantages of 2-D transducers are their established clinical usage and typically their higher frame rates.

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Biography

Prof. Heinrich Martin Overhoff, Dr. habil. MD Dipl.-Ing, is professor for medical engineering at Westfälische Hochschule, Gelsenkirchen since 1999. He heads the Medical Engineering Laboratory, which has coordinated more than ten national and international research cooperation projects with industry and SME partners funded by among others DFG, BMBF and Landesregierung Nordrhein-Westfalen.

Vision for the future of Healthcare, 20 years along the line

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1. Introduction

Presently, our healthcare system are built on a "sick-care" approach, where a patient waits for the symptoms of a disease to appear and then the physician tries to do damage control. But technological breakthroughs are revolutionizing the way healthcare is being delivered. Modern technology is changing the organization and structure of the entire medical domain.

While robots and computers might probably never completely replace physicians and the healthcare staff, Artificial Intelligence paired with robotics is transforming the healthcare industry, improving outcomes, and changing the way doctors think about providing care. A patient centric system is being established and within the next 20 years, we will see the dawn of a new era. Healthcare would be largely data-driven, we would be able to predict diseases long before any symptoms appear, treat them with personalized medication, live longer and healthier, and healthcare would become more accessible.

2. Materials and Methods

Nearly every cell in the human body contains the operating instructions in the form of a complete set of DNA that influence everything from a person's eye color to vulnerability to a disease. Decoding this genetic data would enable us to create a more personalized healthcare system. In the coming few decades, genome sequencing costs will drop down equivalent to a cup of Starbucks coffee, and based on genomic information, Cancers and conditions like Alzheimer's will be largely preventable through very early intervention and sharing of effective treatment result data among doctors over cloud-based medical systems [1]. Pharmacies would quickly prepare medications tailored to perform specifically for a patient in treating an ailment or maintaining health.

To continuously monitor the condition of our body, nanobots would be deployed inside us. These untethered and wirelessly controlled/autonomous ingestible devices will make existing medical procedures less invasive and will enable us to perform tasks that were never before possible. With technological advancements, we can imagine nanobots capable of autonomously carrying out complex operations [2]. These robots could be administered into the body by a pill or be injected into the bloodstream and they could be used for

- Localized delivery of biological and chemical substances, as well as focused energy, as shown in Figure 1.
- Removal of unwanted materials from the body
- Transmitting information from a specific location, that would otherwise be difficult or impossible to obtain.

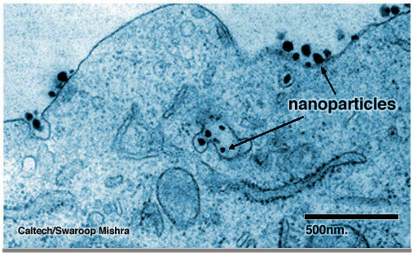

Figure 1: Nano scale robots developed at Caltech killing cancer cells.

The next decade is vital for us in understanding and controlling how stem cells behave. Within our lifetimes, stems cells could be used to repair and regenerate our organs and our body parts. Nanobots could be used to deploy stem cells at a particular location and they would be able repair for example, regenerate the heart muscles after a heart attack, which is the holy grail of cardiovascular stem cell therapy. Regenerative medicine also includes the possibility of growing tissues and organs in the labs, using the patient's own tissue or cells, and implanting them where the body is unable heal itself, would potentially solve the problem of the shortage of organs available for donation, and the problem of organ transplant rejection [3]. This organ replacement would contribute significantly, to the longevity of a person.

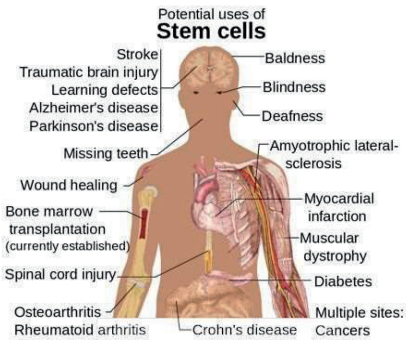

Figure 2: Potential uses of Stem cell therapy.

If we analyze the current method of developing vaccines, it's all about data and luck. Scientists begin with figuring out, what drugs can affect a virus, how effective is the drug, and for whom and then it's all hit and trial until they stumble upon a cure. Soon, cognitive artificial intelligence will help researchers rapidly process those huge data sets to come up with a cure more quickly.

Robotics and Artificial Intelligence will help us create bionic body parts which will not only be used by disabled people but by normal people as well, to enhance their body functionality for example super human strength and improved vision. Assistive robots will help us age better by helping us do our tasks independently, for longer.

Within the next few decades, we will witness one of the most exciting point in medical research, the preservation of a person's conscience. Either by uploading the conscience through a human-machine interface or through a complete head-transplant [4]. Either way, this would allow us to preserve the greatest minds, to help propel our technological advancements to greater heights.

3. Discussion & Conclusion

We are at a point in time when a lot of exciting research is being done that could create a paradigm shift in how healthcare is delivered.

But there are quite a few technical and ethical complications in realizing these research. We are currently at the stage when genome sequencing is slow, relatively expensive and we are unable to decipher the information in the genetic code. Moreover, it may also have ethical implications. Although genetic testing can potentially diagnose preventable diseases, it has potential downsides such as genetic discrimination, loss of anonymity, and psychological impacts such as discovery of non-paternity. We don't have the technology to make small enough motors to propel nanobots and we don't yet have the technology to let them move autonomously for prolonged use. Regenerative medicine is still in its rudimentary stages and we don't fully know how to control stems cells. Nevertheless, these above mentioned research suggest that future seems promising, but the real challenge is not only their efficacy but their affordability and accessibility to the masses. With newer research, we will have to develop new laws to use them safely and effectively.

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Biography

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Healthcare areas that will experience strong development

Lisa Klemm

1. Introduction

Nowadays, nearly all areas of life are directly or indirectly affected by the technical progress. As described by Moore's law, the complexity of integrated circuits doubles every year – so does memory capacity as well as computation speed. In this paper, the focus lies especially on the future vision of the healthcare system for the next 20 years. Which areas in the healthcare system will experience a strong development? Which tasks might disappear? Are there yet possibilities to realize it? This paper will give some possible answers to these questions.

2. Materials and Methods

People have modified life since thousands of years. Due to selective breeding, useful properties of animals and plants were enhanced. Some examples of these modifications are the different dog breeds, where the properties of the dogs were adapted to particular tasks, or even the different modifications of vegetables, to improve the taste or increase the storage life. These modifications could be accelerated with genetic engineering. Until recently, genetic engineering was very expensive, complex and took very long time. This was changed by a new technology called CRISPR [1]. The costs of genetic engineering have fallen by 99% and instead of one year, it takes now several weeks to perform experiments. With the CRISPR technology particular sequences in the DNA can be found and also be replaced. Already first human trials were performed in 2016 [2]. With this technology, an enormously high number of diseases can be treated, such as cancer, diabetes, age related diseases, HIV, and even obesity. For that reason, the tasks in the healthcare domain will change both the tasks of physicians and the technologies tremendously.

Neural networks are discussed very often in recent days. Due to the great interest in this issue and the high number of possible applications, the development of artificial intelligence will be very fast and the possibilities to use it in the healthcare domain will increase as well. This will lead primarily to a better data evaluation and therefore a stronger data acquisition concerning the whole human's life. With neural networks, it will be possible to connect a patient's habits (e.g. eating habits, physical activity and psychological health) in all kinds of variations that was never possible to evaluate before. Neural networks can include all the data and suggest possible diseases. The task of physicians therefore will change. When the program makes the decisions, the physicians are mainly needed to translate the results for the patient, explaining the consequences and being available for answering the patient's questions. Consequently, the education will additionally focus on more psychological, empathic and rhetorical issues.

When such a high amount of data can be evaluated and interpreted adequately, a more precise and permanent monitoring will be justified. With a so called "Lab-on-a-chip" medical check-ups will be done at home, while the results are sent directly over internet to a service center and the patient is only connected to a physician via internet for discussing the results. Because these chips can be delivered to the patient's home, the availability of healthcare increases especially in rural areas. Also, the evaluation period decreases and the test results are available within few hours. A more and more intuitive handling of technical devices makes it possible for elderly people to use the services.

Nevertheless, there is still a need for imaging or surgery devices that are too big and expensive to have them at home. For that reason, there will be few but great hospital-centers located in the major cities, where patients can be examined. The imaging resolution will increase further and the imaging methods will mix up to achieve better results. The surgeries will be more and more precise and therefore will be done partially by telerobots controlled by a surgeon and partially by fully-automated robots. With large training sets received by the telerobots and the ability to include more and more information, the fully-automated surgery robots will replace the surgeons and make less errors.

With the development of new materials, it will be possible to 3D-print whole organs or even whole extremities. Specific scanners will be able to determine the exact body structure and make it possible to copy patient's organs. Once every five years the whole body of a patient will be scanned, so that in case of diseases or accidents the damaged organs can be replaced without complications or long waiting time.

By means of permanent monitoring and easy 3D-printing there will be devices as present photo-printers in drugstores, that can print customized drugs for each individual patient, adapted to the patient's needs.

3. Discussion & Conclusion

One main problem in the future will be data safety and safe communication via the internet. A huge network will only be possible if the data storages cannot be hacked and the transmission of data is encrypted sufficiently. Therefore, a fast development in data safety is required as well.

The high degree of automation will have a serious impact on employment and education and will cost lots of jobs. This is only desirable if at the same time the society's wealth can be ensured. One way to manage a high degree of automation, unemployment and wealth is to establish a Universal Basic Income that will cover the basic needs of the residents. On the one hand this will ensure that the people will still be able to buy basic needs and also have time for things they really enjoy – this still can be work, but more in the sense of voluntary services. On the other hand, one can argue, that people will stop working entirely, also in hard jobs that still are needed, and this will lead to a huge chaos of unproductivity. Also, this could decrease the competition between companies, that could on the one hand counteract burnouts, but on the other hand slow down research and technical progress. All in all, further studies and research on this topic have to be commissioned to state a realistic prediction, if that is possible at all.

In conclusion, the healthcare system in 20 years will more and more be dominated by automation and artificial intelligence. The treatment will develop into a more specific direction, adapted to the needs of each individual patient. Most common diseases can be treated with gene engineering. Most of the medical care and surveillance will take place at home, increasing healthcare availability especially in rural areas. Smaller hospitals will vanish and be replaced by bigger hospitals and service centers in major cities, where the big and expensive imaging and surgery devices are located.

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Biography

Since she completed the Bachelor of Science in Mechatronics, Lisa Klemm is studying Medical Systems Engineering at the Otto-von-Guericke University of Magdeburg. She did an internship in Healthcare-Sector at Philips in Hamburg and could collect experience in different HiWi-Jobs.

Advancement in Healthcare System - Down the Line.

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1. Introduction

Healthcare systems today have to address a host of different challenges posed by medical and scientific advancement. Developments in the field of genetics, information technologies, and nanotechnology are enforcing a more individualized approach to healthcare – often outside the hospital setting, while we have already seen the rise of user-centric healthcare and increasing patient empowerment. Concepts such as 'the average patient' are now viewed as outdated. And standards within modern medical systems are measured by different parameters, including: patient access to the best-available treatments and to non-institutionalized care; compliance with treatments; and, even – patient choice.

For companies active in healthcare this is a highly volatile and rapidly changing environment to operate in, but only few have started thinking proactively about what the future might look like. Many are too constrained by their standing assumptions of how the industry has operated in the past, or they have a rather narrow perspective.

This paper will discuss many ambitious ideas about possible developments in the field of healthcare. These glimpses into the future of healthcare, provided by leading health, technology and innovation experts, project a fascinating new world that could become very real within the next few years.

2. Implications and possible future scenarios.

Shifting the health focus of the system can be a notable point in the future. It includes early identification and prevention.Access to new forms of care delivery to improve patient knowledge, self-help and health .Connection to benefits design to increase coverage for those services which prevent disease and improve health over long term. Reducing administrative and clinical waste can also be seen as a potential move for future development.

Satellite structure could also be a drastic change towards development. For this scenario to become true, a technologic leap by all public and private healthcare structures is required. It will consist of Satellite Hospital which will include remote hospitals where surgeries are carried out through technology such as remote patient monitoring and robotics. Then there will be main hospital where centralizing hospital activities such as research and academics will be carried out. Finally there will be Territorial Units which will be something like home care units and will assist patients at their homes through advanced technology.

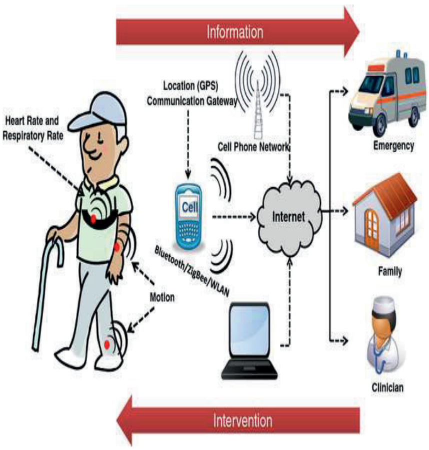

Figure 1: Typical architecture of wireless sensor network.

New technological applications for engaging, communicating with, and delivering care to patients will be "huge" over the next 20 years. As a result, providers will be able to serve more patients with existing resources. There will be more monitoring of chronic conditions through mobile apps, in which the patient provides information that feeds directly into our EHR system, which will be able to evaluate those data. If, say, a diabetic's glucose levels are within a predetermined range, the information is just recorded for future reference. If the glucose levels are problematic, both caregiver and patient will get a message saying 'We need to connect.' And, if something changes with a patient, we will be able to send her information that's relevant to the new stage of her disease. One telemonitoring development already proving its clinical efficacy is the depression automated remote monitoring system (D-ARMS), developed by the Los Angeles County Department of Health Services in partnership with the University of California. This is a phone system that makes multiple simultaneous outbound calls to patients at high risk for depression on both a scheduled and data-triggered basis and collects touchtone or spoken responses to recorded questions.

Remote monitoring can also be used to encourage healthcare staff to adopt best practices. One example is a wearable, electronic hand-hygiene prompter, which promises to slash healthcare-acquired infection rates and, with them, hospital length of stay and related costs. The technology tracks clinicians' hand washing and delivers a sound or vibration to prompt washing between patients, along with data reports that summarize compliance rates by location and department.

3. Discussion & Conclusion

However, most of the innovative ideas that he we hear or think have less to do with medical advances and more to do with improving how health care is accessed, provided, and paid for in a particular country. This makes sense. While medical science has advanced at rapid speed over the last 60-70 years, the cost of health care has spun out of control, the level of quality is inconsistent, and the patient experience is in need of repair. In other words, it's the way we deliver care that really needs a mammoth dose of innovation.

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Biography

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The future of health service delivery and access

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1. Introduction

Technology is improving every day and developing at a rapid rate. It is already a part of our lives and has also infiltrated the healthcare.

The benefits of technology in healthcare are multiple. Diseases can be localized by the help of medical imaging devices without necessarily harming the patients, surgeries are lifesaving and minimal invasive. Through internet people can get information about diseases and ways to prevent and get rid of them. The life expectancy is increasing [1].

However new innovations and technologies are still being introduced and this trend does not seem about to reverse. This paper discusses the possible up-coming innovations in healthcare products and services.

Some limitations and problems of current technologies are listed in the following section in order to have a vision of the possible breakthrough technologies. This reflection is based on own expectation and in some aspects on the actual need of the population in African countries.

2. Materials and Methods

The use of new technologies has some limitations. For instance, internet is a huge source of information. According to the Pew Internet and American Life Project, there has been a “sharp growth in the number of American doing key internet activities, such as health searches” [2]. They reported that, in 2004, 66% of a sample of more than 2000 American senior online searches healthcare information on the web [2].

People look up symptoms, treatments and medicines. But the overload of information results in a decline in quality of information, leading to inaccurate self-diagnostic. By trying to treat the symptoms with the inappropriate medicines, the worst case could happen.

Another technology uses in hospitals is the ultrasound scanner. It is used for imaging purpose of the internal body. Ultrasonography widely performed during pregnancy to confirm

fetal heartbeat und determine its sex. But common 2D-ultrasound images are white and black images, the poor resolution makes it hard for the future parents to decipher the image.

Regular check-ups are important; health problems can be found at an early stage and even before they start. But in general the clinics are overloaded, the waiting time is sometimes too long and the doctors are overstretched. On the other hand it is not likely to find people who would like to schedule an appointment with a physician every single week; even less if the next healthcare facility is far away.

3. Discussion & Conclusion

The up-coming healthcare products and services must be ease of integration and use. They must be safe for the patient and the environment. They must be available, affordable and acceptable.

To improve the quality of healthcare related online-information and services, a web platform or an automatic machine or an application could be developed by software-developers in close collaboration with physicians. It should be then certified by the state. These apps could be used as “online-clinics” where people could enter the symptoms they have and get as response a diagnostic. The application should ask further questions in order to find if other symptoms show up and prescribe drugs.

The accuracy of these “automatic diagnostic” must be high and could be adapted to region specific realities. In African countries where the costs of healthcare are high for the average citizen, these “online-clinic” could prescribe at first herbal remedies, which are easier to find, cheaper and safe.

The use of High Definition 3D-ultrasound scanners would help to determine with more accuracy the sex of the baby and earlier than it is possible with current technologies. Furthermore parents would no more make efforts to decipher the image and to recognize the anatomies of the baby.

Figure 1: A possible up-coming technology: An HD-3D-Ultrasound image of a baby [3].

At birth wearable smart watches could be worn for life, to continuously track the heart rate, the blood pressure, calories burned, perform skin screening and other health services, with the purpose to guide each person to a healthy life and furthermore to discharge the clinicians.

Finally there is worth to say that every solution could breed a new problem. There is a need to educate the public about the fact that these tools and technologies are help and could never replace a doctor or an expert. Furthermore everybody muss be aware that the human body can heal itself. Medication, surgeries and other healthcare services are not always necessarily.

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Biography:

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Affordable technology for improved healthcare using Tele-health application

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1. Introduction

The median estimate of the world's population is projected to reach 8.5 billion by 2030 [1]. However, the traditional health care would not support the population health and treatment of patients. Indeed, there are some key aspects to develop the global health care system. First of all, the ideas should be designed for preventing of devastating diseases such as cancers, ischemic heart diseases, diabetes, infections, and congenital diseases. Furthermore, every patient all around the world must have an opportunity to be provided with high quality care.

Personal Health Application would be a technology to improve the quality of health care dramatically. This technology has the potential to reduce the cost of health care and improve well-being in many ways. It can support continuous health monitoring at both the individual and population level, encourage healthy behaviors to prevent or reduce health problems, support chronic disease self-management, reduce the number of health care visits, and provide personalized and localized healthcare systems which patients can receive consistently high quality care wherever or whoever they are [2].

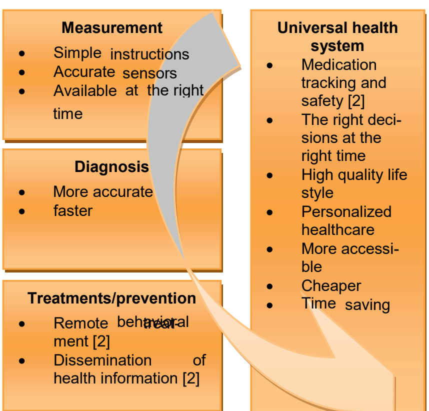

Figure 1: The advantages of personal health application in different steps.

2. Materials and Methods

This application would be designed such that the patient can explain her problem (by speaking or writing) and then by voice recognition and with the help of machine learning and artificial intelligence, the illness will be categorized. If the information for an accurate diagnosis is not enough, the patient should answer some questions or send a related image or even a bio-signal (figure 3). The small imaging devices such as mobile phone type ultrasound scanner and tiny x-ray emitter- which can be embedded in small and portable x-ray machine- will facilitate the procedure of diagnostic (figure 2).

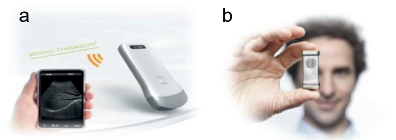

Figure 2: a) Mobile phone type ultrasound scanner, source: https://www.pinterest.com
b) Tiny x-ray emitter (Tribogenics), source: https://www.wired.com

Furthermore, people have an opportunity for a monthly checkup which consists of blood test, urine test, blood pressure and heart pulse rate. The monthly checkup prevents further diseases and also can suggest an instruction or a diet to reduce the risk of developing a disease. For example, the application uses the current blood glucose level, the amount of carbohydrates in a user's meal (derived from nutrition tables filled by user daily) and the intensity of physical activities (counting the pace and the amount of steps), and then compare the results with the similar situations and scenarios of the past as a suggestion for the person if there is any probability for the diabetes. Also, this application by using these parameters can suggest a patient specific insulin dosage plan for patients with diabetes [3].

In case of need for medicine, the patient can order the drugs by the application, and in emergency cases delivery will be done by quadcopter drone.

The application improves the life style by tracking persons' health. For instance, it can record the activity of the user (standing, walking, running, falling, etc.) and track the number of steps taken each day as a measure of the exercise level and active lifestyle of the user [3].

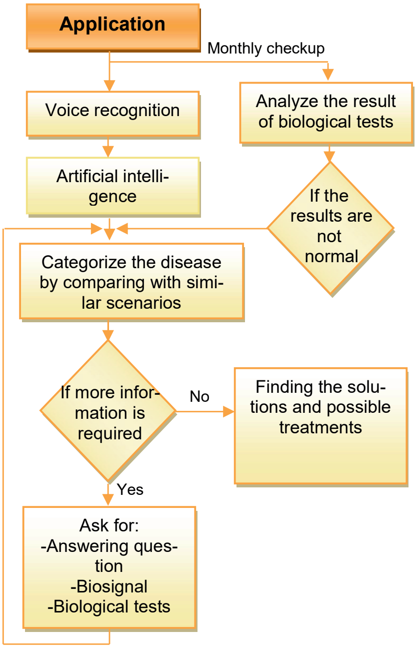

Figure 3: A part of application algorithm

The application can be installed in smart phones or tablets which are connectable to sensors to measure bio-signals and biological tests.

Besides, a small robot will complete the procedure of diagnostic and treatment. It has ability to help the handicapped patients and serves as companions for the elderly or psychological patients. The robot can be programmed in a way which by interaction with a person, realize the illness and find the solution to treat that, or even report the problem automatically to the related doctor.

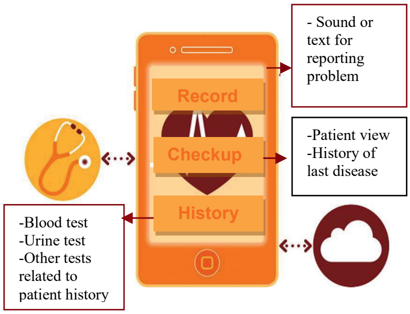

Figure 4: A view of health application
Source: https://www.kingsfund.org.uk

3. Discussion & Conclusion

Due to the dramatic growth in population and concentration of population in developing and underdeveloped countries, any innovation in health technology must have the potential within the global health care system. Telehealth application is an affordable technology, which has ability to improve the quality of health care and keep the patients out of high cost care. It not only has a tremendous effect on care and prevention of disease, it provides rehabilitation therapies for both psychological and physical patients. As well as, it is a way to shorten the procedure of diagnosis and treatment in comparing with the time required in traditional care.

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Biography

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Developments in Health Industry in the Future

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1. Introduction

Health industry has been undergoing revolutionary changes throughout the human history. The major research and developments in the world are related to health care industry. Health care industry has a significant role in the economy of a country.

In the past few years' healthcare industry has witnessed many drastic developments like increase of life expectancy, eradication of diseases like small pox, invention of many medicines and devices, transplantation of organs and so on. All these developments have helped the survival of humans to a great extent. For this reason, the developments and research in this field will continue to grow at a great pace and we will be able to see many major changes in the years to come

2. Materials and Methods

One of the changes that can occur in the future is the personalized health care approach. The medicines and the devices needed for the patient will be made only to suit a single individual. This can be seen particularly in case of implants. The implants will be made to suit just one person rather than having some standard sizes like we have now.

There may also be a revolution in the type of medicines that are produced. Instead of curing medicines that we have now, preventive medicines will be available.

The health care facilities available now in different countries differ from each other. There are chances that this situation will change in the future so that people all around the world get uniform treatment and facilities.

The use of robots in the medical field will be increased substantially in the years to come. They can be used in different areas like assisting the surgeons in surgery, helping nurses in shifting and taking care of patients. In the future there are chances that the role of doctors will reduce. The work to be done by them may be done by robots. Another chance is the use of sensors or devices which can monitor the vital signs of the individual and thus predict the likelihood of having a disease in future. Software's have to developed which accurately assess the signs and do the prediction.

The method used to teach medical students may undergo a change in the coming years. Instead of using cadavers, augmented reality and 3D models will be used which helps them to understand things in a better way.

The need for organ donors is increasing day by day. Many patients are waiting for a suitable donor so that they can get cured and lead a healthy life. This wait will be ended by implementing 3D printed organs which can be used as a substitute for human organs. (Fig 1)

Figure 1: 3D printed ear that shows both biological and electrical part

Another change that can be found in the future is curing disease at molecular level. Many diseases such as cancer are recurring even though proper treatments are done. If it can be treated at the molecular level, patients can get cured completely and thus diseases like cancer will no longer be a deadly disease.

Telemedicine is yet another area that will undergo drastic change in the coming years. With the advancement of telemedicine, there is a high chance that healthcare delivery will be moved from hospital to home. There is also a chance that new diseases will emerge in the coming future.

3. Discussion & Conclusion

With the advancement in different technologies, various entrepreneurial ideas will also come up in the future. There will be need of companies which produce 3D printed organs, pharmaceutical companies which produce new drugs, software developing companies which develop various softwares needed in various areas of healthcare.

The innovations found in medical field take a long time to be implemented. This is because before launching a product to be available for use on humans, thorough experiments and approval is needed. One thing that should be kept in mind is that the developments that are produced should be cost effective and affordable.

The changes mentioned above will be easily visible in the developed nations due to the inequality in healthcare access and delivery. This trend will be eliminated in the future by increasing global investment in medical research and development. Testing and standardization of medical products have to done faster so that new developments will reach those who are in need faster. Whatever be the case, the health care industry will totally be different in the future than what we see now.

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Biography

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HEALTHCARE DIGITISATION

Digital translation of processes, organization and businesses in future healthcare

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1. Introduction

The trend towards digitalization continues and brings new challenges. Today the clinical everyday life is already marked by huge amounts of data by collecting patient data, varying statistics, medication lists, treatment options, ordering systems and patient accounting systems.

In future, digitization will expand options for medical treatments, take over the organization and the management in the clinical all day, shorten development and certification processes for medical technologies and accelerate market launches. Faster processing power, increased networking and focusing on telemedicine systems make it possible- but it also prepares innovative future technologies. Special diagnoses make it possible to intervene premature and more specialized which, of course, also changes the treatment chains in their course. In addition, the organizational restructuring of the medical sector faces the digitization with new challenges.

The therefore included interdisciplinarity does not only demand technical solutions, but also solutions for process design, the service sector and demands flexible business models

2. From lifestyle- app to healthcare management system

Nowadays electronic monitoring systems (e.g. mobile apps) can already record the scope of movement, show the heartbeat and give nutrition information. In the near future these compact systems will give complex information for blood values (chemical values, blood gas, hormones and diabetes, enzymes, proteins, inflammatory values etc.) or monitor bio signals (ECG, EEG, EMG, ERG). The most common chronic diseases can be monitored based on these values [1] and will affect diseases and their progress.

In the field of prevention, this poses challenges for direct communication systems with appropriate data security and reliability. This also means that physicians and the treatment system have to be restructured. To act appropriately, quickly and reliably. A telemedical healthcare management system, however, ensures early detection and / or continuous monitoring, which enables early diagnosis and treatment and increases the treatment success.

Based on high computing performance the diagnosis in the future is supported by tumor profiling, CRISPR systems, DNA tests, protein biomarker analyzes or various applications of sensor technology [2]. This in turn requires more specialized therapeutic measures which are realized through the use of nanotechnologies, brain computer interfaces, robotics, hybrid imaging and monitoring systems.

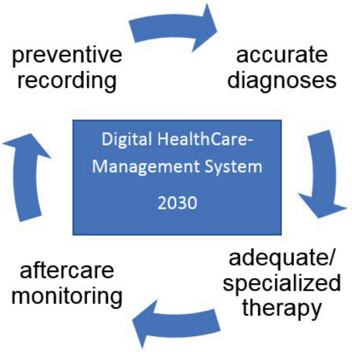

Fig.1: Networking of medical responsibilities into a digital system

However, more specialized measures/ solutions also lead to products becoming more individualized- and become obsolete faster and faster. Manufacturers who want to keep up, need versatile plants and products. In order to meet the requirements of digitization and networking, flexible and fast alignments are not only to be found on the technical side, but business models as well as services will take a new course.

3. Key factors for future success

In the future, the development is heading for the reduction of inpatient treatments, increased outsourcing of specialized clinical services (e.g. radiology), network providers with higher quality and efficiency as well as vertical integration between providers offering various services, from preventive fitness studios to acute- care and after- care solutions [3], as a whole healthcare management system.

Digital networking with the related telemedicine services and equipment is faced with various challenges. It is necessary to have:

- development / expansion of medical infrastructure
- close interlinking of products and services with far-reaching national, international and international standards
- interdisciplinary extensive ongoing research and development work involving biotechnology and information technology (for effective, non-redundant, simple and secure structured data management)
- comprehensive state regulation for the protection of patients, cost carriers and manufacturers
- national characteristics

4. Outlook

The technical development is exponential: it has accelerated from century to century, and will be even faster in the coming decades. The number of scientists, engineers and technicians worldwide continues to grow, they "produce" more and more knowledge, and so technical innovations are developed more and more rapidly.
In the future, Germany will face new social and economic changes, such as demographic change, increasing civilian diseases, and the lack of skilled workers [4,5]. Digitization is an important solution for improving the networking, effectivity of systems (accounting, organization, care, etc.) and for direct communication. Technical, economic and legal challenges must be solved. This means being prepared for the future development should already be based on computer-assisted and medical basic knowledge, management and moderation experience, additional business qualification and skills for project management and planning.

The task of the future will be to create efficient, user-friendly and comprehensively accepted electronic health services through the involvement of professionals and patients in strategy, design and implementation.
Direct communication through telemedicine systems, with a well-organized healthcare management system (the doctor is the manager); from prevention through diagnosis to therapy and aftercare; support by small, flexible online companies with adaptable business models, techniques and services will be the future in the healthcare systems 2030.

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Biography

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For the PhD program, he heads a university-based start-up laboratory for innovation generation and technical transfer of medical technologies in minimal invasive therapies with the aim of creating a network node between industry, medicine and university teaching.

Age as a chronic state? - Conditions, opportunities and solutions of our future medical world

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1. Introduction

Some say the world grows together, I think it will grow apart. According to the World Health Organization (WHO) 41 out of 135 countries did not have one computer tomography (CT) device per one million inhabitants in 2013 whereas first world countries like Austria on average had 28.5 devices [1]. Therefore when talking about a medical future, we may have to distinguish between diverse developments.

By 2050, the world's population is assumed to reach 9.1 billion which is mainly attributable to the population rise of developing countries. The relatively young average age will cause a high potential work force and therefore emerging markets will have a considerable growth potential. Because of the relatively low living standard, the difficult accessibility to healthcare and medical devices as well as the contribution of fast technological development, the main challenges for the medical device markets in developing countries might be the access to comprehensive and affordable medical applications and products.

Conversely, the demographical changes in the first world are on a completely different track. The analysis for future healthcare tendencies includes multifactorial dimensions like the demographic/ societal challenges, economy and technology prospects, research, education and innovation etc. [Figure 1]. Demographic predictions for Europe in example, state a decreasing population and a rise in average age. The continent will have more over 65-aged inhabitants than under 20-year olds. The age wave will have widespread sociopolitical impacts. The growing group of pensioners will be one of the most challenging facts as the current pension system which is based on contribution by younger inhabitants, will not be an up-to-date solution. Consequently, age will be treated as a chronic state and accordingly medicine has to find appropriate solutions for this condition.

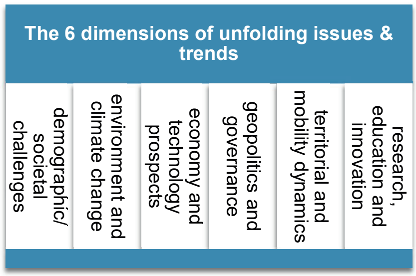

Figure 1: Contributing dimensions to future developments and tendencies. All of them should be taken into account when analyzing the future healthcare and medical technology market. (https://ec.europa.eu/research/social-sciences/pdf/policy_reviews/global-europe-2050-report_en.pdf)

2. Main Part

The medical trends which already tend to be affordable minimal technology, diagnostics which can be simply used at home and applications with the purpose of optimizing health conditions will lead innovations for medical technology. Prevention rather than treatment might become an important keyword for the future medical world. Therefore it will be of high interest to provide people with smart and wearable sensors or devices which could help to detect main causes of death faster and therefore prolong lifespan. According to the WHO, ischemic heart diseases and strokes accounted for approximately 15 million deaths worldwide in 2015 and for this reason are considered the two main causes of death [1]. As increasing age elevates the risk of contracting such serious medical conditions, a multi tool which measures several body parameters, monitors them and gives an instant feedback might be an innovative device. Important features of the multi tool could be to not only measure the vital parameters like body temperature and heart rate but detect specific antibodies or proteins by taking a blood sample. The main benefits of such a device would be the simple and handy use, inclusion of multi

factorial health parameters, instant monitoring and feedback as well as relief of medical doctors and staff. The instant feedback system could not only be based on a general algorithm approach for detecting abnormalities but the patient might be able to upload multiple data to a cloud and require personalized medical consultation. This solution yields the big advantage of further relieving medical doctors and shortening waiting times. All in all, this multi tool might increase effectiveness of medical procedures while lifting living standards and prolonging lifespan by providing personalized medical solutions.
Although prevention of diseases will be one of the biggest challenges in future medicine, other health trends have to be taken into account. Nowadays robotics has been already used to take over tasks during surgery and hence, artificial intelligence is known to be one of the most promising fields in the upcoming years. Nevertheless this healthcare trend has to be critically evaluated. As robots are only able to respond in a limited way based on a number of algorithms they might not note anatomical individualities and lastly, and importantly, it is hard to believe that a robot will at some point replace human empathy. It is more likely that robotics in medicine might be used as a guidance tool, to provide additional information or for medical training purposes [3]. Furthermore, one more promising, reliable inclusions of robots might be in the field of assistive and rehabilitation systems. Microprocessor-controlled prosthetics may be able to replace limbs by processing myoelectrical signals and reacting in an appropriate way [3]. Moreover exoskeletons may function as walking assistance which enables users of wheelchairs to stand, walk and climb stairs.

3. Discussion & Conclusion

The healthcare market is known to be one of the most emerging fields in the upcoming years. Though, so far only speculations can be made about future conditions and related to that, assumptions about possible issues and needs as well as opportunities for innovative healthcare systems. It is a fact, however, that first world countries will face a demographic shift towards a high amount of older population and a comparatively low number of under 20's. Age is likely to be considered a chronic state, the pensioners might be the most important customer group and tendencies of the medical market will accordingly adjust. Possibly the most aiming features of medical systems in the first world will be the improvement of living standard, the easing of life and the early prediction of diseases including efficient and time-consuming procedures which partly can be simply used from home. However, the here presented future developments in the field of medical technology are only a tiny glimpse of what will await us in the upcoming years.

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Biography

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Digital development in Healthcare

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1. Introduction

In fast developing countries like India which has a population of 1.2 billion, more people have access to mobile phones than toilets. The digital connectivity is expected to grow from 15% to 80% in 2034, with rural Internet users increasing by 58% annually [1]. Digital technology will be a key player and will clearly disrupt the healthcare sytem by changing the way of delivery of healthcare services. It is estimated that till 2030 the cost of compuatation, data storage and bandwidth will drop enormously roughly by a factor of 1000 and along with miniaturization of medical devices and more sophisticated wearables will transform the healthcare into a completely different model [3]. This new model will largely overcome the traditional diagnostic and service practices continued till now. Due to all these development, healthcare sector in India will be prime target for investment [1].

2. Materials and Methods

With significant advancement in technology, there is large access to data, these data can be harnessed to drive decesions.

New technological advancement in wearbles and mobile applications will enable digital health care providers to process information and data relative to patients. These data can in turn be used to enhance decision making and reduce the cost by pin pointing the problem and avoiding uneccessary procedures. These devices provide high quality measurement and monitoring features for people living in remote locations [1][2].

The potential of wearable technology is much beyond then just assisting the doctors. These can be in the form of smartwatches, smart clothing, wrist-bands etc. that monitors glucose levels, blood pressure, breathing rate, heart rate, ECG monitors or sense stress. Due to availability of these real time personal data, one can keep track of his own health and maintain good health. Patients suffering from chronic health conditions such as high blood pressure, cancer, arthritis, heart diseases or diabetes can use such devices for self-monitoring and improve their health. This technology will ease the communication between the doctors and their patients and will help them to take quicker and better decisions and on the other hand the number of visits to the clinic will reduce [3].

India has large amount of rural population. Therefore, remote diagnosing or telemedicine will play a crucial role. Also in many areas there is lack of infrastructure and healthcare facilities therefore, smart phones with innovative applications will be key. For example a wireless health monitor that measures blood pressure, oxygen saturation, pulse, body temperature, blood sugar, blood cholesterol and total haemoglobin count with a mobile application on your smartphone [1].

Digital and social connectivity is an upcoming trend in India as an average person spends 25% of his/her time on social networking sites. This platform will benefit both patients and doctors. It can be in the form of patient support communites or knowledge portals on patient side. Doctors can use this platform for sharing their knowledge and ask for help. It can help connect to other doctors around the world for second opinion or training purpose [1].

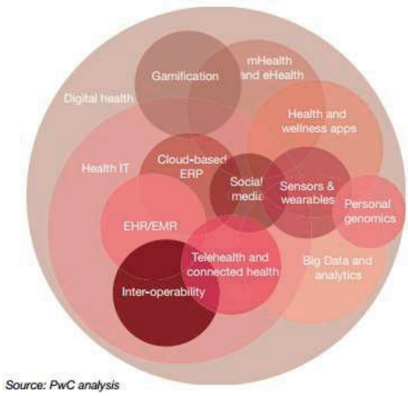

Fig. 1 Components of digital healthcare [1].

3. Discussion & Conclusion

Currently, the healthcare market in India faces a lot of challenges like rural inaccessablity, manpower shortage, inconsistent quality standards and an ageing population. There is a need of a major change therefore digital technology can prove to be a game changer [1].

During this transformation there will be a lot of challenges. Like regulatory issues and technological barriers. There are lot of complex backend operations in core technology that needs to be considered such as Electronic Medical Records (EMR) and its integration with other interfaces. Therefore, the whole technological implementation should not be underestimated. Service and efficiency is also a task in digital healthcare. Along with that people's willingness to adapt to new technologies is also a slight concern. Other basic challenges include Data security and privacy [3][4].

The main goals of digital health care system is to improve access, provide quality care, have better patient outcomes, increase patient engagement and enhance information flow.

In the future, the healthcare industry in India will become smarter to ensure better delivery of care and will be more personalized, faster and more accurate. With these opportunities , India is emerging as the global leader in digital Health [3].

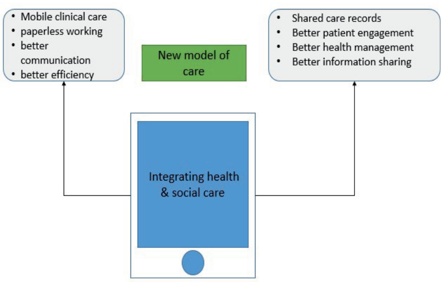

Fig 2. New model of care [4]

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Biography

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How will the healthcare system in 2037 deal with common diseases and related challenges?

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1. Introduction

In high-developed industrial countries, citizens as well as governments, spend high amounts of money for healthcare too keep the society healthy. Hence, healthcare is a fundamental part of most of the western societies. But this came with a fact: the average age of mortality rose steadily. This fact leads to new challenges for the society and the healthcare system since high age goes most of the time with high risk to develop certain diseases. This includes systemic vascular and neural diseases as well as cancer (see fig.1).

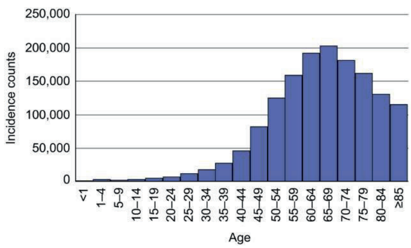

Figure 1: Invasive cancer development by age on the example of the United States of America [1].

Complete treatment and cure of these diseases can potentially be achieved through medical and technological developments, but not change the fact that people with high age need also a lot of care even without any disease, since rejuvenating the human body is still not in sight. Also the relation between old and young people is increasing which can lead to short-comes regarding medical and nursing staff. Thus it is crucial to develop conceptual solutions for the mentioned challenges to have the healthcare system and the society prepared. In the following section some distinguished potential challenges will be shortly introduced and ideas for solutions will be envisioned and discussed regarding:

- Treatment and handling of patients with a common disease on the example of diabetes
- Patient care with more patients and less medical personnel on the example of established medical doctors

How could these challenges be mastered in 2040? Are innovations in the healthcare sector the solution?

2. Materials and Methods

Two types of diabetes, diabetes type I and II, are known in medicine. Symptoms of the disease are mainly low insulin levels, leading to high blood pressure, neuropathy and peripheral artery disease and other resulting pathologies. Hence diabetes is a serious disease which should not be taken lightly but is not immediately life threatening. Nevertheless patients diagnosed with either of the mentioned types of diabetes needs special medical care. Since high life-expectancy will be maintained through the well-developed healthcare system the number of diabetes patients will potentially increase. Since there will not be enough medical and nursing staff available to care for each and every patient, solutions need to be developed.

Drones could deliver required pharmaceuticals to areas which are difficult to reach e.g. in rural areas. An automatized and autonomous (maybe robotical) injection unit could take care of patients which are not able properly inject insulin if needed.

But could the solution be one step before, meaning the prevention of the development of diabetes?

Since diabetes type II is developed with age and obesity, maybe the change of nutrition could be an option. This would include a special and personalized diet for people at risk of developing diabetes and could be controlled via telemedicine and smart phone apps.

Another major upcoming challenge was mentioned above already: The need for medical and nursing staff at the patient's side. Since there will most likely not be enough staff around in 2040, especially in rural areas, technical and social solution have to be found.

This problem could be addressed in two ways. One way could be a centralization of patients at risk.

Inspired by the principle of retirement homes, people with the same disease could be gathered at especially dedicated institution with accordingly trained medical and nursing staff to achieve an efficient care.

Another way could be the automatization of certain medical procedures. Patients could be scanned with dedicated scanners for physiological parameters which are, too a certain extent, already available through smartphone apps or computers with attached sensors or acquisition units (see figure 2).

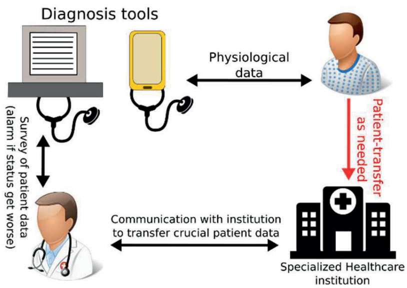

Figure 2: Tele-medical patient survey with subsequent transfer of the patient to an specialized institution, dedicated to the patient's pathology, if required.

Hence the number of patients occupying established doctors could be drastically decreased which could lead to a more efficient healthcare system since the number of patients with negligible pathologies would be minimized.

3. Discussion & Conclusion

The mentioned topics and envisioned solutions could be important for the society and the healthcare system in 2040. But does automatization and centralization really lead to a more healthy future? Since the western societies are growing older, prevention and social solutions should be considered.

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Biography

Alexander van Oepen, MSc, received his degree in medical engineering science from the University of Luebeck in 2014. He has worked in different fields of technology in medicine ranging from biomedical optics in diagnosis and treatments to ultrasound and nuclear imaging with focus on minimally invasive procedures. He is currently working at the INKA chair of Prof. Michael Friebe as research assistant on medical imaging technologies with focus on minimally invasive interventions at the Otto-von-Guericke University Magdeburg.

Developing Design in Clinical Settings (D2CS): The Future of Clinical Design and Development

Monali Shah B.S.; Biomedical Engineering (Student); **Jeremy Ackerman**, M.D., PhD, *FACEP*

1. Introduction

Aside from the shadowing and clinical observation privileges, clinical immersion programs offer a chance for community involvement. Few undergraduate programs take advantage of clinical settings to train their students. One current course taught at the Georgia Institute of Technology, Clinical Observation Design Experience, has a curriculum which offers a program that places undergraduate biomedical engineering students in the Emergency Department. This allows them an extended clinical immersion experience and to discover genuine problems. A second course that is required for graduating Biomedical Engineers at Georgia Institute of Technology, Capstone, focuses on problem solving and developing a finalized prototype to test. However, it is essential to bridge the gap between problem finding and problem solving. With a course focusing on understanding the fundamental problem, students can have ample time to find a genuine problem, understand the genuine problem, and refine their ideas with rapid prototyping prior to entering the Capstone course.

2. Materials and Methods

The Clinical Observation Design Experience (C.O.D.E.) course focuses on providing an immersive experience in an active clinical environment. This introduces observational design in an active clinical environment, broadening the understanding of engineering as it applies to clinical environments, and providing service to the hosting department (Emergency Medicine) by supporting their ongoing research and quality improvement. In the Emergency Department, students are often able to observe a broad range of procedures and diagnostic tests along with complete care of patients throughout a single observation period. The observation and immersion component of this course allows students to interact with various members of the community. Throughout their clinical shifts, students gather their observations, judgements, and insights regarding a specific problem [Figure 1, Figure 2]. Furthermore, they have the opportunity to gather data to support community research. Assisting in data collection helps the students gain comfort working in a clinical environment and in developing an understanding of the broader complexity of healthcare. Throughout this course, the students are presented with various methods on problem finding in a clinical department.

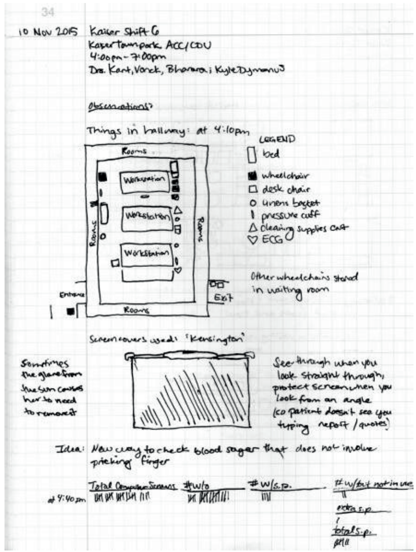

Figure 1: A student's notes regarding department layout, observations, judgements, and insights.

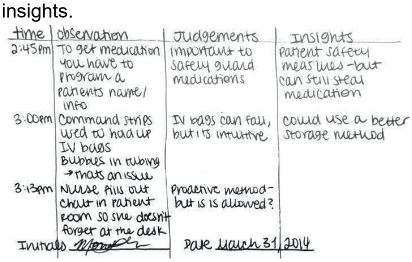

Figure 2: A student's notes regarding observations, judgements, and insights throughout their clinical shift

The Capstone design course allows students to identify user needs, define design inputs, generate concepts, perform patent and prior art search, and participate in prototype testing. The course's focus on creating or improving a specific device pushes the students to move through the product development phase in one semester, rushing them through the problem-solving process. Therefore, offering a course that focuses on understanding a fundamental problem would allow a bridge for the gap between problem finding and problem solving.

3. Discussion & Conclusion

By creating an extension of the C.O.D.E. course, Developing Design in Clinical Settings (D2CS), the gap between problem finding and problem solving can be fixed [Figure 3]. The course would be structured with three main components: finding a genuine problem, understanding the genuine problem, and refining the problem through rapid prototyping.

The Emergency Department of a hospital introduces students to a wide range of injuries including major trauma, severe sepsis, and cardiac and neurologic emergencies. However, D2CS would allow students immersion into a specialized clinical setting. The Neurology ICU/ Interventional Lab, Cardiac Cath Lab, and Combat Medics organization would allow students to develop on their observations, judgements, and insights. By surrounding themselves with personnel who specialize in the problem that the students are searching for, they can receive mentorship and guidance from experts in the field.

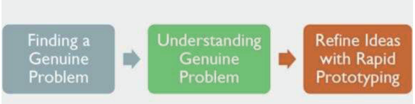

Figure 3: The structure of Developing Design in Clinical Settings (D2CS).

The students would then move on to understand the genuine problem. With weekly lectures and multiple team-based meetings per week, the students have ample time to discuss and learn more about their topic of interest regarding their problem. With clinical mentorship from the department staff, the students can fully understand the problem.

Finally, the students will participate in a rapid prototyping process, where they can refine their ideas with significant input. The rapid prototyping would consist of minimal investment of material and time, and can receive feedback from the specialized department physicians and staff. Students can successfully communicate the problem by attending a storytelling workshop that provides advice on pitching a product. Furthermore, the prototype will be continued into the Capstone course for further development after the semester.

There are many components of the course that need to be addressed. First, identifying hospital departments to focus on in the course is essential. Within the specific departments, it is also important to have physicians or other healthcare staff who are willing to mentor the students. Moreover, the course would not be possible without students having access to the clinical environment. Therefore, it is essential that the funding is secured for badging and background checks for the students.

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Biography

Monali Shah is a 4^{th} year undergraduate student at Georgia Institute of Technology. With her major in Biomedical Engineering and minor in French, she has participated in various activities across campus that integrate her passion for her major with her drive for community service. She currently serves as the Director of Repair Sessions for Engineering World Health, the Chair of BME Student Advisory Board, and was selected as a University Innovation Fellow. Moreover, she is representing Georgia Tech for the Coulter College Competition this fall. She has served as Dr. Ackerman's Teacher's Assistant for the C.O.D.E. course and is currently pursuing an independent study with him to create an extension course (D2CS).

Dr. Jeremy Ackerman is an assistant professor and clinician researcher in the Emory School of Medicine Department of Emergency Medicine and an associate professor/program faculty in the Coulter Department of Biomedical Engineering. His research focuses on medical applications for new and emerging technologies. He is particularly interested in developing medical applications for new and emerging technologies and in the use of simulation in training of residents and medical students. He currently teaches for the BioID Masters Program at Georgia Tech along with the Emory University School of Medicine Residency program. He has been a speaker at BME-IDEA in the past and looks forward to attending again.

EXPONENTIAL TECHNOLOGIES

The Promise of Machine Learning in Medical Imaging

Georg Langs[1,2]

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1. Introduction

In clinical routine, we acquire a tremendous amount of complex imaging data such as computed tomography, or magnetic resonance imaging capturing characteristics ranging from structure, or function, to metabolism on a daily basis guiding individual prevention and treatment. While each of these data are already a central part of patient care, together they hold information covering a wide variety of disease- and treatment courses critical for research into disease mechanisms, and treatment possibilities.

Medical imaging and the computational analysis of the increasing amounts of data are bound to fundamentally change our ability to understand disease, risk, and treatment. They will serve as basis for the development and implementation of novel treatment strategies, and the effective and early delivery of care and prevention.

Linking research in machine learning and medicine will act as powerful driver in this endeavor. It is a key to create better models for predicting disease course and risk in individual patients, and to forecast response to a growing landscape of possible treatments, to deliver early prevention, and to make optimal care for each individual possible.

2. A Vision for 10 Years From Now

Many view automation as the prime capacity of machine learning algorithms in medical imaging, and ask *“Will it take over tasks currently carried out by experts?”* This might be the wrong question, since a more powerful potential is the discovery of new, yet unknown relationships in complex observations, and their reliable quantification. The more important question is: *“Can machine learning help us to improve individual care by discovering new markers, and rendering them useful?”*

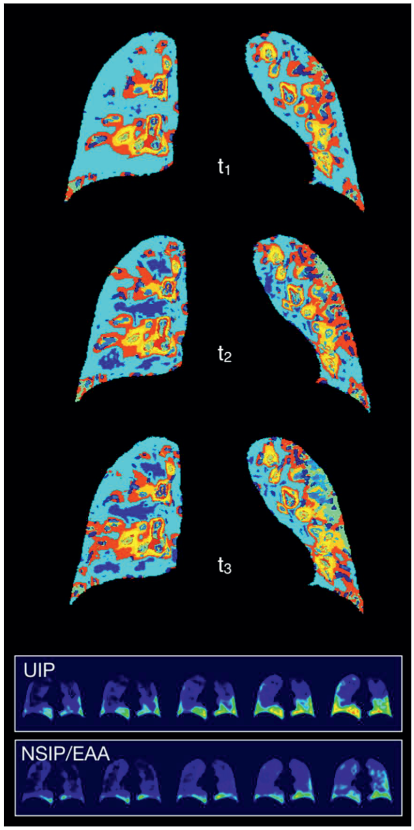

Figure 1: Patterns in the lung discovered by unsupervised machine learning. They are basis for aligning disease paths across a population, for modelling disease progression in the lung, and for early classification of disease based on imaging data [1].

Ultimately, machine learning will empower medical experts in several ways:

We will likely have powerful computational models that enable a more accurate prediction of individual disease course, and forecast response to treatment from observations such as imaging data, and disease history.

These models will enable selecting personalized treatment strategies more effectively based on assessing each patient in light of an unprecedented scale of evidence from thousands of disease and treatment histories, and models that translate these observations to accurate prognosis.

As we become able to detect and quantify complex but subtle patterns in observations earlier, diagnostic categories might change. Through grasping the link of distributed signatures to prognosis, we will discover novel disease- and response phenotypes [2], which in turn will contribute to research for novel treatments.

3. Challenges and merging Research Communities

We will have to overcome a number of challenges on the way. The research communities advancing machine learning and medical disciplines such as radiology have to collaborate closely, learning to trigger algorithmic methodology by clinical questions, and to ask new clinical questions whose tackling is rendered possible by computational algorithms. We will need to find methods dealing with heterogeneous multi-modal data, and means for their efficient and possibly automated curation. Algorithms will have to identify prognostic feature patterns in complex imaging data, and robust models will need to be able to predict, simulate, and assess the certainty of their output at the same time.

While these challenges are significant, an increasingly joint effort of researchers across varying fields renders their solution plausible, and the future of medical imaging might change more rapidly than we expect right now.

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Biography

Prof. Georg Langs, PhD is Associate Professor at Medical University of Vienna, Department of Biomedical Imaging and Image-guided Therapy, directing the Computational Imaging Research Laboratory. He is co-founder and Chief Scientist at contextflow GmbH. He was post doctoral associate at the Applied Mathematics Laboratory at Ecole Centrale de Paris, and research scientist at Computer Science and Artificial Intelligence Lab, at MIT, where he still holds a research affiliate position. His research focuses on machine learning methodology in the context of medical imaging, predictive models, and computational neuroscience. www.cir.meduniwien.ac.at/langs

Everyday Healthcare Monitoring through genetic analysis, artificial intelligence and constant monitoring tools

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1. Introduction

Many advancements are in store for the healthcare systems of the future; however, following current trends is a poor way to extrapolate them. The exponential growth of technologies that influence the healthcare system would lead to better diagnostic tests and more decisive cures for our health problems. Urine tests will soon be able to detect cancer. Smartphone apps could diagnose STIs. Chatbots could provide quality mental healthcare [1]. Nevertheless, the focal point of future breakthroughs will be the prevention of diseases using technologies such as genetic analysis, artificial intelligence, and constant monitoring tools available in everyday devices.

2. Exponential Technologies

Exponential growth means that technology will advance more in the next two decades than it has in the previous two millennia. Digitalization; virtual Reality; cognitive and quantum computing, including artificial Intelligence and deep Learning; and additive manufacturing (3D printing) are all examples of exponential technologies, i.e., technologies that are progressing at an ever-increasing rate. 3D printing combined with huge advances in materials science, is a game changer in medicine. More and more customized body parts will be printable. In addition, A.I. will play a very big role in diagnosing illness in very early stages or even before it occurs. Digitalization will transform the shape of medicine, minimizing iatrogenic errors and all but eradicating the subjective approach to medicine currently observed in our doctor-centered healthcare systems.

3. Vision of the Future

In the future of medicine, it can be imagined that each person would have a large database containing the information about their DNA, genes, and even complete 3D structure of their bones. This database would be useful in predicting the risk factors the patient may be subject to and his/her liability towards various medical conditions. The complete anatomical information of a person's bone structure would provide information for the times when there is the need to 3D print a replica of their bone for grafting.

Another innovation that is coming up in the near future is the integration of electronics within live tissues. Each person could have a neural probe implanted in their brain which would monitor brain activity. This device would supplant fMRI and EEGs for detecting irregularities in brain function. Even as of today, very thin neural probes have been developed that do not interfere with brain function at all. This, combined with artificial intelligence, means that the system would detect problems before the person senses them.

Also as part of personal accessories, mirrors could be equipped with image processing capabilities and artificial intelligence, to find out if anything is wrong based simply on facial expressions and features.

Cell phones would have capabilities of voice recognition, diagnosing possible medical problems based on voice, intonation, and patterns of speech. The German company, Audioprofiling is using voice analysis to diagnose ADHD in children, achieving a sensitivity of more than 90 percent in identifying previously diagnosed kids based on their speech alone [2].

Another case in point is the Parkinson's Voice Initiative, which is changing the costly in-clinic analysis by analyzing 30-second voice recordings with machine learning software, achieving 98.6 percent accuracy in detecting whether or not a participant suffers from the disease [3].

Another possibility is a fully automated clinic in each residential area, in case of less serious illnesses. The patients would enter the clinic and their conditions diagnosed and added to their medical profiles. Customized drugs, tailored specifically to each patient's needs, would be produced on site with 3D printers. In addition, injections could also be prescribed in this automated way.

We have to bear in mind that it is still impossible to predict all the possibilities that could result from the exponential growth of all the fields affecting the health care system.

4. Entrepreneurial Opportunities

Meanwhile, it is also worthy to reflect on what opportunities lie ahead for entrepreneurs and investors. There is much more work for entrepreneurs to do in the following decades than any other time. It is a golden age for entrepreneurship, where the declining cost of technology means more entrepreneurs than ever before have the tools to build new companies; all the ingredients for a startup revolution in health care are ready now. Healthcare startups have boomed over the last several years, as evidenced by the number of venture funding deals, which grew some 200% between 2010 and 2014 [4]. The boom is driven by health reforms that are changing the landscape of business models, an aging population that's demanding more (and better) care, and the adoption of technology — such as wearables and video chat — into the medical mainstream.

Although, there are several universal laws and regulations that govern the patenting, testing, safety, efficacy, and marketing of healthcare-related products, there still are big opportunities for entrepreneurs in the digitalized world of medicine.

5. Conclusion

The immense pool of possibilities imaginable about the future of healthcare systems is outright dazzling. Some of these innovations seem right around the corner for us while for others, we may seem quite far off. Nevertheless, we can also be sure that there will be new things in our healthcare system that we cannot even imagine. Importantly, we must not get carried away with this unstoppable march of science and technology. Humankind's booming knowledge has posed ethical questions which have concerned the very fabric of his nature. More advanced technologies would only pose questions that are even more difficult. Therefore, we must be able to keep this explosion of information in check and we must make sure that our ability to resolve these ethical concerns grows at the same pace. This, however, must not stop us from getting excited about the endless possibilities the future holds as it promises faster, error-free, cheaper, more accessible, and most importantly, better delivery of care.

References

Biography

Maryam Sadeghi is a Master student in Medical Systems Engineering at Otto-von-Guericke-University, Magdeburg, Germany. She has a Bachelor of Electrical Engineering from Tabriz University, Iran. She has worked in the field of Artificial Neural Networks as the Bachelor thesis. She was the CEO of a R&D company in 3d printing and rapid prototyping. She is working in the field of Image processing in Medicine.

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Towards a Remote Surgeon-Patient Infrastructure: The Future Role of Robots and Teleoperation in Medicine

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1. Introduction

Our technological developments are at this time exponential in their growth; one research field that is certainly no exception is medicine. From the knife to the needle, and to nothing, we will witness changes in interventional medicine in the coming centuries that many once thought were impossible [1]. Medical imaging and surgical robotics are both quickly evolving. Out of the collision of these two, we will see technology emerge that may change how surgical operations are performed and will one day question the hospital infrastructure itself. In the next 20-30 years, we may see a shift towards a more remote approach in surgery that could help operations be performed less invasively, by the greatest surgeons, and with the best tools.

2. Materials and Methods

Remote telesurgery has always been a strong motivator for the introduction of surgical robots. The ability to deliver surgery over long distances gives rise to more availability for surgery and improved surgery outcomes. In teleoperation, the surgeon will still be the quintessential part of the system, but will implement his skill at a distance utilizing digital communication. There are a variety of situations where this could be beneficial. For example, one surgeon could serve in several thick combat zones at once offering his expertise through deployed robot systems increasing his safety and convenience. Even more, care could reach destinations where it previously could not; many lives would be saved, and the best surgeons could be utilized more often.

This technology may be substantially closer than most may think. Consider the da Vinci system in Figure 1. Hundreds of thousands of procedures are performed with this technology every year. All of these surgeries are indeed teleoperations of the robot system, though performed only over several meters. However, some surgeons have already started transition to a long distance infrastructure with this system [2], and it has been proven that the da Vinci system could be operated at distances as far as 4000 km from the operating room [3].

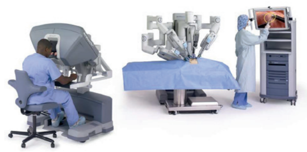

Figure 1: The da Vinci system: the state of the art in robot tele-surgery [2].

While teleoperation of the da Vinci system is promising for the procedures is can do, its safety and level of invasiveness is still limited by the size and rigidity of its manipulators. Researchers are currently working to amend such tele-surgical systems with the inclusion of continuum manipulators. These thin, flexible manipulators may one day replace their rigid counterparts. In Figure 2, one type of continuum manipulator is shown that may eventually rival the da Vinci system in prevalence.

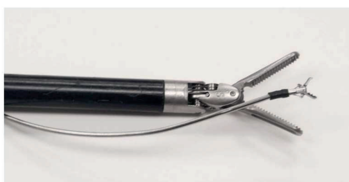

Figure 2: A needle-diameter concentric tube robot as compared with the da Vinci manipulator [3].

The effectiveness of such manipulators has been proven for many surgical applications, and the prospect of long-distance teleoperation has been explored and subsequently confirmed [6]. Continuum manipulators are attractive for many reasons in surgical robotics. They are minimally invasive due to their inherently thin nature, and they are flexible allowing them to achieve complex geometries that may arise inside human anatomy. The tools and surgical skills necessary for tele-surgery have arrived save for a few years of optimization.

3. Discussion & Conclusion

The course of surgical progress has been set by hardware advancement in the area of continuum robots and medical imaging. Naturally, current surgery and hospital infrastructure will soon be pressured to adapt to these changes to suit the needs of patients who may not have access to skilled clinicians in their area. In a large, remote surgery center, all of the most skilled surgeons could collaborate together in operations. A surgeon would arrive potentially thousands of miles from the surgery site, analyze 3D, segmented images of a patient, and prepare for the surgery mentally. At a surgeon console, perhaps similar to the current da Vinci console, the surgeon would have all of the tools and information required for the procedure. Small, thin tools would be used in the patient mimicking the motion of the surgeon many miles away to perform the operation. When the surgeon's job is done, he could immediately move on to the next case. As for the patient, he would arrive at the surgery site and would be cared for by more widely available clinicians and nurses; the entirety of surgery would be carried out through a robot communicating via wire or wirelessly. Cost of surgery could dramatically decrease when a surgeon is not required to actually be present.

Much of time in an operating room is spent performing repetitive tasks which could be sourced to different surgeons. After the removal of tumorous tissue, the job could be handed to a suturing expert for example. In a given procedure, many different surgeons could work on a given patient each offering their own area of expertise. To add to this, the surgeons would not lose time in waiting for others' jobs to be carried out. Each surgeon would have a designated schedule and could be constantly preparing for surgeries and switching patients.

Risk of infection has always been an issue in surgery. In the above scenario, surgeons would never even need to sterilize their hands! With all of these perceived benefits, it seems now that this shift may be inevitable as the future benefits by far outweigh the costs.

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Biography

James M. Ferguson received the B.S. degree in mechanical engineering from The University of Tennessee, Knoxville, TN, USA in 2016. He is currently working towards his Ph.D. degree in mechanical engineering in the Medical Engineering & Discovery Laboratory at Vanderbilt University, Nashville, TN, USA. His current research interests include medical robotics and continuum robotics.

Prevention, robotics and big data analysis: the biggest trends of the future healthcare

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1. Introduction

It's a great time to be alive. There's no doubt about that. The likelihood of dying premature or violently has never been lower in the developed world. On average we are better educated than ever and poverty has been constantly decreasing [1]. On the same pace, healthcare has been improving, bringing life expectance to almost double over the course of only one century. So, what can we expect from the next future in the healthcare field and what implications will that have?

2. Diagnosis

Why should we wait for a long time for a specialized visit? It will probably take more than 10 years, but the diagnosis could be easily be done by a computer program, even at home. The patient would only need to answer a series of questions, asked by the computer. Where the physical interaction between patient and doctor is required, the doctor will be still needed (at first). This change will have multiple effects: first, the doctors will not be needed as much, therefore the expenditure for the entire healthcare system will decrease. Patients will have access to a quicker diagnosis and, along with an increase of prevention policies, the patients will less likely suffer of advantaged stage diseases.

3. Medical Records

Medical records online, also available outside national borders, will soon become reality. The doctor will easily have a clearer picture of the patient's medical history, leading to a better treatment of the patient.

4. Surgeries

There will be a big push in the use of robotics and minimal invasive surgeries. The actual main problems that slow down the use of robotics are initial costs and lack of tactile feedback. As a matter of costs for these machines, an increase of competitiveness in the market is expected in the next 20 years.

Intuitive Surgical, with his DaVinci Surgical System, is the only company that has provided the market with a similar system. This has been detrimental for the growth of this technology. However, many of Intuitive surgical early patents were filed 20 years ago and therefore more companies will join the market and challenge Intuitive Surgical supremacy. Verb Surgical is an example. Verb surgical has been created by the partnership of Google and Johnson&Johnsons. The financial backup of this company makes us sure to see some exiting things entering the market in the next years. A higher competitive market will take care of all the current major problems: costs and lack of tactile feedback.

Robots will be guided remotely by highly specialized surgeons that could operate the patient from the other side of the Earth. In the next one hundred years we can expect robots performing basic procedures by themselves.

5. Hospitals

Big hospitals, especially in the developed world, will become even bigger and able to cure, with all the necessary equipment, all the types of diseases of every department.

Small general hospitals without a specialization will disappear.

6. Prevention

Fig. 1 - Proteus Digital Health Feedback System-The system consists of ingestible sensors embedded in tablets, a skin-worn receiver patch and a mobile device based user interface. [2]

The healthcare expense of developed countries will drive towards prevention. This will enable everyone to quickly check the most important blood values directly in the phone. Hafezi et al. [2], with their ingestible, inexpensive sensor, already showed that it could be possible.

The values given by the sensors inside our body will be combined with the information we obtain from the genetic tests, which will give an overall value (visualized on a smarthphone) of the risk of developing a certain tumor, leading us to seek a specialized check up more often. This will lead, along with better and faster diagnosis, to a decrease of the number of people affected by advantaged stage diseases.

7. Government control of the personal lifestyle and health information

Information coming from the patient's genetic and from the patient's lifestyle could be also monitored by the National Healthcare Service in order to apply less taxes on the individuals that follow a healthier lifestyle. This system will not only reward citizens with a healthier lifestyle but also provide the scientific world with much more data which will be analyzed by big data analysis algorithms for various purposes. This will not take place in the next few year, but could be a direction governments could follow.

The importance of privacy however will likely slow down this trend. This topic, however, will surely be in the center of major political debates.

8. Costs

The costs of healthcare will surely increase due to the aging and increase of population.

9. Emergency Interventions

Due to the fact that prevention will have a major role in the upcoming years, emergency interventions will decrease. Robots will substitute the human in the most dangerous and repetitive works, that will contribute even greater to the decrease of accidents (car or job related accidents).

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Biography

Marco Ferrari is currently a master student at the Otto von Guericke University. Former student at the Politecnico di Milano, Marco has decided to expand his knowledge in the medical field related to interventions and he's currently working on a project that involves the use of microcontrollers for educational purposes.

More in general, Marco is interested in the electronics and sensors and how this technology could revolutionize the healthcare market.

FUTURE OF ARTIFICIAL INTELLIGENCE BASED PRECISION MEDICINE IN HEALTHCARE - 2030

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1. Introduction

This paper explores the potential of Artificial Intelligence (AI) and precision medicine in varies healthcare sectors that could revolutionize future Healthcare System. Precision medicine (PM) is a medical model that focusses on the customization of medical treatment tailored to the individual patient for those who will benefit, sparing expense and side effects for those who will not. Precision Medicine's targeted, customised approach to health care has a widespread impact on everything from genomics to medical devices, and as a result it is creating new opportunities for startups across the sector.When it comes to the future of diagnosing and treating cancer and chronic diseases, computers– not humans could hold the key to delivering the best quality precision medicine and increases the product pipeline and speed-to-market for healthcare companies, as well as the ability to quickly eliminate development paths unlikely to work out

2. AI and Medical Record Management

Medicine is an oral science.Patient talk to doctors about their problems. Doctors listen and ask questions. Good communication between doctors, nurses and all sorts of experts helps to solve the patient's problems and improve their health care.

The electronic medical record has killed the oral science.Electronic Medical Records are a source of huge frustration because of the excessive amount of physician time involved in data entry, time that could be spent with patients.

Computer Programs like Apple's Siri and supercomputers like IBM's Watson and their relatives could solve this. Doctor can use Siri to retrieve patient records and also Siri can update the records. So, Medical staff would never have to waste precious time looking through screens for information and improves the accuracy of medical diagnosis.

Companies like Google-stablemate DeepMind is working to improve medical diagnoses with machine learning tools. AI Medical Record Management system provides good opportunity for startups to create seamless, efficient user-friendly AI medical Record system.

3. Assisting repetitive jobs

Most of the repetitive jobs in healthcare will be replaced by AI systems.Algorithm called Medical Sieve (IBM) is a next generation “cognitive assistant” with analytical, reasoning capabilities and a wide range of clinical knowledge. Medical Sieve is qualified to assist in clinical decision making in radiology and cardiology. Radiologists in the future should only look at the most complicated cases where human supervision is useful.

Technology start-ups are taking aim at the examination room to make diagnoses based on images.

Israeli start-up, Zebra Medical Vision, reckons it can create a ‘bionic radiologist’ using the advancements in computer vision and AI that previous computer-aided detection companies didn't have at hand.

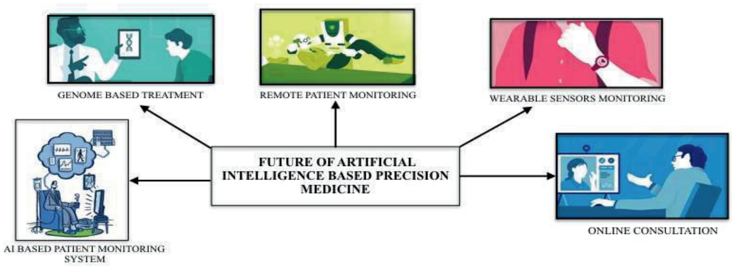
4. Common Blood screening Test

Diseases like cancer can be cured effectively when it is diagnosed early. But, still most of the cancer diseases are diagnosed only after the appearance of symptoms which reduces the chances of treatment's success. In Future, a single blood test can give whole information the patient's health history, and paves the way for efficient treatment management. Rapid development in AI, Gene mapping and bioinformatics can help this hugely. There are many opportunities for bioinformatics startups by applying AI and machine learning to genetics and analysing disease causing genes.

Startup called “grail” has been working for early detection of cancer by analysing cancer genomics using blood screening technique.

There are umpteen of Startups currently working in gene sequencing to find the cancer causing genes of various cancer diseases.

Figure: Future of AI based Healthcare Technologies.



5. Future of Cancer Treatment

Cancer is a disease of the genome. Cancer genomics aims to advance personalized medicine through the DNA sequencing and analysis of patient tumors to find new genetic alterations associated with specific cancers. Providing researchers with comprehensive catalogs of the key genomic changes in many major types and subtypes of cancer will support advances in developing more effective ways to diagnose, treat and prevent cancer. Genomic information has already helped to shape the development and use of some of the newest cancer treatments.

Already a researchers in Columbia university have created a first user-friendly computational tool to integrate whole genome-based approach to identify individual cancer driver genes and selecting appropriate treatment options.

6. Health Assistance Application

Home is where much of the medical care takes place and it is no longer confined to clinics and hospital.The ubiquity of Digital communication will make the virtual doctor-patient visits and deliver the care to the patient in their home. This system also gives the doctor more time to spend on trauma and emergency care.

Online medical consultation and health service, Babylon has already launched an application which offers medical AI consultation based on personal medical history and common medical knowledge. Users report the symptoms of their illness to the app. After taking into account the patient's history and circumstances, Babylon offers an appropriate course of action.The app will also remind patients to take their medication, and follow up to find out how they're feeling. Through such

Solutions the efficiency of diagnosing patients can increases, while the waiting time in front of doctor's examining rooms could drop significantly. The World's first virtual nurse, Molly developed by the medical start-up Sense.ly. The interface uses machine learning to support patients with chronic conditions in-between doctor's visits. Sentrian, a startup analyzes biosensor data using AI and sends patient-specific alerts to clinicians.

7. Conclusion

From the above information, it is clear that AI and precision medicine will transform healthcare system and also the opportunities for startups raised in various healthcare sectors. Obviously, Preparations should be taken to avoid the pitfalls of the utilization of AI like, establishing strong ethical standards for AI, Acquiring some basic knowledge by medical professional about working of AI in medical settings in order to understand how it helps them in their everyday job and companies should take necessary steps towards offering affordable AI-solutions. If we succeed this, huge medical discoveries and treatment breakthroughs will dominate the news not from time to time, but several times a day.

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Biography

Ms Jayashri Masilamani has been doing Masters in Medical Systems Engineering at OVGU University in Magdeburg. She is from India. She has graduated from Anna University with Bachelor's degree in Biomedical Engineering. Her research interests lie in the area of signal processing and machine learning.

3D-printable science

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1. Introduction

3D printing currently plays a major role in a fourth industrial revolution by lowering previously prohibitive costs of early prototyping and individualized production.

There is potential for a similarly transformative impact of 3D printing on scientific research, lending tangibility to innovative ideas and empowering creation. By mid-century, 3D printing will have influenced every aspect of life-science research, from discovery and communication to teaching and commercialization.

2. 3D printing for science applications

3D printing is a term for manufacturing techniques by means of which materials are deposited in individual layers to form three-dimensional objects. These techniques were originally limited to prototyping, but have found new applications thanks to materials allowing high production quality and functional parts [1]. Readily used in industrial applications e.g. by Siemens [2] and General Electric [3], 3D printing shortens the time to market and reduces prototyping cost.

Traditional manufacturing methods such as casting are governed by economies of scale, i.e. the cost per part decreases to an economically viable level when a series of hundreds or thousands of parts is produced and the cost for up-front tool production can thus be distributed over the entire series. In contrast, 3D printing is characterized by economies of one, where mass production is not a requirement [4]. From a production perspective, it becomes economically viable to produce one-off, custom creations for niche applications in science.

3D printing is already advancing healthcare [5], and applications have the potential to spill over to the research 'back end' where the basis of innovation lies. Here, 3D printing can be used for individual experimental equipment, teaching resources and prototypes for spin-off products. Time and cost savings are available for research labs that make their own equipment [6][7]. Two examples of co-development projects by scientists and a product designer are shown in Figure 1.

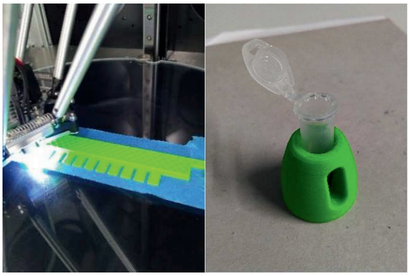

Figure 1: Custom placeholders for gel electrophoresis being manufactured on a 3D printer (left), custom stand for Eppendorf tubes (right).

3. Discussion of future trends in 3D printing

A more widespread adoption of 3D printing can be expected until 2030 owing to lowered barriers to entry and increased exposure to 3D printing, sometimes driven by a lab member's personal interest in 3D printing as a hobby.

1. Since the introduction of inexpensive consumer models, 3D printers no longer present a prohibitive investment cost. Especially in the field of fused filament fabrication (FFF), kits including consumable filament are available starting from 200-300 €. If a digital model of the object exists already, prints can also be ordered from online services or made in fabrication laboratories and maker spaces which are being established on research campuses worldwide.

2. Modern, user-friendly computer-aided design (CAD) software requires little training and allows novices to complete basic 3D geometries within a few hours of starting to work with the program. Additionally, there are open-source digital models specifically for science labs [6] and projects of collaboration with industrial designers [8].

By 2050, what can be pictured is an ecosystem of innovation with fluid boundaries between discovery and creation. Ongoing optimization will bring more efficient printers and open new research avenues which are foreshadowed e.g. by flexible or electrically conductive 3D-printable materials. Additionally, 3D printing provides a stepping stone into the entrepreneurial landscape of the life sciences by empowering academic inventors to prototype ideas and render them tangible. 3D-printed models can be thought of as boundary objects to facilitate seamless interaction with stakeholders, including patients and investors.

Aside from difficulties in integration which could arise at the boundaries of fields of expertise, there may be a need to address new challenges regarding intellectual property. The Open Science movement is likely to become the subject of discussion, especially when it comes to questions of sharing CAD models. A re-thinking of existing architectures may be necessary, e.g. in order to include 3D model data in publications.

4. Conclusions

3D printing is a promising addition to scientists' repertoire of methods, in line with the tradition of creating custom solutions for highly diverse and individualized research objectives. Custom 3D-printed tools already allow labs to optimize their operation and to transform ideas into practical objects almost instantly.

As with intricate geometries which were impossible to produce before the advent of 3D printing, new applications which cannot be imagined with today's knowledge will evolve in the coming decades.

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Biography

Stefanie Rothkötter, M.Sc., trained as an interdisciplinary product developer at Otto-von-Guericke University Magdeburg and has since been co-developing products with researchers and practitioners at Stanford University (USA), Charité Medical University and the German Center for Neurodegenerative Diseases (DZNE) in Berlin. Her research focuses on pathways of innovation in the life sciences.

Deep Learning: The Answer to Future Healthcare Systems

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1. Introduction

The technology which will reduce burden to humans, by making the tasks simpler, which everyone is looking for has come to all fields of science and could make many great impacts in the healthcare department. Deep learning will bring us in to surprise by the level of accurate output prediction.

Deep learning is technique of machine learning that learns features and tasks directly from data. Data can be images, texts, or sound. The number of inputs given to computer to learn, increases its accuracy and learning capability to perform the task of our requirements. For example, feeding it with an image of X-ray of hand, the number inputs of similar X-ray types it learns helps it in identifying accurately an X-ray of hand. Most deep learning techniques use Neural Network Architectures. It has many hidden layers of processing which is complex and difficult to understand which we can term as a black box. Input is given to black box and then output is received. This technique is quite encouraging to help and make positive impact in the healthcare systems because of the results it gave in other fields of science, namely, automatic colorization of black and white images, automatic image caption generation and automatically adding sounds to silent movies. Following paper will give an overview of how future health systems can be operated, new technologies which could be implemented and availability of healthcare to every person living in the world.

2. Future Scope, methods and materials

Deep learning can be used as device to predict the type of disease and give feedback to patient, what are the outcomes of disease and what care is needed to prevent the growth of the disease. Apart from disease related data, the future of this concept could be to predict the life-span of human being according

to the previous data given to it from the Medical images of persons, the breath rate of particular person at a particular age (because breath rate per minute decides how healthy a person is) and the data of how long a person lived with the particular environmental conditions and other factors.

Deep learning (as in Figure 1) consists of neural networks, which has many hidden layers like 100 to 150 in number. It has complex algorithm in it perform the tasks. Each layer learns a concept from data and further layers are formed from the experience it gets. The higher the number of layers, better the output.

Mobile applications with deep learning concepts can be implemented with certain software like MATLAB, Big Data, Python. With the help of internet to mobile phones, one can get access to all the features. Advanced applications in hospital can use deep learning supercomputer to tackle the problems.

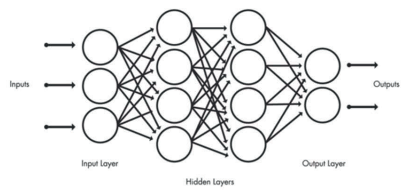

Figure 1: Concept of Deep Learning

3. Discussion & Conclusion

Deep learning mostly has positive side in healthcare making it available to every individual in rural and urban areas at lower cost and at emergency situations. It can suggest the immediate preventions we can take for a disease or an accident. A Digital machine can be an assistant to doctor that can suggest him/her about the quick opinion about the case. For example, finding out solution from a MRI scan and suggesting a doctor the preventive methods from its knowledge. The negative potential is no one knows what's happening in these neural networks. It could be danger to jobs of doctors such as Radiologists. However, it is believed that deep learning could only help them to better interact with patients and improve the intervention procedures.

A basic knowledge of computer or educational background to understand some basic wordings will definitely be required to just operate a system which uses deep learning. It is mostly convenient to be used by a professional.

In healthcare systems, the entrepreneurship can be very profitable and show faster results. The best results can be mostly to ones who identify the needs of people and bring the innovative idea into reality.

It could have a large social impact in the lives of human, with these coming into force by which it could give human a better and quick solution like a doctor and apart from healthcare systems, it has a lot of applications. This mainly could help human by predicting the disease symptoms and help one get into notice about the future diseases that could enter the person.

This strategy of developing healthcare systems would be the future for best results. The self-learning of computer from the data and improve itself is a concept which makes a machine do the works where man is not perfect in implementing it in a faster and better way. However, data manipulation could be major problem. Improvements can be done to overcome such problems. In future, this could be the technology to improve healthcare vision.

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Biography

Harish Kongari, a Masters Student pursuing Medical Systems Engineering in Otto-von-Guericke University, Magdeburg, Germany. He has done his Bachelors of Technology in Electronics and Instrumentation Engineering under Jawaharlal Nehru Technological University, Hyderabad, India. He has done his Bachelor project in Water Level Measurement Systems using PLC. He has been trained for 12 weeks in ATI-EPI, Hyderabad in the course Industrial Automation using PLC/SCADA.

Medical Artificial Intelligence: A new Doctor

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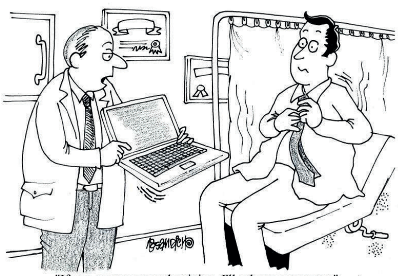
1. Introduction

In the modern healthcare systems, some of the major problems are countless options for treatment of the single disease and increasing complexity/costs. Sometimes, lack of ability to choose optimal treatment option leads to negative outcome. This needs to be overcome to achieve lower costs and higher efficiency. Also, training a human doctor to learn, understand and memorize all the complexity of modern healthcare, even in their special domain, is lengthy and expensive process(10 years). In the countries, where doctor-population ratio is very low, it is very hard to get efficient and cost-effective treatments, especially in rural/remote areas. These problems can be addressed by developing Artificial Intelligence (AI) which can think like a doctor. Also, AI in medicine also has some potential advantages for people living in rural/remote areas.

2. Materials and Methods

With the help of electronic health records (EHR) and public biomedical data-sets, AI techniques could be used to predict optimal treatments, minimize possible side-effects, and reduce costs & errors. Such AI framework should provide a simulation environment for understanding and predicting the consequences of various treatment choices. Such simulation could improve decision making and fundamental understanding of clinical process.



"If you want a second opinion, I'll ask my computer."

Fig.1

This would also eliminate potential risks in advance. It should also form a plan to avoid the uncertain danger. Machine learning algorithms can be integrated to obtain optimal treatment selection for each patient (individually). Such AI technology also has potential applications as automated clinical assistant and next-generation clinical decision support system.

The number of smart-phones is increasing rapidly (2.32 billion in 2017). Majority of population is using smart-phones, even in rural areas. If such AI can be integrated with smart-phones, huge amount of population can get basic treatment without even going to the clinics. People could feed their medical data (acquired by using sensors: inbuilt-on-phone/wearable) to the AI based mobile application and then AI could scan and process the data. Based on the data, AI could give the result whether the patient should consult the doctor or can directly take medications (suggested by AI app).

There could be a AI powered ATM like machine with all sensors integrated in it. People could go there and can take basic tests. Based on the test results, AI would suggest the medications and whether to go to clinic or not. This would help the people living in rural/remote areas.

3. Discussion & Conclusion

If this type of AI framework will be developed, it would change the way of treatments. It would affect not only the people living in urban areas but also the people who are living in the rural/remote areas. This would enhance the telemedicine services. Combining this technology with human clinician can maximize the potential of both, human and machines. With automated assistance, the physician could supervise the decision making process, applying her or his experience and intuition to guide the input process and to evaluate the output of the machine intelligence. This would reduce the cost as well as complications. This could work

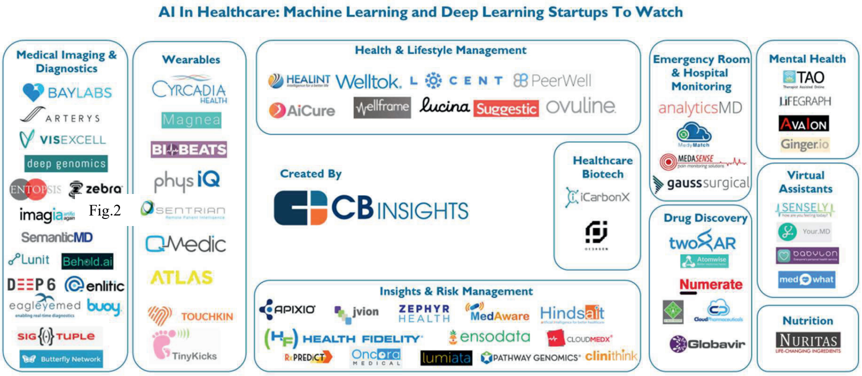


Fig.2

"By 2025, AI systems could be involved in everything from population health management, to digital avatars capable of answering specific patient queries." - Harpreet Singh Buttar, analyst at Frost & Sullivan.

at any level. For example, it could help normal physician as well as surgeons. People could take regular check-ups at their homes and if needed then only they have to go to clinics.

However, there are some challenges, which need to be overcome to make this happen. AI would require databases to compare data. For revolutionizing the existing healthcare system, data management is crucial task. AI should collect, store, normalize and trace the lineage of the data. Thus, data security would be a big problem. To address this problem, some encryption algorithms should be developed according to the international standards of information security. Also, affordable and small sensors/transducers will be needed to acquire data at home.

Another question is the liability of AI, whether the AI should be trusted or not. We must help general population understand how AI could be beneficial and how can we fight possible dangers. AI should gain the trust of doctors, nurses and patients. Doctors must be involved in development process of such devices to ensure that the systems are well-engineered and reliable.

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Biography

I have done B.tech. in "Biomedical and Instrumentation Engineering" in India. I have been involved in project "Jaundice-meter for neonates". I have done internship in ICU equipment based company called 'RHP medical services' in India. Currently, I am pursuing masters in Medical Systems Engineering at Otto-von-Guericke University, Magdeburg, Germany.

Nanotechnology in Medical Field

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1. Introduction

Cancer is one of the most unfavorable and painful disease among all other diseases. Cancer can be simply defined as uncontrollable growth of abnormal cell. The exact reasons behind the cancer disease are become very controversial topic for scientist. Prostate cancer and breast cancer are very common found in cancer patient.

Surgery and radiation therapy can able to remove the cancer cell in particular area but chemotherapy is specially qualified to kill the cancer cell from whole patient body. It can be applied after surgery or radiation therapy as the secondary treatment. In radiation therapy, cancerous body parts need to be exposed under x-rays. These x-rays react with water to produce free radicals which destroys DNA and other molecular structures killing cells. Unfortunately these free radicals destroy healthy cells as well as cancer cells shown in figure 1. In future some innovation must be required to solve this problem. Use of Nanotechnology in the health care system is become essential for future. Some concept and approaches are mentioned in this paper which gives enlighten about use of nanotechnology for healthcare system.

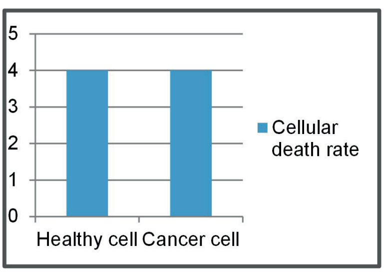

Figure 1: Cellular death rate in radiation therapy.

2. Future concept and approach

Nowadays technology has made huge changes in medical field and help to improve efficiency and flexibility. Use of Nanotechnology in the healthcare system offers different path for improving the method of medical diagnosis and therapy. Cancer therapies like surgery, radiation and chemotherapy will damage the normal tissue or incomplete eradication of cancer. Nanotechnology refers directly to the target and provide selectively to cancer cells which enhance the therapeutic efficiency than other treatment modalities. Nano shells are manufactured with the help of nanotechnology which can kill the cancer cells without adding toxicity in standard radiation therapy. Nano shells are incredibly small particle. The size of a Nano shell is equivalent to the 5000 division of human hair. These crystals are surrounded by a soft protecting layer minimizing unwanted interaction with the body. The Nano crystals are directly inserted on the tumor with a standard syringe. These Nano crystals are influenced by x rays and produce more free radicals which can break tumor cell DNA more effectively than the surrounding healthy tissue. Due to Nano particles the x-ray effect is amplified and localized within the tumor. Healthy tissue is kept safe with the standard dose of radiation and the tumor dies more quickly. Only one injection of Nano particles can reduce several radiation therapy sessions. Nano x-ray therapy can be used to fight a wide variety of cancer.

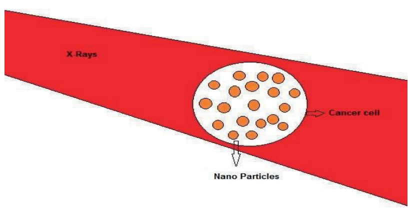

Figure 2: Nano therapy for cancer cells.

Apart from Nano X-ray therapy there are lots of applications in the field of Nanotechnology.

In future years, Nanometer sized box which is a Nano robot embedded with a tiny camera can travel into heart and blood vessels. These Nano robots can send alerts to your smartphone when a disease or illness selects your body. Maybe in future these Nano robots will have the ability to remove harmful clots, collect tissue sample and absorb toxins in blood. But the main disadvantage, the details of a person could be easily tracked from the servers and can cause a major security issues with the privacy of the person. One of the possible defenses against the attack is a cryptographic approach in which the particular person's data would be more secured.

3. Discussion & Conclusion

Healthcare in future year may have a successful growth in the field of Nanotechnology which can add up to a decreased risk of patient and increased probability of survival. It can be implemented on urban and rural areas. This would only be suitable for person who has cancer in one area and whereas for multiple cancers in a person it would not be suitable. In the field of education, the students should have a lot of exposure to nanotechnology for better inventions.

In the future use of Nano technology could become more complex and cost effective but this will give most effective solution for health issue. Nano technology would able to give precise solution of fatal diseases.

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Biography

Akanksh Gurupadappa Akki, Btech in Instrumentation Technology, Karnataka, India. He has worked on two projects which are based on Embedded system and undergone six weeks of industrial training on Embedded system in 'Inventron Technologies and business solution LLP' in Bangalore, India. He is currently pursuing Masters in Medical System Engineering, Otto Von Guericke University, Magdeburg, Germany.

Nanobots – Future life-saving technology

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1. Introduction

A nanorobot is an extremely small robot that is designed to perform specific tasks at the nanoscale dimension of few nanometers i.e. 1 nm = 10-9 meter (A red blood cell is about 7,000-8,000 nanometers in diameter and A strand of DNA is 2.5 nanometers in diameter). Over the years it has been found to be useful in many situations as well as uses.

Nanobots have recently injected into the human brain silently acting as artificial organs or acting as neurotransmitters. As years go by the use of technology in medicine becomes more needed. In the future, nanobots will be able to communicate wirelessly, download software when new pathogens arrives, and attack cancer, cancer stem cells, bacteria, viruses, and all the disease agents. They can also work on metabolic diseases like diabetes [1].

Nanobots could maintain healthy levels of everything we need in the blood, including nutrients, and basically repair and eventually replace damaged organs. It helps to maintain healthy immune system. Nanobots can extend the average lifespan far beyond the remarkable achievements of the last century by curing life-threatening disease. With nanobots, it is possible that scientists will be able to wipe out most diseases in about 15 years and thus making humans immortal by 2040.

2. Materials and Methods

As per research theories, nanobots will possess at least two-way communication. Through sound waves, these robots will receive power or even reprogramming instructions from an external source and will respond to acoustic signals. A special network of stationery nanobots will be positioned throughout the body which will keep the track of each active nanorobot passes & then report the results. Physicians or doctors could not only monitor a patient progress but can also change the instructions of the nanobots in vivo to progress to another stage of healing. After treating, these nanobots would be flush out of the body immediately.

A creative theory in the use of these devices to fight cancer involves using silicon nanomachines with a thin coating of gold and light in the near infrared spectrum. Light in the 700-1000 nanometer range will pass through tissue with minimal absorption. When this near infrared light strikes this particular type of nanomedibot, the device gets hot due to the oscillation of the metal's electrons in response to the light. Using an MRI to precisely place the nanomedibots in the cancerous region, the light causes the devices to heat to 131 degrees Fahrenheit which destroys the cancerous cells but doesn't damage surrounding tissues. Also regarding cancer treatment, ribonucleic acid interference is a method that attacks cancers on a genetic level. Nanobots laden with interfering RNA that deactivates the protein production of the cancer and kills the malignancy would attach themselves to the tumor and deliver the lethal genetic material [2].

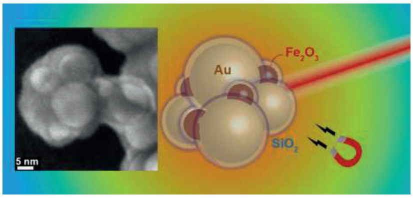

Figure 1: Scheme of gold and iron oxide aggregates with silica shell. Left: electron microscopic image of an aggregate.

3. Future of Medical industry with Nanobots

Nanobotics is steadily and exponentially advancing as the technology advances, and more applications for it are found, more advanced methods are being devised. Nanobots may be employed to detect specific chemicals or toxins and could give early warning of organ failure or tissue rejection. Also used to take biometric measurements, they may be employed to monitor the general health of an individual. In addition, current research is investigating their application in nanophotonics to produce light more efficiently. Computer circuits may be produced by these tiny devices. They could create circuits on a smaller scale than current etching techniques and would allow for the manufacture of extremely small processors and chips [3].

The extension of the human lifespan could be facilitated through the removal of a substance called lipofuscin from certain types of non-dividing cells, including the brain, heart, liver, kidneys and eyes. Lipofuscin is a metabolic end product that accumulates primarily within lysosomes (the garbage disposal organelles within cells). It's thought that when lipofuscin accumulates to certain levels, it begins to negatively impact cell function, which eventually manifests in many age related conditions. Researchers have proposed that soil bacterial enzymes might have the capacity for degrading lipofuscin, also proposes that humans might live as long as 1,000 years under the appropriate rejuvenative therapies [3].

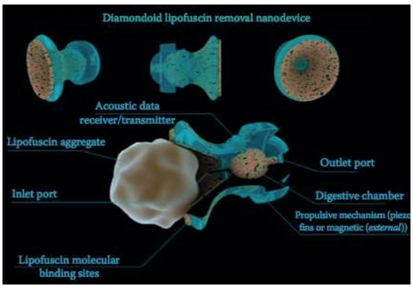

Figure 2: Artistic rendering of a conceptual “Defuscin” nanomedical device.

4. Discussion & Conclusion

Medical nanobots may be able to extend our lives in two ways. They can repair our bodies at the cellular level, reverse aging and providing a certain version of the fountain of youth, and it can help the medical community to eradicate life-threatening diseases such as stroke, heart attack, HIV or cancer. This technology can be easily envisioned within the next 15 years. However, from the day of the creation of the first cancer curing nanobots, we will still have huge developments to make – it won’t therefore be an instant cure not only for cancer but also for other various diseases. Mass production will need to be perfected, and so initial cost will be extremely high, due to high demand and low supply. Plus the tech will still be going though rapid improvements, both in itself and in its production techniques.

While it is still being pushed out of testing to desperate terminally ill patients, the full realization of nanobots will basically eliminate biological diseases. We'll see widespread use in 20 years of nanotech devices that perform certain functions for us. In 30 or 40 years, we will overcome disease and aging. The nanobots will scout out organs and cells that need repairs and simply fix them. It will lead to profound extensions of our health and longevity and we will finally be able to say that the end of mortality is in sight.

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Biography

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PBD – Photo Booth Doctor / Medical Advisor 2035

Philipp Steinert[1]

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1. Introduction

The future of our healthcare system will face some immense problems. Two of them are the increasing and aging population – and the increasing cost of healthcare delivery.

To deal with these challenges the future developments in and for the healthcare system require strong focus on preventing diseases.

Planned surgeries and emergencies will need to be treated in centralized medical centers, which may need to provide all medical disciplines and specialization in one center to reduce costs.

In the following one visionary possibility of a technical implementation to observe and subsequently prevent diseases is described. To goal is to connect all people in a convenient way to the healthcare system.

It is based on the "out of fashion" photo booth. The described "medical" photo booth doctor (PBD) is used to connect the increasing population to the public healthcare system.

An example can be seen in Figure 1. The idea is to implement different technologies to make the visit at the general practitioner unnecessary.

Figure 1: Example of a modern Photo Booth converted to Medical Diagnostic Check-Up system (PBD) [1]

2. Materials and Methods

The basic concept is build on a central data base of individual anonymized patient data, a personal advanced smartphone and an advanced photo booth. A system overview can be seen in Figure 2. The smartphone of the future collects data like electrocardiogram (ECG), pulse, blood pressure, etc.

Whenever the patient feels like seeing a doctor or in a periodic time interval he or she goes to a "medical" photo booth, the PBD. There the data from the smartphone is read out. The body temperature can be measured and blood can be taken automatically. The blood is analyzed by the photo booth in a few minutes. The patient can also interact with a software system to give further information to the personal anamnesis.

The integrated camera system allows the software to make different diagnosis and a psychological test. If necessary also a video call can be established to a doctor. The doctor will sit somewhere in a medical center and is only contacted in special cases. It can be used to teach the patient for example with short videos about certain medical topics. As a result it will give advice to the patient. The advice can also be related to the diet of the patient or to changes in his or her lifestyle, but also medical advices.

To ensure a clean and sterile environment in the photo booth an automated self-cleaning mechanism is installed. Needles for blood test are single use and most of the other measurements are touchless. To ensure enough privacy the photo booth can be closed completely.

In case of a disease the photo booth can advise the patient directly to a specific doctor in the centralized medical centers. The photo booth will be directly connected to the emergency medical services, so in case of an emergency it will directly start an alert and give all the collected information to a specialized hospital. For minor diseases it could either give a prescription or has a small pharmacy directly included. The overall examination time is between 10 to 20 minutes.

The PBD will be owned by the government. This is to ensure that everyone can access the PBD independent of his or her health insurance.

The PDB will be placed in shopping centers, and other public places like airports or train stations, museums, stadiums, retirement homes or even in regular intervals in rural areas. Basically it can be placed anywhere and it can also be portable to ensure that all people have access to the system. It makes sense to place it where people have some waiting times, so that they can visit the PBD during shopping, waiting for their flight or during lunch break.

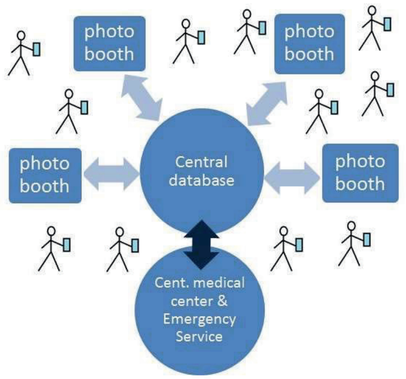

Figure 2: Medical Photo Booth system

3. Discussion & Conclusion

The PBD can be seen as a result of combining available technologies of today in one system connected to an intelligent evaluation system. The measurement technologies are either implemented in the smartphone or the PBD. The main communication system is based on advanced IoT - technology (Internet of Things). The evaluation systems could be based on a system similar to the IBM Watson Health. [2] [3]

For a future development a camera system which can gain molecular and anatomical information could make the medical examination completely touchless. The PBD could be an excellent supplement to the work of general practitioners and pharmacies.

Depending on how the transportation systems will develop in the future, the systems could also be implemented in buses, trains or even airplanes. These waiting times can then be used for the medical examination. The collected data allows to detect diseases early in their development stage and to prevent diseases in a long term.

It is essential to ensure the privacy of the patient data and to prevent any type of misuse. Encryption and anonymous data storage for comparative use is necessary, but at the same time needs to be assigned to the individual patient for comparison over time and detection of changes.

The personal contact to the doctor will potentially be lost. This can be a disadvantage especially for older people – but special setups for this group could be established.

A clear advantage is that the PBD, as a medical institution, has more time per patient than a doctor, collects all the data from billions of patients using standardized procedures and with that will make it easier to find good treatment options in the future.

This system would not solve all problems of the future in the healthcare system, but it could be a development in one part of the healthcare system. It could be the connection between billions of people and the expensive medical centers to ensure a sufficient medical care for all patients with an optimal use of all available resources.

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Biography

Philipp Steinert is pursuing a Master of Science degree in Medical Systems Engineering at the Otto von Guericke University Magdeburg. He holds a fellowship of the Foundation of German Business (sdw). During his Bachelor´s Degree in Industrial MedTech he completed two internships in the USA.

Intelligent Virtual Agent Technology in Health care

Siva Jyothi Peteti

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1. Introduction

As virtual health is staking a larger claim on health care space, patients might start hearing a different version of that familiar waiting room greeting "The avatar will see you now". While the use of avatar or intelligent virtual agent (IVA) technology is still in the early stages, experts predict it will give health care providers a new set of tools to better manage patients, boost engagement, improve treatment adherence rates and reduce costs. If the avatars are human looking and have eyes and emotions, then people will treat them like other people, so they really open up and they offer up really personal questions. So I'm having these symptoms, can you help me out?. Patient centered virtual health assistants designed to respond to voice or text questions through mobile devices, is the best option to give patients 24/7 access to current information, specific to their age, social setting, likes and dislikes, tastes, financial ability, literacy and culture.

2. Intelligent Virtual Assistants: a strategic solution

An intelligent virtual agent for health care or a virtual health assistant (VHA) is an effective, infinitely scalable and affordable way to not only survive but thrive in the face of the industries ongoing service level challenges.

Figure 1: Virtual health assistant engages a patient on a Smartphone.

A VHA facilitated interface can be designed and implemented using existing technology to take on many of the tasks currently being administered by the clinical and operational staff within the contact centre. In addition to automating the more repetitive tasks, such as verifying insurance and the continued need for a drug, VHA's can engage patients on a daily basis and work intimately with them to improve medication adherence.

3. The emergence of artificial intelligence and natural language processing

The history of intelligent virtual agents can be tracked back nearly 50 years, beginning with the quest for artificial intelligence(AI) creating an intelligent virtual agent, however requires not only artificial intelligence but also the ability to recognize natural language.

Artificial intelligence is defined as the ability of a computer or other machine to perform actions thought to require intelligence. Among these actions are logical deduction and inference, creativity and the ability to make decisions based on past experience or insufficient or conflicting information.

Natural language is using human written or spoken language to engage with a computer, as opposed to computer language. This differs from mere speech recognition, which is used for dictation and requires only that a computer recognize the word and insert it into a medical record. Intelligent virtual agents are trained to deliver value through user friendly, human like interaction that is consistent, scalable and personalized.

Virtual health assistants can integrate lab values, clinical guidelines, electronic health record, drug interactions, hospital discharge, prescribing information, health applications, physician recommendations.

4. Discussion & Conclusion

Virtual health assistants that integrate with electronic health records allow active monitoring of their patient base and provide context for deeper, richer conversations.

Caseworkers, specialists, physicians and drug makers are consistently missing opportunities to collaborate, due in large part to logistic barriers. Further complicating the issue, these conversations often happen above the patient, leaving gaps in the flow of information and patients with more questions than answers.

A virtual solution designed to integrate information from each piece of the physician patient dialogue, can give caseworkers the information needed to reach the patients that need them most urgently.

Advanced virtual health assistants have the ability to recognize speech and understand user intent solving problems at the patient level addressing the 300 million people who need help with the day to day health decisions.

Virtual health assistants bring limitless options. Retail pharmacies can reach out to people not taking their prescribed medication on a recommended basis.

Hospitals and physicians can deeply engage patients.

For the entire healthcare community from drug maker to caseworker, virtual health assistants are our best opportunity to take advantage of a technology that can truly impact the long term wellbeing of patients.

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Biography

Miss. Siva Jyothi Peteti is a student in Otto-von-guericke-university in Magdeburg, Germany pursuing her masters in medical systems engineering. She completed her bachelor's degree in electrical and electronics field from India.

REGIONAL HEALTHCARE VISION

Could the Norwegian Primary Care System be an option for Germany? – Some ideas what needs to be changed in the medical education

Marie-Fee Rühe

1. Introduction

As a medical student in Germany you get taught quite early about how you need to ‘function’ in the healthcare system in order to survive it. In the second year of medical education you get trained to perform a physical examination within 5 minutes. In the third year you learn to stick to the check-up list for the general anamnesis. These are just two examples I experienced so far during my studies.

During those three years I always came across the question why the German healthcare systems focuses so much on performing as many procedures as possible and not so much on the patients diseases – may they be physical or psychological – and on the overall positive outcome of a treatment.

Some years ago I came across the healthcare system of Norway and in this short written overview I will outline some aspects of this system and discuss what changes primarily need to be done in the medical education.

2. Main part

The consulting firm Frost & Sullivan show in their analysis on the Megatrends Impacting the Entire Spectrum of Care that the reimbursement of medical treatment will in all probability develop from a procedure-based to a outcome-based payment system. Other changes are additionally outlined as it can be seen in Figure 1.

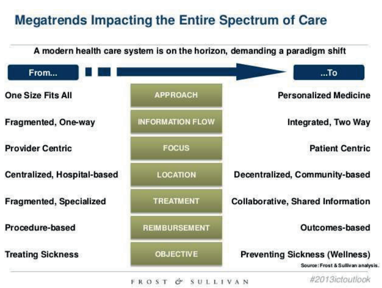

Figure 1: *Megatrends Impacting the Entire Spectrum of Care*. An analysis of Frost & Sullivan [1]

This is an interesting aspect because in Germany the healthcare system focuses its payment on the number of procedures.

In the Primary medical system in Norway patients register to one family doctor: The physician gets a base income depending on how many patients chose him. This automatically leads to a different strategy for the doctor to work: he or she will focus on the outcome and prevention in order to see the patients less [2].

The difference to the German system is basically the different reimbursement. The doctors in Norway get a basic payment which correlates with the number of patients treated and not how it is done in Germany by the number of different treatments.

In order to treat a lot of patients with a good outcome and the overall aim not needing a lot of medical procedures the doctor-patient-interaction needs to change (apart from the fact that the payment system needs to be reformed). But the Norwegian principal interaction is not taught at universities. I am experimenting it myself that the procedures not the patients itself are put into focus. You get told that you do not have enough time for a long talk to get to know your patients and you get told to do medical procedures even though you think they are not necessary and only get the hospital a lot of money.

The medical education needs to be changed in the direction of focusing on the individual patient: This can only be reached if we spend time on a good communication and establishing a working prevention system.

Even though the expenses of the GKV are constantly increase more can be done (see Figure 2).

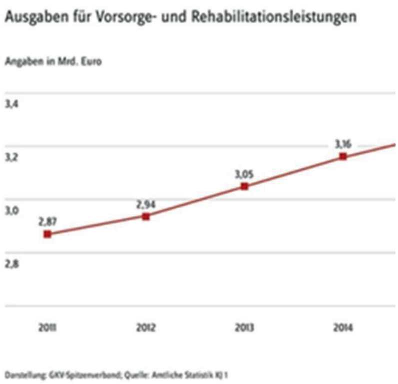

Figure 2: Expenses of Prevention of the GKV [3]

3. Discussion & Conclusion

In my opinion the Norwegian Primary Care System could be an option for future reforms in the German Healthcare System. It focuses on the successful outcome of medical treatment.

But despite changing the payment system the education of the medical students needs to change as well. In nowadays teaching to do medical examination in as less time as possible is not an option. This will take time because the interaction between patients and their doctors will be changed fundamentally.

Biography

After finishing her Bachelor of Engineering in Medical Engineering at the University of Applied Sciences in Jena, Marie-Fee Rühe started her medical education at the Otto-von-Guericke-University in Magdeburg. In March 2016 she successfully passed her first stage of the German medical examination. In April 2016 she started studying the master Medical Systems Engineering as a parallel study and will start working on her medical doctoral thesis in Mai 2017. Since October 2016 Marie-Fee Rühe is a scholarship holder of the Deutschland-stipendium.

Rural Healthcare 2030 India: Would it be Different?

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1. Introduction

India is the seventh largest country in terms of area and the second largest in terms of population with a total population of 1.3 Billion of which nearly 67.2% of the people reside in rural areas.[1] The healthcare system in India is classified into three levels of care; Primary Healthcare (Sub Centers, Primary Health Centers, Community Health Centers), Secondary Healthcare (District Hospitals, Specialty Hospitals) and Tertiary Healthcare (National hospitals, Super and Sub-specialty hospitals).[2] Apart from these, the country is also home to large number of private hospitals that, forms the private healthcare sector, which under normal circumstances operate majorly for profit. The rural sector is run by the government and uses the sub centers as the first point of contact for healthcare for the people living there. In the case of specialized healthcare, the patients are referred to the primary health facilities where there are visiting doctors or to the district hospitals and specialty hospitals that are usually located in the cities. The quality of healthcare provided in rural India is fast improving and certain steps have to be taken to ensure scalability of this quality.

2. Materials and Methods

Healthcare in rural India has always been an issue. The dissemination of quality healthcare among the people in the villages has been hindered due to various problems. Rural India lacks the infrastructure in terms of roads that can connect the villages to the cities. Because of this absence, the people have to travel long distances by foot, which tends to be an inconvenience especially when they are chronically ill. Apart from this the under-development of rural health centers (Primary Health centers) is also among the infrastructural drawbacks that has lead to the unequal distribution of healthcare services between the rural and urban population.[3]

The awareness regarding the importance of rural healthcare is something that is drastically low among those who formulate and govern the country as well as the populace. The migration of professionals from India to other countries has lead to a drain in the number of people who can provide the people with the care that they need.[3]

The country is slowly making a move towards adopting more electronic ways to dispatch better quality health services. For this to be a possibility in the near future, it is vital that the professionals in the country have the means and know-how to carry this plan forward. That can only be made possible if they are made aware and educated about how this could improve the quality of rural healthcare in India and how they would benefit from this as well. On a related note, India currently suffers from a problem that needs to be addressed if the healthcare situation in the country needs to be improved and that is weak mobile Internet. By strengthening the connectivity and Internet services in the country we can hope improve rural healthcare by employing applications such as e-Health, m-Health and even telemedicine. This would eliminate the people's need to travel to receive the required treatment and care required by them.

The rural healthcare scenario now is bleak, but can be improved through a collective effort.

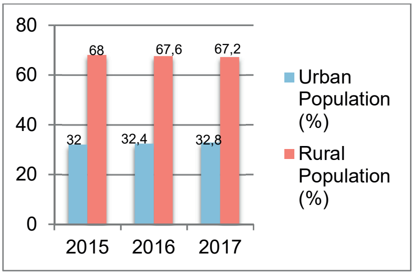

Figure 1: Shows the difference between the urban and rural population over the last three years. [1]

3. Discussion & Conclusion

The Indian subcontinent stands at the brink of a healthcare revolution. This can be made possible only through a collective effort from the government, people and professionals. Rural healthcare, by the year 2030 will be much more accessible to people through the employment of wearable technology and real-time tracking and monitoring systems. Home care will play a major part in ensuring that every individual in the country will be a recipient of quality healthcare.

Applications like m-Health, e-Health and Telemedicine will be better developed and employed widely. The government of India has documented e-Health initiatives for states all over the country that include objectives, strategies and guidelines to ensure the setup of an efficient e-Health network. [4] There's hope that a shift will occur from providing treatment to cure diseases to preventing them altogether. This way, with early diagnosis and care, the patient will have more time to move to super-specialty care facilities from rural areas with minimum harm to oneself.

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Biography

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Socioeconomic burden of cardiovascular diseases in India "Opportunities for future developments?"

Mahurshi Parikh

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1. Introduction

According to Global Burden of Disease study age-standardized (2015), leading cause of deaths in world was cardiovascular diseases (CVDs). Where same applies for India because CVDs are the major cause in fatality in India in the recent years. Even nearly a quarter of all deaths in India are attributable to CVDs, including poorer states and rural areas. The progress of epidemic is governed by the socioeconomic gradients; tobacco use and low fruit and vegetable intake have become more frequent among those with below poverty line. In addition, these people do not receive optimal therapy and leads to poorer outcomes [1].

Countering this issue requires the development scheme such as the establishment and effective implementation of evidence-based policy, government support to health systems and more focus on prevention, early detections, and treatment with the use of both conventional and innovative techniques. Several ongoing community-based studies are testing opportunities with relevant schemes.

Healthcare market is age dependent. After the high cost in the first year of life, it is less for children, rises throughout adult life and increases exponentially after the age of 50years. On the basis of report of United Nations World population prospects the 2015 revision, the population aged 60 years and above is expected to increase from 8.9% in 2015 to 19.4% in 2050, which shows opportunity for Healthcare market for aged people because small percentage increment in populated countries like India shows remarkable figure in absolute terms. The possibility is more evident as likelihood of segment to adopt new technology [1].

Figure1 shows the developing country or populated country's reliability of Health system on four major factors [3]. New developments in this way makes new horizon with partnership between developed-developing countries with all benefits. This will give new directions to innovations and will help to improve the economic development in the countries by reduction of load on Healthcare system.

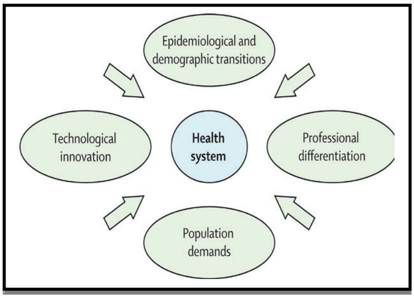

Figure 1. Reliability of Health system on major factors.

2. Possible future development directions

Poor accessibility to cardiovascular care in India has requirement of the integration of CVD preventive care in primary healthcare system, which is very easily reachable in urban as well as rural areas. This need requires innovative models and cost effective solutions, which is described as below.

According to Telecom Regulatory Authority of India, in the end of year 2016, the overall Teledensity in India is 89.90 [2]. That suggests possible establishment of mHealth with Artificial intelligence. With Government encouragement to telecom services and mobile manufactures, basic monitoring of major contributing factors as cholesterol, fat intake, physical inactivity, blood pressure and diet plan can be tracked by sensing from mobile devices with putting only one fingerprint on sensor. This data automatically compared with the cloud information and will recommend the person whether he/she is doing well or not on the basis of diversity of culture. There might be elimination of primary doctors with higher accuracy decision making. This will also compete with the shortage of skilled physician. Nowadays, India needs better surveillance and reporting systems which can be easily monitored by mHealth and continuous evaluation of

CVDs risk factors and trajectories with digitization. This steps will try to improve the prevention of CVDs with middle age groups.

There is also significant need of improvement in the processes and therapy in the management of CVD in India. Generally patients arrived at hospitals very late (mean time of symptom to hospital presentation approximately is 360minutes) leading to higher case of fatality. The major reason behind that in urban areas are traffic problems and costly healthcare service, while in rural areas people are difficult to reach at hospitals due to difficult access to transportation. This problem can be resolved with on-wheel interventional ambulance with all the portable devices inside it with cost effective interventions. This will also decrease the load of big hospitals in developing countries as well as developed countries and will allow to rethink the hospital systems. For example, angiography need contrast medium and continuous x-ray source which can be easily find inside it. On wheel interventional ambulance will continuously roaming in prescribed areas which can reach easily in rural areas on the basis of the symptoms and triggering sign send by the personal mobile device and it can also reduce the reaching time to the hospitals, very helpful in urban and rural areas. Portable devices will be very effective to use and will comply the basic diagnosis with low economical background. The development of such things will be more focusing on cure side for aged people.

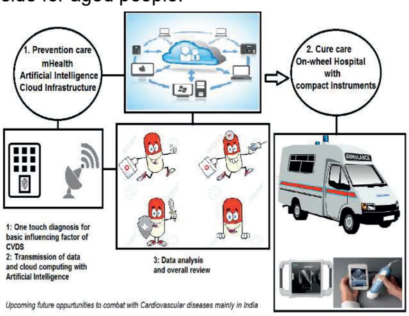

Figure 2. Possible future trends in India to deal with cardiovascular diseases.

Figure 2 shows that by implementing this technological revolution with the people of India's biometric and demographic data (Aadhaar card where 88% of population linked with it), the overall healthcare delivery can achieve higher level compare to current situations.

With all the benefits, it also comes with negative sides. Data privacy and on-wheel hospital should be taken care by providing higher standard of protections. Interventional on-wheel hospital also will face the concerns with sterility and should have capacity to deal with more interventions.

3. Conclusion

The rising CVD burden and damaging consequences it has on individuals, families and populations require urgent attention in India. To address the socioeconomic differentials, it is always recommended to innovate new approaches. To deal with that, small and compact diagnostic scanner with affordable price and combination of mHealth with Artificial intelligence with government schemes will be helpful to reach rural and urban areas. That will give the maximum chances to poorer people and will overcome the problems which are in current scenario. This can also lead us to think about new generation of hospitals, which will not have many big infrastructures but will act as on demand ambulance. It will directly reach to the patient's home on the basis of risk factors. This will bring new innovation and will also impact some of crowded cities in developed countries by providing data security to mHealth and artificial intelligence.

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Biography

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México, a Healthcare Vision considering its Geographical Location 2030

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1. Introduction

México, a democratic republic with a population of 120 million, shows signals of progress, development and social stability thanks to its system of institutions and politics adapted sporadically to the demands of a population every day more informed thanks to a free press disseminated by social media. Considering the health as the basis of social welfare and an important metric in the progress of a nation, efforts in the health sector have made possible increase the life expectation to almost 80 years, reduce to five risk factors the attribution of diseases from 50% of its population and, increase to 84% the population with health coverage. Nevertheless, Mexico faces huge challenge in areas of medical quality assistance and obesity pandemic because its fragmented health system and the inefficiency of its political class to organize and promote an integral solution in collaboration with a population indifferent to participate actively in solving the problems. It is important to mention that the geography and concentration of the riches of the country in big cities makes extremely difficult the medical assistance and investment in rural areas, not to mention security problems, corruption and low wages that doctors receive.

The vision here presented promotes the implementation of a universal health care system that manages its resources more efficiently to be able to provide a service of quality and promotes the prevention of diseases in collaboration with the educative sector and general population. At the same time, it is essential that the private sector in parallel with research centers and universities promotes the generation of new technologies and innovation in the medical field and not only focus in the provision of services; in this point could be important to review possible blocking points existed in the Mexican Industrial Property Law (MIPL) and consider the creation of patents as a strategic economic resource.

2. A Vision for México

In the next two decades, México will exploit its strategic geographic location associated to its alimentary production and prevent cases of chronic degenerative diseases caused by nutrition habits. All this will be achieved thanks to: 1) a continuous monitoring of physical needs and vital signals by non-invasive transductors connected to smart portable devices, 2) the implementation of a universal health care system able to modify its internal structure and implements preventive mechanism embedded in the educative and family cores and, 3) a private sector able to invest in the creation of patents, in collaboration with the academy, to satisfy all technological challenges involved.

The variables involved in this vision requires the participation of multidisciplinary groups as logistics, financial, statistics, game theory, signal processing and psychologists for mention a few ones. Because of this, entrepreneurial opportunities for data mining and its derivatives are present.

Imagine a big city, where you know which fruits and vegetables are produced in the region and you can decide what to order based on your physical needs and be sure they will be in your table in a specific time. You will be aware and conscious that this service will be a little more expensive but it's the best for your health an community because at school and family it was taught to you that a way to contribute and be happy was to take care of yourself. In the rural area, imagine a family of farmers able to know which are the needs of the closes city (or country) and able to planificate its next harvest. The neighbor of the farmer is a company in charge of the logistics to deliver all orders from the city using drones. Based on the information provided by the all users in the region, a map of diseases can be generated and the healthcare system can create a specific center to cover all medical needs. If a person moved from one region to another can be predicted and prevent all diseases because the lack of certain products in the region.

3. Discussion & Conclusion

It is clear that the ambitious of a few ones and the ignorance of an oppressive majority it is not the formula to a prosper nation which require to be healthy. It is clear that the implementation and development of new medical technologies can be sustained or focused considering the characteristics of the region and in the best scenario supported by government institutions. The management of big quantities of data is inevitable and it is without doubt an entrepreneurial opportunity.

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Biography

M. Sc. Ivan Maldonado Zambrano is performing research in non-invasive multisensory mechanisms in the detection of cancer and degenerative diseases as part of his Doctorate studies at Intelligent Katheter (INKA) chair at the Otto von Guericke University Magdeburg.

Future of health care technologies in Pakistan

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1. Introduction

Technological developments have grown remarkably in health care sector past two decades. The evolution of computers in health care domain has improved diagnosis and treatment of most of the diseases. The usage of techniques like machine learning and artificial intelligence has made diagnosis, treatment and prevention from many diseases more efficient. However, these technologies are not being used everywhere.

Developing countries like Pakistan are still far away from these modern technologies. There are a lots of reasons for this but most important are the lack of resources, awareness and poor health care system to name a few. There is a need of a new health care system which can be accessible to everyone.

The trend of using smartphones for monitoring and managing health will increase with the passage of time. Studies show that smartphones will become pocket doctors in future. With help of smartphone applications, people will be able to monitor, diagnose and manage their health conditions on their own.

2. Materials and Methods

The health facilities are not accessible to everyone in Pakistan especially in rural areas. This leads to late diagnosis of many fatal diseases. According to the government records, there are only 12000 public health care facilities available for over 180 million people [1]. The private health care sector covers about 80% of the total outpatients, which is not affordable for most of the people. Government is spending only 2.4% of the total budget on health care sector. These factors lead to death of plenty of people because of not getting the treatment at the right time. Therefore there is a need for a new system accessible to everyone, which can help everyone monitor and manage their daily health.

The usage of smartphones in Pakistan is increasing every year. There are about 40 million smartphones being used in Pakistan [2]. A system can be developed which will include smartphones to diagnose and manage some major diseases. There are many smartphone applications available these days to measure pulse rate and oxygen level in the blood. The trend of using these applications is increasing. Implementation of computer science techniques like machine learning and artificial intelligence in smartphones application will make mobile phones portable doctors.

Taking cardiovascular diseases as an example, about 10% of deaths occur due to heart related diseases in Pakistan [3]. There are multiple reasons for this e.g. smoking, lack of exercises and usage of fatty foods. The basic problem is that people have no awareness about the factors behind these diseases. However, nowadays people are becoming more aware due the increased usage of smartphones and access to internet.

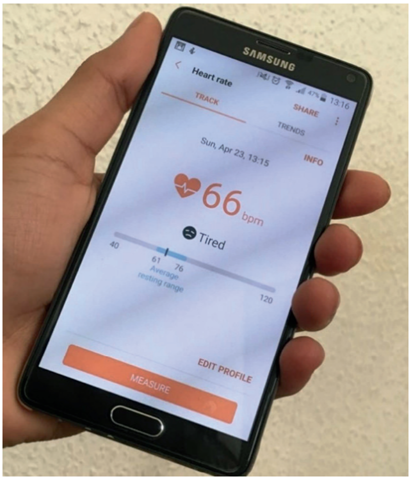

Figure 1: Heart rate measurement using smartphone application

These days some smartphone applications are there which measure pulse rate and oxygen level in the blood. In future, blood pressure measurement and electrocardiogram measurement will be included too. By having this information in smartphones, more applications will be built, which would predict any heart related disease by using machine learning techniques. This will help a number of people who cannot visit doctor on regular basis and this will also reduce late diagnosis of these types of serious diseases. By adding family history and genetic information, these predictions will be more accurate. On the bases of these applications, it will also be possible for the cardiovascular patients to manage daily lifestyle according to their health condition.

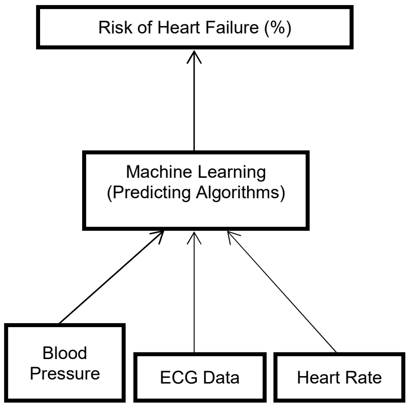

Figure 2: Implementation of machine learning

Diseases like diabetes and hepatitis are affecting over 20 million people in Pakistan which results in the death of about a million people every year [4]. Smartphones will play an important role in this area too. Blood sampling and testing adopters can be added to smartphones and various applications can be developed to diagnose diabetes and hepatitis. Using classification techniques diabetes and hepatitis types can be determined and health risks can be predicted.

3. Discussion & Conclusion

Implementation of real time health parameter measuring applications in smartphones will benefit a lot of people who are at the brink of having diseases like heart related diseases, diabetes and hepatitis. It will be possible to avoid complications which occur due to these diseases. This will set a healthy trend in people to avoid unhealthy habits. It will be beneficial for those people too who are living in rural areas where health facilities are not available.
However, a huge amount of research is needed to be done to implement all these techniques to smartphones. Machine learning and artificial intelligence techniques are already been implemented on computers for prediction of diseases. That is why smartphones will also be equipped with these technologies in near future.

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Biography:

Ghazanfar Ali is an electronics hobbyist and a Medical Systems Engineering student at OvGU Magdeburg. He is from Pakistan. Ghazanfar has done his bachelors in physics in Pakistan. His areas of interest are Electronics, Medical Physics and Medical Computer Science. He has also been involved in different projects at INKA OvGU.

Tele-Diagnostics: How the Demographic Change influences the Healthcare Services in Germany

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1. Introduction

The increase of quality in medical treatments influences the demographic change. In year 2040, the German population of ages of 65-79 and 80+ is expected to have an increase up to 24% and 79%, respectively [1].

Up to 30% of the population would be of an age of 65+ and most of them would be retired from the working life. Medical care at this age is more important in case of maintaining a healthy and comfort life. Especially, the increase of 80+ agers more healthcare resources are needed which can be supported by daily life's diagnostic tools and devices.

Mobile and home service diagnostic tools and devices will be introduced used for accurate and fast health analysis and are connected to a healthcare online network for fast services.

2. Main Idea

The risk to sustain on a disease raises with aging. In 2040, almost every third person would be in an age of 65+, as shown in figure 1, and would be at a higher risk of affection. Early detection of health problems will be the most impacting factor of successful treatment. Therefore, personal smart diagnostic devices and tools will be introduced and be connected to a healthcare network. E.g. local first aid posts, hospitals, medical offices and pharmacies will be connected to that network.

People who have a higher risk of developing a heart disease can be monitored using a smart watch, smart wristband or necklace, smart clothing, e.g. conducting shirt or belt collecting the heart rate. The monitored data will be analyzed in the healthcare network on the fly via Wi-Fi connection or be recorded and send after the device gets a connection to the network. If the data is showing some abnormalities over short or long term monitoring the user will be informed and gets automatically information about the closest location to a doctor or medical center.

Since smart homes becoming a standard in future living also smart diagnostic devices could be included. A small device taking small urine, saliva and blood samples, like a today's glucose meter, will analyze your sample and compare it to one of your own personal healthy data. The collected data will be tested for diseases within the healthcare network. Any abnormalities could be reported to the user and to a medical doctor of the user's choice. The doctor will be informed at his working place and checking the data online deciding if there is a further checkup or a pharmaceutical treatment needed. If the user confirms the doctor's decision, dates for appointments will be suggested or medicine will be send out directly, e.g. via a drone delivery service and drops it into a drone mail box at the patients home.

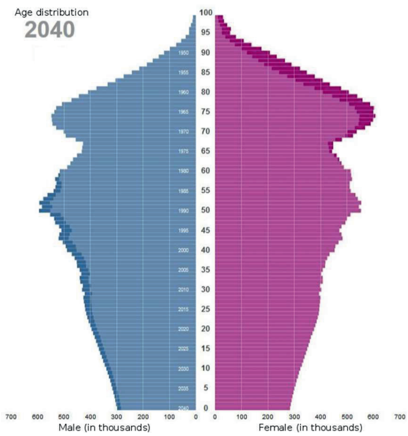

Figure 1: Age distribution of the German male (blue) and female (pink) population in year 2040 according to statistical expectations calculated by the Federal Agency of Statistics, adapted from [2] with editing.

In nursing homes the apartments will be equipped with home health security systems. Sensors, like motion sensors within the room, pressure sensors integrated in bed and couches will observe the people's activities during the daily life. Also, the aforementioned smart tools, e.g. smart clothes, can help to monitor the people's health status. All the data will be processed within the nursing homes own health security servers and transferred to the nurse's mobile devices. According to the data the nurses can act immediately if there are any abnormalities shown. In case of emergency the nurse can send all recent data of health information to a first aid station or ambulance. Paramedics will be supported with information that can help to identify the patient's needs for the medical treatment.

3. Discussion

Building up a healthcare network for telediagnostics can speed up finding the best suitable treatment for patients. Especially, the collected long term monitoring data of older people can support medical doctors in diagnostic decisions. Fast response on personal health information is the best benefit coming out of the healthcare network.

However, building up a highly functional healthcare network needs to include most of the local available healthcare entities. Therefore, the collaborating entities should be provided with some benefits like financial support from the state or the health insurances.

A standard protocol for the network connection and the data collection as well as data storage servers are needed. Additionally, the data has to be encrypted to be secured from interactions from outside the network. Anyway, standard protocols like the Picture Archiving and Communication System (PACS) including the Digital Imaging and Communications in Medicine (DICOM) format has already proven a highly efficient functionality within the medical section.

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Biography

Jens Ziegle, M.Sc., had been graduated in the Master's study program Medical Systems Engineering at the Otto-von-Guericke-University (OvGU) in Magdeburg, Germany. Mr. Ziegle is currently a PhD candidate and team member of the chair of Catheter Technologies at the OvGU and is working on new tracking methods for image guided therapies.

Challenges and prospects of medical imaging and healthcare in Nepal in next decades

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1. Introduction

Medical Imaging is the process of visualizing interior body parts for non-invasive medical intervention and clinical analysis. The history of medical imaging dates back to 1895 when Wilhelm Conrad Roentgen discovered X-ray for the first time [1]. Since then, many new medical imaging technologies like Magnetic Resonance Imaging (MRI), Nuclear medicine, Ultrasound (US), Elastography, Photoacoustic imaging, Tomography, Echocardiography, spectroscopy, Elastography, etc. have been discovered.

However, the advent of computers in the world of medical imaging was seen in early 1970s when computed tomography and MRI were introduced. Since then, numerous approaches have been taken to make medical imaging an easily accessible and easy to use technology. Despite of these improvements, third world country like Nepal has not yet been able to use these technologies to the fullest owing to their poor governmental policies, financial capacity and lack of skilled manpower. On the contrary, there have been numerous improvements in the health sector over the course of last few years which carry some promises for a better future.

2. Materials and Methods

Medical imaging has a 90-year history in Nepal, starting in 1923 when an x-ray machine was first installed in the military hospital in Kathmandu. However, there had not been much improvements in this sector until 1994. It was when the new era of medical imaging began with the installment of first Ultrasound, CT, MRI, mammographic, gamma camera and telecoalt-60 radiotherapy units [2]. In the last two decades, Nepal has been able to acquire approximately 1,200 x-ray, 800 US, 30 CT, 10 MRI (<= 1.5T) and 11 mammographic units. Likewise, there is also scarcity of skilled manpower in this area. There are only about 150 radiologists, 350 radiographers, 20 radiation oncologists, 8 radiation physicists and 20 radiotherapy technologists currently available all over the country [3]. These statistics are a result of lack of investment in the health sector by the government as well as the low level of healthcare practice followed by the people. A study says that the total expenditures on health care accounts for only 5.5% of the total government's annual budget and annual per capita health expense is only 29$.

To overcome these problems, first and foremost, enough manpower need to be generated in this sector. There has recently already been a provision of studying medical imaging technology and radiographic technology in few medical universities in the country. There should also be a practice of a semester exchange programs in the universities in Nepal where the students can go abroad and learn the medical practices taken in developed countries. This is set to produce more manpower in the decade ahead.

While the plans for producing enough manpower is on the way, the government can invest more in the healthcare sector. Firstly, they can attract the young entrepreneurs inside the country by funding them to a certain level to start startups inside the country. Secondly, they should try to lure foreign investors to invest more in healthcare sector. There are enough engineers and computer programmers in Nepal. One way could be to start a collaboration with the multinational companies like GE, Siemens, Toshiba and Philips in such a way that the engineers from Nepal can build different software solutions for these companies and these companies can provide their hardware like US, CT, MRI in return. Thirdly, the practice of health insurance could be made mandatory all over the country. This way the government can generate enough revenue from the people. In the same time, people can also make use of the medical imaging facilities which would have been very expensive l

The next and more difficult challenge is the topography of the country. Every year a lot of people in the rural areas die just because they cannot diagnosis the disease in its early stage as it is very difficult for them to travel to the central hospitals. More than that, a lot of false diagnosis happen due to the lack of skilled medical professionals as well as proper equipments in these areas. One way to solve this problem could be to train the local people in their area to acquire the medical data from the patients. These data can be uploaded in the cloud storage which can be easily accessed by the professional medical practitioners who provide better diagnosis. Possiblehealth is a perfect example of the healthcare center that uses this approach [4]. They have already treated/diagnosed more than 430 thousands patients since they started in one of the rural districts in 2008. In the next decade, these facilities should be established in more rural areas of Nepal.

Another way to solve the problem of topography could be to use the latest technologies like hand-held US, X-ray and Gamma cameras and the recorded data could be easily transferred to the medical doctors. This way it would be like bringing the hospitals to home instead of the patients travelling miles to reach hospitals. Similarly, another approach could to be use the drones and fly-boards to access the places which are very difficult to reach by using normal transport facilities. EHang is a Chinese company based on drones that developed the first autonomous aerial vehicle. This vehicle allows a person to be carried from one location to another automatically by just entering the location of the destination [5]. Similar vehicles have been developed by a German and a UK based company too. Similar technologies will be expected to be a great boon for highly diverse topographical country like Nepal in next few decades.

3. Discussion & Conclusion

It is very difficult to start something new where more than 25% of people live below the poverty line. The idea of making health insurance mandatory could be more than these people can chew as it is very difficult for them to even manage meals twice a day. However, the government can come up with a subsidized plan for such people.

The ideas presented above possess a great future for Nepal as these ideas have already been in practice in developed countries like US, UK, Germany, Canada etc. The idea of using the hand-held diagnostic devices could serve to be the best as it is very cheap as compared to the standard devices and requires less skilled manpower to operate it.

Also, the rules and regulations are not very complex as compared to in developed countries. This makes it less complicated for the investors and the entrepreneurs to invest their money in the areas they want. To put it together, Nepal is a country with numerous possibilities in healthcare and every new idea here could be ground breaking.

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Biography

Prabal Poudel comes from Nepal and is a PhD candidate at the medical faculty of the Otto-von-Guericke-University and an R&D engineer at the Chair of Intelligent Catheter and Image Guided Procedures. His main scientific focus are image processing, computer vision and machine learning.

Telemedicine: An Efficient Healthcare Solution for India

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1. Introduction

Healthcare and technology have long been partners in improving the healthcare scenario of the world. With respect to India, this partnership has been present since the late 1990's. Telemedicine is one of the many fruits borne by this very partnership and is defined by the World Health Organization (WHO) as "The delivery of healthcare services, where distance is a critical factor, by all healthcare professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of diseases and injuries, research and evaluation and for continuing education of healthcare providers, all in the interest of advancing the health of individuals and their communities."[1]

The telemedicine movement in India began in December 1999 in Aragonda in the Chitoor district of Andhra Pradesh. The setup went live in the early 2000's and still stands to this day. Though it has been present for a while now, it still has the potential to better the healthcare scenario in the country in ways we can only imagine. But, to understand that we must first understand what the current scenario of telemedicine in India is.

2. Current Scenario

With respect to telemedicine, starting from its initiation in 1999 to now, the government and private healthcare sectors have kept the ball rolling. The country has a total of 105 telemedicine centers as of August 2016 that are located all over the region. It is interesting to note the way telemedicine functions. The diagnosis of the patient is done by a telemedicine coordinator at the rural site with the help of the telemedicine module through the instructions of a physician that monitors all proceedings through a webcam. Patient data and information is transferred over large distances with the help of computers and integrated systems from the rural telemedicine centers to the specialty hospitals located usually in urban areas[2].

Telemedicine improves the delivery of quality healthcare by saving time and money in terms of travel and stay for the patient. It helps promote home and ambulatory care and facilitate active disease and epidemic tracking. A lesser-used advantage of this technology is that it can be used to spread awareness and educate the masses. Along with the benefits also come the limitation of this technology like low efficiency in the case of bad Internet connection and lack of integration and quality of health information records. Apart from this the lack of awareness plays a major role in improving the scenario[3]. If India is to improve its healthcare system with the help of telemedicine; these are the issues that need to be addressed.

3. Discussion & Conclusion

India has an adequate healthcare system, which needs to be improved into one that can cater to a large and diverse population effectively and efficiently without discounting the rural areas of the country. Telemedicine can be a solution to improve the quality of healthcare in the country and already has in place facilities for it but what it lacks is the awareness and infrastructure.

In any scenario it is imperative that the population is aware of what is happening. The same holds true for telemedicine and the solution to create awareness for this lies in the existing technology itself. Telemedicine can be used as tool to educate the population through videoconferencing wherein professionals explain its benefits and value.

In the case of infrastructure, India lacks a strong and reliable Internet connection. Telemedicine requires greater bandwidth to enable the fast exchange of data and information between the two sites (rural and urban). The improvement of the connectivity factor is vital if a change needs to be seen by 2030. Telemedicine modules are big and bulky even if they claim to be portable. Reducing the size of the components can lead to a decrease in its size as well as provide a scope to add more functions to them like integrating the modules with high resolution Magnetic Resonance Imaging that is small and portable and can be used for pre-screening of anemic patients. Apart from this, instruments to measure all vitals like heart rate, temperature, pressure, imaging, etc.

could be added which would definitely increase the functionality spectrum of the telemedicine centers and hence decrease the need for patient referrals (Figure 1).

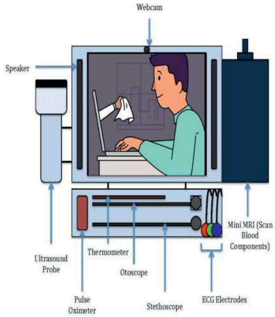

Figure 1: Conceptual Model of a New Telemedicine Module.

Similarly, integrating the specialty hospital's Electronic Medical Records with that of the rural center would be beneficial in many ways. It would mainly act as a platform that can be accessed from both ends (Physicians and Telemedicine Coordinators) in real-time that would in turn reduce the time and money spent by the patient for registration and waiting in the case of a referral from the rural center to the specialty hospital. In cases like this, the Health Records, could also be retrieved, analyzed and rectified in terms of change in treatment, by the physician when required (Figure 2). This would basically improve the information collection process, which is essential for the nt.pdf

Implementing changes like these are a herculean task but, not impossible. A collective effort from the government and people could very well salvage the Indian healthcare system and possibly make it one of the best in the world, which is the ultimate vision and telemedicine can make that possible.

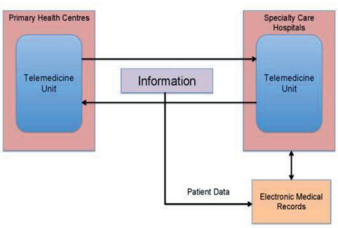

Figure 2: Workflow Depicting the Functioning of a Telemedicine System with an Integrated Patient Data Collection System.

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Biography

Mr. Elmer Jeto Gomes Ataide completed Master of Science in Health Informatics with a specialization in Healthcare IT Management, at Manipal University, India. He has worked on the development of a wearable device for diabetic patients and is currently pursuing his PhD at INKA at Otto-von-Guericke-University in Magdeburg, Germany.

Sustainable strategy for Egypt health care in current, 2020 and 2030

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1. Introduction

The Egyptian health care system faces multiple challenges in improving and ensuring the health and wellbeing of the Egyptian people. The system faces not only the burden of combating illnesses associated with poverty and lack of education, but it must also respond to emerging diseases and illnesses associated with modern, urban lifestyle. Emerging access to global communications and commerce is raising the expectations of the population for more and better care and for advanced health care technology.

A high birth rate combined with a longer life expectancy is increasing the population pressure on the Egyptian health system. By the year 2030 it is estimated that the population of Egypt will have grown close to 120 million people [1].

2. Pressure on Egypt health system!

Many worrying facts regarding Egypt's demographic future. The Egyptian population has been growing at unsustainable rates for decades. This population boom comes at a time when the Egyptian government has struggled to provide even basic government services, and the authorities seem unprepared to deal with the additional stressors that emerge from the accelerating population growth rate seen in the country [2]. Even the expectation for 2030, in the same time, there is a lack to have accurate population number in small cities or villages are not register in Population Census. For that the Ministry of Health and Population has taken many positive steps towards improving the health of the citizens in main city and countryside, a matter that is reflected in the improvement of some health indicators such as the control average birth rate. Meanwhile, considering the financial burden shouldered by the average Egyptian family it becomes clear that the health insurance system, in its current form, does not achieve its purpose, which may be due to the fact that the healthcare service provider is itself the financier of the service [3]. In light of the current situation, the healthcare system is in crisis due to the lack of separation between roles (planning role, the executive role, financing role, and the regulatory and supervisory roles) whereby the Ministry of Health and Population is responsible for all roles. Based on the aforementioned, the enhancement of citizen health and the development of the health sector should not be dependent on the Ministry of Health and Population's efforts only, but must also include the support and contribution of many parties both inside and outside the health sector.

3. Expectations strategy in 2030

The strategic visions for health to 2030 aims that all Egyptians should enjoy a healthy, safe, and secure life. Looking for high quality and universal healthcare system capable of improving health conditions through early intervention. Achieving satisfaction for citizens and health sector employees. This will lead to prosperity, welfare. So most of the Key Performance Indicators (KPIs) and initiatives center around ensuring that healthcare is affordable, that insurance coverage is improved, that reach is enhanced and that preventive healthcare becomes ingrained in the culture [4].

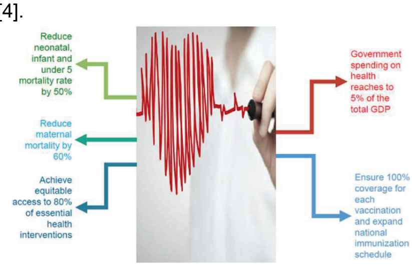

Figure 1: KPIs health care Egypt 2030 [4].

Table1, show a part of set indicators were chosen, to monitor the real achievements registered towards ensuring social health justice, current values as well as target values in 2020 and in 2030 have also been identified.

Table 1: Quantitative Indicators [3]

No	Indicator Category	Indicator	Definition	Current status	2020 Target	2030 Target
1		Life expectancy at birth (years)	The number of years newborn infant	71	73	75
2	Strategic Results	Birth rate (%)	The percentage of newborn	51.8%	39%	31%
3		The number of deaths from road accidents per 100,000	Measure the number of death cause by accidents	26	10	8

4. Discussion & Conclusion

By 2030 the key performance indicators Egypt expects to implement a system of universal health insurance for every Egyptian. Guarding safety, improving services and instituting universal health care will not amend the systemic faults such as administration, structuring and graft in Egypt's health care system. In light of the vision and strategic for health, Table 2, a new indicators has been proposed to be used to monitor progress until 2030. In order to qualify Egypt to become a leader in the field of healthcare services and research in the Arab World and Africa.

Table 2: Propose New Indicators

No.	Indicator Category	Indicator	Measurement Mechanism
1	Output	The proportion of health institutions that contain in their medicine stores, supplies and basic life-saving equipment on the visit day and the average of their availability	Building a database of information on all medicines, medical supplies, and equipment to facilitate its control.
2		The percentage of infections acquired from hospitals	- Building data linking different health institutions to facilitate the follow up of the number of infections acquired from hospitals and the number of departures in the same period. - Develop specific and uniform standards throughout the Republic for the accreditation of health institutions and to control them
3	Output	The accurate registration of births, deaths, and causes of death in the vital registration reports	Automation of the registration of births and deaths and developing a system to review the data and update the regulations to ensure accurate recording by facilities.

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Biography

Marwah Al-Maatoq is a PhD candidate at faculty of engineering and information technology of the Otto-von-Guericke-University and biomaterials engineer at the Chair of Intelligent Catheter and Image Guided Procedures. Her main scientific focus on optimization of MRI interventional devices visualization using different biomaterials strategies.

Mai S. Mabrouk an Associate professor of and department head of Biomedical Engineering at Misr University for Science and Technology. Her biography was selected to appear in Marquis Who's Who in the World in 2012. Along her career, she was a technical reviewer and editorial board member for several international journals and conferences. She published over 60 peer-reviewed journal and conference articles in the areas of medical imaging processing, Bioinformatics and human computer interface.

Impact of agricultural sector in improving the healthcare of Nepal by 2030

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1. Introduction

Health status of any individual cannot be assured unless he/she has the access towards balanced diet all year round, both in terms of nutritional and quantitative requirement. While the world is excelling to develop advanced technologies to ease human survival, here, on one corner of the world, people are struggling to sustain their lives due to the lack of proper technologies.

Nepal is a country, where more than four-fifth of the working population live in rural areas and depend on subsistence farming for their livelihood. The loss of about 60% of production during harvesting and post-harvest has worsened the situation. This is the reason for existing food insecurity in rural Nepal and also accounts for more than a quarter of population remaining below the poverty line. The food insecurity has led to a severe problem of malnourishment among these rural people ruining their health and leading to untimely death as well. All these account for the 36% of stunted, 27% of underweight and 32 per thousand live births as of infant mortality rate among Nepalese. Also, the ill practice of overusing harmful insecticides and pesticides is increasing the risk towards cancer, other respiratory diseases, disruption of endocrine system and severe birth defects as well [1].

However, the silver lining of hope is still gleaming since the trends in awareness of rural farmers on consumption of nutritious food sources and willingness to learn and adopt new tools and technologies is increasing in the recent years. Commercialization of farming and agro-entrepreneurship is also paving a pathway towards ensuring food security and nutritional requirements. This rate of increased awareness and improved government and local level efforts shall certainly improve the health status of Nepalese farmers in the coming decades.

2. Materials and Methods

The first and foremost approach that could be adopted to overcome these problems could be by promoting the concept of Homestead Food Production (HFP). Homestead food production is the production of crops, vegetables and fruits at kitchen garden or household level, initially for the consumption within family and also aims at commercialization. This shall be the strongest means to improve the nutritional status and hence uplift the health of those households in the long run. The concept of Homestead Food Production was started in Bangladesh and since then, this concept has been proven and adopted at different corners of the world as the most basic step towards assuring better health of individuals. In Nepal at least half of preschool children and pregnant women are affected by micronutrient deficiencies [2]. Anemia among women and children aged 6 to 59 months decreased during the HFP practice in some countries [2]. To combat these deficiencies and resulting negative health outcomes, promotion of this concept can be highly fruitful. Growing of seven to ten different types of vegetables and fruits, field crops and a source of animal protein like poultry and goat farming at household level shall certainly increase the household food availability all the year round, consumption of balanced diet and income; thus the existing problem of food insecurity and malnourishment can be minimized to a greater extent. INGOs in Nepal are already working on it and in the next 5-10 years, this seems to be the program where the government would invest a lot of resources to bring specific programs. This would certainly produce ample technical manpower in this field as well as change the attitude of people towards the benefits of HFP. On availability of improved seeds and micro irrigation technologies through government service providers; farmers are sure to be adopting this improved concept of HFP optimistically and by few decades, malnourishment shall be limited to fairy tales even in the rural most villages of Nepal.

Minimization of cultivation costs, harvest and post-harvest losses through adoption of newer and cheaper technologies can lead to increased production and this shall certainly help in meeting up the year round availability of food sources. Latest handy technologies such as power tiller and threshers have maximized the profit and minimized the loss during production and harvesting. Cost minimization assists in uplifting financial status of farmers, which in the upcoming decades, will be the factor resulting in increased investments on health sector by every farmer families. Proper technologies for storage of vegetables can improve health of consumers by assuring their quality. For example, potatoes upon storage by exposing to light turn green and lead to toxicity because of the accumulation of Glycoalkaloids [3]. On this regard, adoption of Root Cellar Storage Technology in rural villages of Nepal can be a fruitful way in ensuring quality of potatoes and many other vegetables and fruits in the upcoming years, which shall prevent the degradation of health due to consumption of unhealthy products [4]. Additionally, the implementation of rules and regulations to maintain the food quality by the government in the next decades would certainly play an important role in improving the health quality all over the country.

Haphazard use of chemical pesticides and insecticides leading to dreadful health hazards is one of the greatest threat among the mass of illiterate farmers of rural Nepal. Adoption of latest technologies on Integrated Pest Management (IPM) such as plastic tray, light trap, pheromone trap and other physical and cultural methods help to minimize the use of chemicals. For instance, the use of pheromone trap for onion protection against cut worm in Philippines has decreased both the pest incidence and use of harmful chemicals [5]. Knowledge of IPM technologies also involves judicious use of chemicals which disposes farmers towards reduced risks of health hazards. Establishment of IPM demonstration sites by local authority can also bring a good change. Also diagnostic tools, pest population forecasting systems [6] and use of ICTs to help farmers with weather forecasting through push messages on their cell-phones have been highly beneficial and are supposed to be a big trend in the coming years in the context of Nepal.

3. Discussion & Conclusion

The concept of HFP in the next decade will play an important role in increasing the quality production at household level, thus leading to good nutrition among the rural people which ultimately will uplift the health status of these people. Similarly, the subsidies by the government to buy modern equipment and adoption of integrated pest management technology will reduce the use of pesticides and thus minimize the risk of fatal diseases.

The ideas discussed above are simple yet very effective as they have been already implemented in various scenarios. The adoption of these technologies in Nepal possess a great potential to directly or indirectly improve the financial as well as the status of healthcare in the years ahead.

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Biography

Lushan Ghimire comes from Nepal and is a student at Tribhuvan University, Nepal specializing in agricultural studies. Currently, she is also a Homestead Food Production Marketing Officer of Good Nutrition Project funded by USAID and led by Helen Keller International in one of the rural districts of Nepal. Her main scientific focus is plant genetics and being on this field, she aims to improve the agricultural scenario of Nepal.

DEDICATED HEALTHCARE TECHNOLOGIES

Concept for a comprehensive simulation based tool to assist intracranial aneurysm treatment

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1. Introduction

Intracranial aneurysms are local dilatations of brain vessels with an estimated prevalence of 5 %. To prevent aneurysm rupture and severe brain bleeding, endovascular treatment has been established. Stents to assist coiling therapy and flow diverting stents are important devices to gain an improved clinical outcome.

During the implantation of such devices an unintentional deformation of the artery due to the stiff stent structure was observed in several cases. Figure 1 shows an aneurysm from 3D rotational angiography at the middle cerebral artery bifurcation before and after the intervention with severe deformation.

This leads the authors to the question: Can this side effect be used to intentionally provoke an advantageous artery configuration to improve the blood flow behavior?

Figure 1: Segmentation of pre- and post- interventional vessel lumen: before intervention (left), follow-up (middle) and superimposed (right). The dashed lines indicate the approx. stent position and reveal a severe deformation of the aneurysms parent vessel causing changes in the local blood flow behavior.

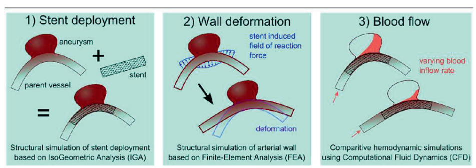
2. Description of Idea

Our proposed approach aims to provide scientific insights into the stenting procedure, the induced wall deformation and the resulting hemodynamic changes. The simulation of different configurations within the intervention planning should lead to a better understanding of the possible issues and estimation of the clinical outcome. The necessary simulations can be further divided into three main tasks, the whole workflow is presented in Figure 2:

1. Realistic stent deployment
2. Deformation of the arterial wall
3. Comparative blood flow simulation

2.1 Realistic stent deployment

The simulation of stent structures poses its own challenges in terms of capturing real material behavior arising due to its ‘smart’ material properties. With features such as excellent biocompatibility and high flexibility, Nickel-Titanium alloy is one example of a smart material which is a prominent choice for stents.



Computational modeling based on Finite Element Analysis (FEA) is a popular tool and is proven to be an important aid in gaining detailed information about the structural properties. However, FEM has its own challenges in terms of a) capturing the accurate geometry of the stent from CAD geometry and b) high computation effort and time. In order to overcome these drawbacks, a numerical method called Iso-geometric Analysis (IGA) based on non-uniform rational B-splines (NURBS) has been developed. NURBS based computation can be an important step ahead towards 'real-time' simulation.

Figure 2: Concept of proposed workflow going from left to right: Calculation of 1) stent deployment,
2) induced vessel deformation and 3) resulting hemodynamic changes.

The accurate stent deployment simulation addresses the following aspects:

1. Optimal positioning of the stent with regard to the aneurysm ostium, side branches and wall alignment.
2. Identification of stent regions which are prone to kinking, compression, high stress values.

2.2 Deformation of the arterial wall:
As second step the vessel lumen from medical imaging is used to set up a FEA or IGA model of the arterial wall. The force field acting on the wall obtained as a result from the stent deployment in step 2.1 is imported and calculated in order to reproduce the assumed vessel deformation. Depending on the stent model and size, different grades of deformation are expected and can be compared in advance. With regard to increasing capabilities of medical imaging, more and more individual properties can be involved in the simulations, including material properties, accurate wall geometry and interaction with surrounding tissues. The resulting post-interventional state is then used for the third task.

2.3 Comparative blood flow simulation: Aneurysm occlusion is closely related to a decrease of blood amount entering the aneurysm and reduced blood velocities inside the aneurysm in order to cause thrombus formation and prevent aneurysm rupture. These quantities rely on the actual vessel shape and the implanted devices (coils, stents). The presented approach suggests to incorporate both of these aspects into advanced hemodynamic simulations, based on Computational Fluid Dynamics (CFD). Therefore, the pre- and post-interventional state is simulated and compared. Accordingly, different stent designs and positions might be compared in order to find the best option for a certain patient.

3. Discussion & Conclusion

The authors present a concept for a simulation based tool to assist minimally invasive treatment of intracranial aneurysm. To their knowledge, this is the first attempt to perform and combine a) fast and realistic stent deployment using IGA, b) structural modeling of the stent induced vessel deformation, and
c) comparative hemodynamic simulations. Accordingly, this investigation aims at a targeted modification of the parent artery in order to slightly redirect the blood reducing the blood inflow rate into the aneurysm. This might be a new approach to improve the rates of complete aneurysm occlusion in the long term.

4. Funding

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Biography

D. Juhre (Jun-Prof.) and S. Chavalla (PhD student) are working in the field of material modeling & characterization, continuum mechanics and finite element simulations for several years. G. Janiga (PD) and S. Voss (PhD student) are working in the field of biomedical flows, Computational Fluid Dynamics, virtual stenting, fluid-structure interaction for several years. O. Beuing (MD) is working as senior physician with several years of clinical and research experience.

Thin-film Surface Opto-Electrodes to Control Neuronal Activity

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1. Introduction

Currently, electrical methods are the preferred way for therapeutic brain stimulation. Despite the name, however, electrical stimulation often relies on disturbing or silencing a brain structure instead of truly stimulating it. In addition, electrical methods cannot be targeted to specific neuronal subpopulations but rather act on all neural elements within effective reach of the applied electric field[1]. Much more precise neuronal stimulation has become possible through the use of optogenetic tools[2]. These engineered and proteins, derived mostly from algae or bacteria and expressed in neurons, allow selective stimulation or inhibition of a particular neuronal subpopulation. In order to use such tools to "write" information of meaningful complexity into the brain, the current stimulation devices have to develop much further. Currently, most experiments use single optical fibers to guide light to the stimulation site[3]. The stiffness, size and invasiveness of such fibers critically limits their number in a therapeutic context. In result, only low resolution stimulation is possible, Here we present the approach of using LED surface illumination to project high resolution patterns of stimulating light into neuronal tissue. High numbers of individual light emitters are implemented into a thin polymer foil. These emitters can be individually addressed, for example using printable semiconductors. The emissive surface can therefore generate highly dynamic stimulation patterns tailored to neural activity which is measured simultaneously from electrodes placed next to light emitters.

2. Materials and Methods

Our electrodes are based on a polyimide thin-film process in which metal layers are deposited and lithographically structured between individual polymer layers. Within this sandwich structure, individual micro-LED emitters are placed and embedded. Openings in the surface of the opto-electrode make contact with tissue fluids and allow simultaneous recording of neuronal activity along with optogenetic stimulation. Currently, our opto-electrodes route connecting traces for LEDs and electrodes individually to a connector. While we have achieved a high reliability of contacting these individual traces through a cost-effective flip-chip soldering process, packaging presents a challenge to achievable channel counts and device reliability. Thus, we are exploring options to serialize the interface through the use of active switching electronics on the implant. Such a strategy would allow for surpassing the current technological limit of 128 individual stimulation and recording channels.

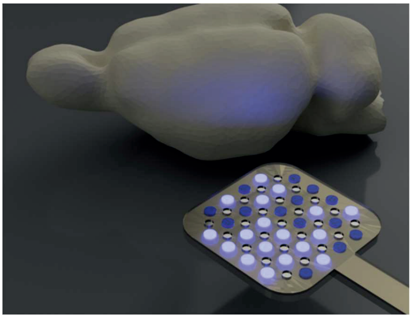

Figure 1: Rendering of a 32-channel thin-film opto-electrode in comparison to a mouse brain.

3. Discussion & Conclusion

Using surface illumination to optogenetically stimulate neurons bypasses the need for light guiding structures and, hence, allows higher density stimulation than what can be currently achieved. Our polyimide-based thin-film opto-electrodes present one approach to bring high numbers of individual light emitters into close proximity to the optogenetically sensitized brain. Active switching electronics will allow future devices to contain thousands or millions of individual stimulation "pixels" and recording electrodes. While such a complexity is certainly advantageous for brain stimulation, even peripheral neuronal stimulation applications could benefit. For example, retinal implants or cochlear implants with unrivaled spatial resolution can be developed. In the case of direct brain stimulation the achievable high emitter density would, for the first time, allow a read/write neural interface with meaningful bidirectional bandwidth. The use of light-field excitation[4] or directional light emission could even further increase achievable stimulation complexity. However, one of the biggest obstacles in efficiently exploiting such complexity is light scattering in brain tissue. This issue is exacerbated by the short wavelengths typically used for optogenetic excitation. Currently the most promising solution to these scattering limitations is the development of red-shifted optogenetic probes. To excite such a probe, the light emitters emit red or even infra-red light which is scattered much less compared to currently used blue light. Red light is also absorbed less by blood, further increasing penetration depth and limiting potential thermal damage of the stimulation[5].

In conclusion, high density surface emitting opto-electrodes provide a promising approach to manufacture practical read/write neural interfaces to the brain and peripheral neuronal tissues with meaningful bandwidth.

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Biography

Michael Thomas Lippert is a group leader at the LIN in Magdeburg, Germany. He has previously worked at the Max-Planck-Institute for Biological Cybernectics in Tübingen and received his PhD in 2010 from the Otto-von-Guericke University in Magdeburg. He specializes in optical techniques to measure and influence neuronal activity.

Martin Deckert works as a research associate at the Chair of Microsystems Technology at OVGU Magdeburg, Germany. In 2007 he earned his Master's degree at Rose-Hulman Institute of Technology, Indiana, USA. His diploma in the field of mechanical engineering was granted at OVGU in 2008. Currently, Mr. Deckert is completing his PhD with respect to the development of novel MEMS optrodes.

MEMS, Is it a vision? Or a challenge to enhance the Medical hospitalization?

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1. Introduction

The emerging world of microsystems is building strong foundations in innumerable areas of Medical applications. Microelectromechanical systems (MEMS) are known for more than 80 years, utilized in many fields gaining experimental and economic accomplishment.

The health care industry showed more attention on microsystems as it is undoubtedly helpful to perform microscale operations and processes in human body for accurate success. Yole development is one of the excellent companies, which provides different micro-devices like bio-sensors, bio-chips, microfluidic devices and solutions for medical problems along with commercial contribution.

MEMS market share is predicted to increase 72% in the global medical arena. So, this kind of exposure in health sciences and Medicare industry may lead to precise and fast treatments for people.

2. Materials and Methods

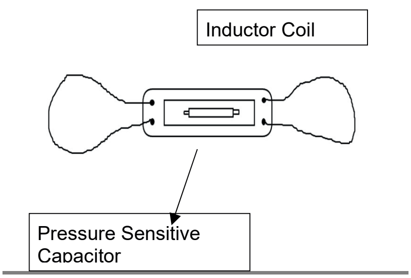
The methods used to develop MEMS devices are categorized basically into four Processes. They are: -

1. Photo lithography or Soft lithography (which transfers pattern into the material)
2. Thin film growth/deposition (films of µm range are deposited or grown on a substrate)
3. Etching (which creates components by removing films/substrates from a well-defined pattern)
4. Bonding (mostly framed with films)

Coming to the type of materials used are mostly semiconductors. Silicon is one of the earliest microfabrication material used in most of the applications, because of its outstanding electrical and mechanical assets. But in medical applications, silicon cannot be good choice, due to its cost and lack of transparency. Borosilicate wafers, fused silica wafers, polymers like Parylene, Metals like platinum, Silver etc are some of the materials used in manufacturing some microdevices, which may act as contact sensors to sense some required inputs and display outputs even from micro displays.

For the clear understanding, MEMS device in Medical field, it is better to notice the bio-MEMS system with method of fabrication and usage of material.

Cardio-MEMS device is one of the example for microelectronics application. The materials required for this device fabrication are copper-sheathed liquid crystal polymer, PTFE. This



can be manufactured by Photolithography or wet etching.

Figure 1: Cardio MEMS Heart Failure Sensor [1]

This device recognizes the changes in pressure and monitors Pulmonary artery (PA) blood flow data. This system has the following components.

- Wireless Implantable Sensor
- Hospital or Patient electronic system
- Patient database

This sensor can be permanently implanted in the Pulmonary artery.

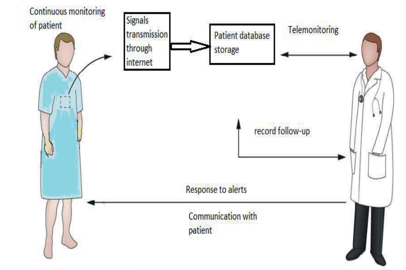


Figure 2: Measuring of pressure using Cardio Sensor at home. [2]

After its implantation, this provides continuous and uninterrupted information about hear pressure and any changes in the blood flow. The patient's data is secured in the respective physician system or in hospital, which can be available in all times in internet.

Results of the Cardio HF sensor are tremendous. Medical management became very easy for the patient to obtain prior treatment according to the alteration in pressure in the heart. This device led a way to decrease in the heart failure patients admitting in emergency cases. So, there is substantial reduction in the sudden heart deaths, due to heart failure and slow medication.

3. Discussion & Conclusion

Extraordinary development of uninterruptable device for a long-term monitoring of pressure changes in the heart and critical changes in patients coined the term homecare and telecare in Medical applications for cardio attacks, based on the information obtained from the sensor at home and collection of data by electronic system in hospital.

The main areas that can be improved by these bio-MEMS are:

- Irrespective of rural and urban places, it can be fitted in any home and monitored from even normal hospital with electronic data collection system
- Patient can be skipped from long-waiting times and expensive treatments as it is prior indicated and leads to decrease dangerous situations
- Application and implementation of microdevices will be improved with less cost and ease of operation

These developments are taking place from 1970's starting as microelectronics field, but improving with its vast involvement in healthcare systems. As of now, there are lot of microdevices like pressure sensors, microfluidics, accelerometers etc in the fields of medical imaging, diagnostics, drug delivery and surgeries.

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Biography

I am Jaya Lakshmi Mekala studying Masters in Medical System Engineering. I have my Bachelor degree in Mechanical Engineering in India. I am more fascinated in the area of computational fluid Sciences. This interest drew my attention for working on many projects for the simulation and analysis of fluid flows in certain devices. World is full of microelectronics in every application. This quest made me to integrate my interest in the field of microelectronics.

Recent and Future Directions in CT Imaging

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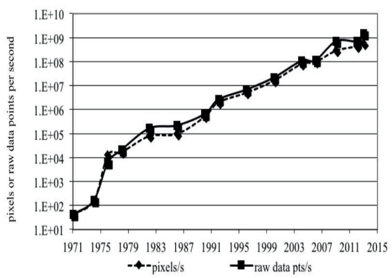
1. Introduction

Computed Tomography has made enormous technical advances since its introduction into clinical use. The engineering improvements have in turn led to important clinical applications and significant impact in patient care. This paper reviews the technology development trends in Computed Tomography since its introduction and uses these trends to help illuminate likely future progress. The expected future developments in sped, spatial resolution and dose efficiency can be expected in the next decade.

2. Materials and Methods

Computed Tomography is a diagnostic imaging technology that uses X-rays to measure the projection of an object from all directions, and from that data reconstruct the linear attenuation coefficient throughout the object. As can be seen in figure a phenomenal increase in imaging speed of CT since its introduction in the early 1970's. the growth n imaging speed is essentially exponential.

Figure 1: Speed of CT since its introduction in raw data points measured per second, or in the number of pixels that the measured raw data is used to reconstruct.



The desire to reduce radiation dose has more recently emerged as an additional technology. CT imaging was responsible for approximately half of the man-made radiation dose. CT technology development in the coming decade can be expected to be driven by same factors that have driven the development of the CT since its inception: image quality, speed, new and improved applications, and dose reduction and cost reduction.

The imaging speed of CT since has increased by 9 orders of magnitude in 4 decades. This great increase has been accomplished using two approaches. One is important of scan time itself, that is reducing the time it takes to collect the data foe any single slice. The second is increasing the data foe any single that are measured in parallel using multi-detector row technology.

The minimum, time of Ct system over the next decade might be reduced from current values of around 0.250s to 0.15 – 0.2s. this would lead to minimum imaging times of around 0.040s in dual source system and about 0.075s in conventional single-source systems.

An important determinant of the spatial resolution of a CT scanner is the detector aperture the spatial resolution of the detector itself. The reason for this is the detector technology that's been used in CT since that time. All current commercial systems use scintillator photo diode detectors. They comprise scintillators that are individually cut and polished, coated with reflectors to prevent crosstalk between cells, and optically coupled to photo diodes. The nominal spacing of these detectors is ~1mm, the typical thickness of the reflectors on the order of 100 microns.

Even though it is difficult to improve the aperture and the sampling of CT detectors, it is worth to do so, obviously, the limiting spatial resolution of the system would be improved, but interestingly, the detective quantum efficiency of the system would be improved substantially, especially at mid to high frequencies. The reason for this is that while the finite resolution of the CT detector blurs the signal, the noise in the various detector cells is independent. Thus, even though the modulation transfer function is a attenuated at mid to high spatial frequencies, the noise power spectrum is not. That shows the accuracy of the CT scanner in the these very high resolution tasks would be significantly improved.

Turning now to the issue of radiation dose, it is worth noting the recent progress and future advancements that can reduce the dose to the patient from CT exams. Important dose reductions have already been obtained through the development of optimized imaging protocols, smarter and more efficient X-rays been collimation, advanced reconstruction algorithms and by control of the X-ray flux illuminating the object.

However, even further improvements could be achieved with more flexibility in controlling the X-ray illumination. Inverse geometry CT is a new system architecture that can customize the illuminated flux though the concept of virtual bowtie. But is very complex. Recently dynamic pre- patient attenuators with either piecewise constant or piecewise linear attenuation have been described. Such very fine controls in a sense, personalize the illumination pattern to the patient and application and have been shown to be to improve the dose efficiency by factor of ~2. Thus, in future the radiation dose may be totally reduced.

3. Discussion & Conclusion

Computed Tomography technology has made tremendous advances since the technique was introduces in the early 1970's. the technical improvements have led to excellent and reliable image quality and in turn to its ubiquitous use in clinical medicine.

By analyzing the historical trends informed predictions of future directions can be made. Improvements in temporal resolution can be expected, with minimum rotation times of less than 200 milliseconds, scan times of 80 milliseconds for single-source system and 40 milliseconds for dual source systems, and further immunity from residual motion using reconstruction will continue to become more widespread as the algorithms become more robust and the reconstruction times become shorter.

If X-ray detectors with finger apertures and fast photon counting capabilities become available, it is likely that they will be introduced first for targeted deployment. They can be expected to produce substantial improvements in spatial resolution, and in detective quantum efficiency, especially at mid to high frequencies.

Lower radiation dose will be achievable using these higher efficiency detectors and advanced reconstruction algorithms.

Through all of this, exciting advances in diagnostic computed tomography can be expected.

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Biography

Pamulapate Lokeswara Reddy pursuing Masters in Medical Systems Engineering in Otto-Von-Guericke-University of Magdeburg. Completed my Bachelor's in Mechanical Engineering from JNTU Hyderabad. Interested in new innovations and new ideas.

Prospects for Customized Medical Implant in the Field of Endoprosthetics

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1. Introduction

Medical implants are man-made devices inside or on the surface of the body, intended to restore or support in somehow human tissue and organ functions, deliver medications or monitor vital parameters. Compared to more sophisticated implants such as intraocular lens or cardiac pacemakers, artificial joint replacements have to fulfil more or less simple tasks. Their purpose is to substitute the bone and cartilage tissue and replace the mechanical as well as support function of the joint, therefore sustaining the patient's ability to move without pain.

The following article deals with potential future developments in the field of orthopedics replacements as well as medical implants in general. Considerations of the impact on medicine and society give an idea of how life would look like in 2030 and later in 2050.

2. Materials and Methods

Arthroplasty as the replacement of a human musculoskeletal joint is widely recognized as one of the surgical breakthroughs of 20th century, restoring and preserving quality of patient's life as few other standardized surgical treatments.

For this reason, the amount of total joint replacements (TJR) increased steadily over the past decades. Although the nature of the growth is unclear, it is unquestionable that the future demand for TJR will have a major effect on the healthcare systems of countries such as US, UK or Germany. Assuming a linear relationship, the number of total hip and total knee replacements is expected to grow in the US by ≈ 50% from 2006 to 2030 [1] and ≈ 34% from 2015 to 2035 in the UK [2]. Considering social influences such as the development of the average BMI, changes in population demographics and an increase of life expectancy with a simultaneous increase in the number of young patients (<65 years) results in a virtually unpredictable future impact on the healthcare system costs of these countries. [1-2]

Nevertheless, research focused mainly on geometry, tribology and bearing materials, while selection of the appropriate implant is still based on a more or less simple one size fits all approach. Patient-specific differences are only considered by geometry, diameter and length of the shaft and size of ball head and acetabular cup. It is obvious that issues like variations in the morphology and structure of the bone, the type of fracture and tissue properties related to gender, age and health condition of the patient cannot be addressed sufficiently by the standard care.

One possible solution to overcome these issues are customized 3D-printed implants. Modern image modalities such as CT or MRI have made it possible to create digital 3D-models of complex body structures while advances in additive manufacturing opened up new possibilities to use these data. Researchers and physicians are able to build models of specific anatomical structures for treatment and intervention planning for example. Using common bioinert and bioactive materials such as Titanium or Hydroxyapatite for printing, the procedure could be used to fabricate personalized implants. Next step in this direction would be the use of biological materials and tissues for manufacturing, called bioprinting or biomanufacturing. The application of patient-specific cells or adult stem cells would empower physicians to build endogenous bone and cartilage grafts in the laboratory. Such a customization to the specific conditions and needs of patient would result in major advantages. Instead of restoring solely the mechanical function, such grafts would be capable to perform biological and physiological tasks as well.

Although significant steps have been taken and applications already exist (e.g. cultivation and transplantation of knee cartilage), there are still a lot of obstacles to overcome. The development of appropriate printing modalities and bio inks, the use of suitable scaffold materials and the integration of growth factors to just mention a few of them. Besides that, the micro and macrostructure of included cells and the vascularization of the graft is crucial to ensure required physical properties and a viable integration in the human body. By overcoming these issues, the workflow of a arthroplasty in 2050 could consist of subsequent steps, shown in Figure 1. Nevertheless, customized implants out of bioactive and resorbable materials will be required for many reasons beyond 2030. For example, for delivering growth factors to the transplant-bone joint, to promote ingrowth and bone healing. Another application is to ensure stability of the interface until the graft is incorporated into the tissue structure or to monitor curing process with supplemented sensor hardware.

Implementing the approach of customized implants and treatments into medical practice by 2050 would probably result in a better outcome for patients, less revision surgeries and a decrease in follow-up costs.

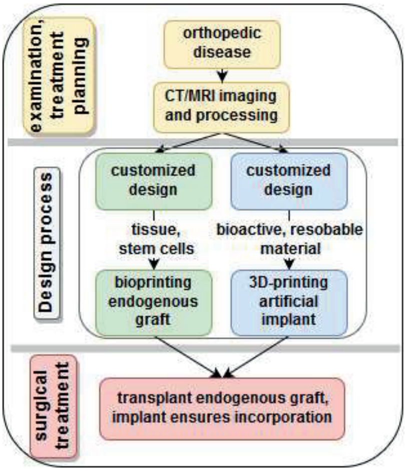

Figure 1: Possible workflow of a customized arthroplasty in 2050.

3. Discussion & Conclusion

As the example of endoprosthesis shows, the approach of bioprinting custom-made and endogenous medical implants is promising. However, key prerequisites are a decline in rapid prototyping costs and fundamental breakthroughs in tissue engineering technology in the next decades.

The effects on society would be fundamental, especially related to healthcare. Once able to manufacture and replace bones, it is easily imaginable to print more complex tissue and whole organs. Furthermore, it would open up the possibility of conducting clinical trials and safety and performance tests for new medicinal drugs and devices without animal testing or patients being involved. Hence resulting in an accelerating effect on development of pharmaceuticals and medical treatments. Related to educational aspects, organs out of the laboratory could be used for teaching of physicians and surgeons, who could perform surgical interventions on living samples without any risk. All in all, it is hard to predict whether the impact on medicine would lead to increasing or decreasing of healthcare costs.

In addition, the entrepreneurial opportunities of this technology are divers, but also challenging and risky. Future health policies and regulatory requirements, although difficult to predict, must be considered. Furthermore, a longer time to market, a viable commercialization pathway and the management of intellectual property should be carefully examined. [3]

However, the potential of this technology to significantly influence life in 2050 is promising.

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Biography

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Estimation of arterial compliance through noninvasive blood pressure waveform

I-Lu Chen[1], Yashbir Singh[1], Wei-Chih Hu[2]

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1. Introduction

Cardiovascular disease has become the foremost part of mortality rate in the world. This disease follows an asymptomatic phase of development which builds up in body silently over a period of time without any major sign on health of an individual. Many recent studies showed the relationship between biological aging and arteriosclerosis towards the risk of cardiovascular diseases, such as hypertension, hypercholesterolemia, and end-stage renal failure. Arteriosclerosis is a commonly occurring form of cardiovascular disease. This is very common health condition that exhibits significant changes in distensibility, compliance, and elastic modulus of the arterial vascular system [1] which is related to spreading of fats, cholesterol; initiate the damaging of endothelium which leads to the formation of plaque. These factors create severe narrowing, decreasing wall buffering capacity and hardening of the arteries [2]. In this work, we aimed to develop a method of evaluating arterial compliance using non-invasive blood pressure waveform.

2. Materials and Methods

Overall framework in this paper has been majorly grouped into various categories namely data extraction, algorithm implementation, waveform computation, experimental architecture.

Data Extraction: In this step, we extracted data from arteriosclerosis screening device (Colin VP2000, Omron, Japan) (fig.1) that measures non-invasive blood pressure [3]. In case of invasive blood pressure data acquisition, we used Millar catheter (fig.2) which consists dual pressure sensor [4]. This device can capture invasive blood pressure waveform of two arterial positions simultaneously.

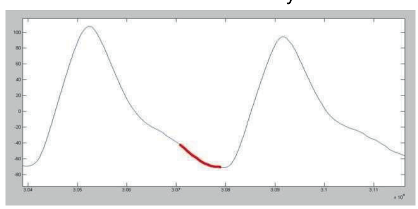
fig.1

fig.2

Algorithm implementation: We use the Windkessel model to estimate the arterial compliance (decay constant) as vascular index using data after aortic valve close to the end-diastolic point of blood pressure waveforms [5]

$$P(t) = P(t_0)\times e^{\frac{t}{RC}} = P(t_0)e^{-\alpha t}$$

(t): Blood pressure value at time (t), P (t_0): Blood pressure value at time (t_0), t: time (t); R: Resistance of the blood vessel; C: compliance; α: Decay constant Waveform computation: we used algorithm to calculate blood pressure wave data. We have taken noninvasive data from oscillometer and Pulse volume recording (PVR); invasive data was taken from aorta and bronchial artery.



In this figure, blue line is for the blood pressure waveform; red line is the assessment section for invasive and noninvasive

After getting data, we propose invasive and noninvasive degree of arterial compliance using Bland-Altman difference plot, T-test, box whisker plot and Scatter diagram.

Experimental Architecture: We took a group of 15 volunteers for this experiment; the purpose of this study was explained and written consent was taken from them. After that we measured simultaneously invasive and non- invasive blood pressure waveform signal from Oscillometer and Millar catheter, before and after applying nitroglycerin (NTG).

3. Discussion & Conclusion

Previous studies suggest that assessing of the arterial compliance using invasive way was more precise. Most of the methods have been used to estimate compliance, but till date there are no longitudinal studies that relate abnormal compliance. According to clinical data, arterial compliance was estimated by in vitro methods using excised arteries. In vivo (invasive) methods of determining compliance frequently use pulse contour analysis and require catheterization. The other invasive technique for estimating compliance was intravascular ultrasound. With this technique, it was considered pressure and area simultaneous. Pulse wave velocity (PWV) uses the concept for hard artery and faster pulse wave transmission. While transcutaneous ultrasound techniques are limited by the ability of the ultrasound method to accurately image the anterior and posterior arterial wall. Each technique has limitations and not more frequent (6, 7); but in this study we performed analysis with physiological real data and find the better correlation to the non-invasive and invasive blood pressure wave form. We used the exponential decay constant of the blood pressure waveform in the exponential linear function. Non-invasive compressive pulse waveforms can be used to assess the total compliance of the arterial blood pressure waveforms of the invasive aorta that indicates non-invasive vasculature waveforms which contain the buffering of muscle and adipose tissue. Arterial algorithm can be use direct on the electronic sphygmomanometer, so that subjects can be measure arterial compliance immediate, doctors could get the patient's daily situation and it would be great potential in the homecare application.

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Biography

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Advanced Medical Therapeutic Ultrasound — small, versatile, cheap Diagnostic and Therapeutic solutions

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1. Introduction

In the modern era, technology leaves an undeniable impression in medical world. Recent years many countries show their interest and made a significant investment in healthcare systems. We can see technological growth rate exponentially in the area of medical imaging modality. This exponential technology delivered more reliable, smaller and improvised products or services. MRI and CT are the most popular imaging modality and also give an ideal contribution to diagnose diseases so it becomes favourable research field. Ultrasound has less popularity and gives poor result compare with other imaging modality but there is some remarkable aspect about ultrasound such as a lower price, easy to handle, flexibility, etc. An ultrasound machine has become smart choice for small hospitals and clinic. Present day ultrasound is specifically used for imaging of unborn baby, measure blood flowrate and therapeutic solution. Transducer and display are the important component of ultrasound which is dominated by MEMS and electronics technologies. The main focus of this abstract is to show the new approach of a transducer and vast future opportunities of ultrasound for an entrepreneur. This abstract contains future concept and approach for transducer, opportunities and challenges and conclusion.

2. Future concept and approach of ultrasound device

Future of medical system engineering can be approximate by looking towards the trend of research and development work. According to projection of Moore's law, the computer will able to calculate billion of arithmetic operation in a millisecond in near future so this speed of computer processor can help to reconstruct 3D image [1]. Interlinks between medical devices and MEMS technology can able to change the whole scenario of medical engineering world after two decades.

Medical ultrasound was first used on members of European soccer team as physical therapy in years of 1920. After two decades this device was first used for diagnosing arthritic pains. Size and shape of ultrasound device keeps changing after adopting research and development in transducer and display

Figure 1:Siemens ACUSON freestyle Ultrasound device

technology. Figure 1 shows advance innovation on ultrasound machine which have wireless transducer with the display [2]. Ultrasound machine efficiency and quality were improved by introducing MEMS technology and advanced display technology gives better resolution. Dimension of all component of the transducer could be up to millimetre scale Using MEMS technology. The future size of the transducer will near to cap of the bottle. Group of subtle components of transducers could be arranged in the array so there will be multiple source of ultrasound. This transducers will scan organ from different direction and create 3D Image. The organ will surrounded by soundwave sources. The transducers will start one by one to avoid image disturbance.

Figure 2: Future 3D Ultrasound display control by hand gesture

Wireless transducers will become much smaller and lighter. A Face of the transducer will make of special kind of rubber material so sound waves can be entered in human tissue without any interrupt of air and also able to stick with skin. We do not need a special operator for the ultrasound machine. Interface of this devices will become much easier and able to connect with 3D screen. In 3D screen image can manipulate by hand gesture. Figure 2 shows in the future doctors will try to change 3D image position by hand gestures [3]. Special kind of ultrasound contrast agent will introduce which can give more precise image value.

For doing therapeutic treatment, gel will take place inside the transducer and automatically fill gap between transducer face and skin. Some robotic method could be implanted to keep moving around desire body parts. Healing speed will optimised with new innovation in this field.

There will be very limited use of MRI and CT scan because ultrasound will employ every place where MRI and CT are to be intended. Use of ultrasound will become a vital surgical tool in operation room for doing surgery. Every electronic devices inside the operation room will become completely wireless and attach with high effective battery.

3. Challenges and opportunities

Basic training will necessary to use a new devices for doctors. Robust standard protocol will take place to support radiation free environment which makes restriction on X rays. The complexity of product will increase so it will bring difficulties during manufacturing of medical devices.

Different field of studies will be merged and open new area for innovation. Production of Artificial bio-organ, Laser tools, Ultrasound machine and a robotic system will give profitable business in future.

4. Conclusion

In the future all medical devices will specifically improvised and give superior output but only cheap and reliable product will able to survive in the market. Ultrasound will gives one of the most cheaper and efficient images so it will highly qualify to become essential imaging tool in future. In order to achieve this approach, transducer need to be develop and united with robotic system and mems technology.

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Biography

Mr Harsh Patel has completed bachelor studies in Mechanical engineering from Gujarat Technological University, India. He has done bachelor project in the field of mechanical design with designing software skilled. Currently, he is pursuing master degree in medical system engineering from Otto-von-Guericke University, Germany.

Advanced Biomimetic Electronic Prosthesis Controlled by Non-Invasive Brain-Computer-Interface

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1. Introduction

Since the first prosthesis was developed, it has played an important role for people with either upper or lower extremity amputation. The quality of life (QoL) is enhanced with prosthesis by enabling them to access the environment as the general public do.

Nowadays, thanks to the fast developing technology, different kinds of sensors, motors, materials, and control methods have been introduced to us and they are integrated into the prostheses to enable the users to perform better function in their activities of daily living.

In this article, we would like to discuss about 1) the possible development of brain-computer-interface (BCI) without any implant in user's brain for commanding the prosthesis and 2) the prosthesis might also evolve with new sensing, and robotics technology, which could help a user move the prosthesis in a more natural way as a human body part.

2. Methods

In this section, we will separately discuss the current progress of BCI and the prosthesis of upper- and lower-extremity.

2.1 The evolution of brain-computer-interface (BCI) and electroencephalography (EEG)

EEG signals are one of the important signal sources for the BCI operation. Today, we can acquire these signals by attaching electrodes on the skull. [1][2] However, we still need more researches to fully understand the working areas of brain of different movements. Besides, with the help of other correction methods, such as electrooculography (EOG), electromyography (EMG), or even artificial intelligent (AI) could assist the BCI to verify and find out the user's genuine intention more effectively.

We are convinced that, in the future, we would be capable of detecting all the necessary signals during action and all of them could be individually traced and monitored.

2.2 The enhancement of biomimetic prosthesis

2.2.1 Upper-Extremity (UE) prosthesis

Hand function is one of the most important part of human species and is also the foundation of our civilization. Thus, the more sophisticated a prosthesis is, the less barrier a user in the real world will encounter.

Although there have been various types of electronic prosthesis already available on the market, they still have limitations when facing certain situations, for example, holding a cup of tee is an easy task for a normal person, but it might be difficult for an UE amputee because the electronic hand could either squeeze the glass too hard or let the glass slip off to the ground. As a matter of fact, we could use force sensors to help the hand determine how much force it should exert, but once again, this is only a one-way route, which means that the user still has no clue about what really happens with the glass if he is diverted from something else. [3]

Therefore, we strongly believe that the information of the object that the artificial hand is dealing with should be simultaneously conveyed to the user's brain. With the information feedback other than visual input, the operation of UE prosthesis would be safer and more accurate.

2.2.2 Lower-Extremity (LE) prosthesis

Lower extremities are mainly in charge of our balance and locomotion, so the very first principle is to keep the user away from the risk of fall. Both, the somatosensory of the sole (or the whole feet) and proprioception play crucial role in this part. Every time when the foot contacts the ground, they give us the awareness of the alignment of LE, including the position of the ankle, the reaction force from the ground, and the surface condition of the ground. However, an artificial leg is attached to the user by a socket, and all the information mentioned above is missing. Under this circumstances, a LE prosthesis may be trapped before the foot leaves the ground or at contacting the ground.

Therefore, using the inertia of moving forward to keep the foot off the ground is a common strategy currently.

3. Discussion & Conclusion

Using one's thought of intention to control prostheses or assistive devices is not a just an imagination or content of a fiction, with the help of technology we are now approaching the goal.

We believe in the future, as more data are collected from the trials of neuroscience, brain image, motor control, and other related fields, we could attain a better insight to map these biomedical signals with individual movement and increase the reliability and efficacy of BCI system.

With the 3D modeling and the 3D printing technology, we could now easily duplicate the key features of the extremities so as to build up a customized biomimetic prosthesis for the user. In addition, perhaps one day we will be able to grow our cells on the prosthesis so that the skin would look just like the nature one.

Even more, when the biotechnology is ready, we could even print out the missing part of the extremities, including the bone structure, the skin, and the muscles, and integrate sensors and micro-motors into the prosthesis. If this method works, we could then use the signals from the receptors inside the skin tissue to help the prosthesis calculate and perform more efficient and smoother movement.

To sum up, it is possible that in the near future, a UE/LE amputee could totally control the biomimetic prosthesis with BCI and move as good as normal person without latency. We hope that they will not only accomplish regular tasks, but also retrieve the capability to work as usual.

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Biography

Mr. Chien-Hsi Chen, MSc, has been involved in the field of assistive technology, as rehabilitation system developer, clinical trial conductor and researcher. Mr. Chen is also a licensed physical therapist in Taiwan and is currently a master student of Medical Systems Engineering of Otto-von-Guericke-University in Magdeburg, Germany.

Proposal to innovate Arterial Pressure evaluation using a non- Invasive and minimally- Intrusive (nIml) methods based upon Photopletysmography and Machine Learning

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1. Introduction

Considering the high mortality and complex morbidities associated with Arterial Hypertension (AHT), the increasing charges to the Social Security and the intrusiveness of current non-invasive methods making elusive the detection, monitoring and control of this clinical condition, urgent innovations are required in estimating Arterial Blood Pressure (BP).

Non- Invasive BP measurements use Mercury Sphygmomanometers, that have evolved during near 200 years to more advanced technologies such as Oscillometers, Arterial Blood Pressure Monitors (ABPM). All of these techniques are based upon halting the blood flow during a short period of time and on the assumption that Heart Rate (HR) is invariant under a given clinical condition.

Halting blood flow is perceived as intrusive by patients, whom leave the BP evaluation procedures [1]. On another hand, the assump-tion of HR invariability introduces intrinsic imprecisions in the BP measurement.

Alternative to Sphygmomanometer methods, not requiring halting blood flow to evaluate BP, but currently not in used, are Applanation Tonometry [2], Volume Clamp (VC) [3], Photopletysmography (PPG) (re- emerging in recent years [4]; attractive to minimize intrusiveness).

We claim that innovative solutions to the puzzle of non- Invasive and minimally- Intrusive (nIml [5]) BP evaluation is rigorously supported by an already developed set of tested pieces. Such pieces are, but not limited to, the Connectionist Approaches [6] and Machine Learning (ML [7]), Hornik theorems [8] on Feedforward Artificial Neural Networks (FANN) trained as Universal Approximators, the emergence of Big Data paradigm [9] and its recent application in Healthcare [10], and the access to proven new technologies based upon VC [4] methods for continuous, non- Invasive BP monitoring [11,12] and for wirelessly connecting patient to analysis systems [13].

The puzzle weakest part, however, is to build up, see Figure 1, a broad enough Training Set (TS), to comply Hornik requirements [8] on Data Completeness and Consistency (DCC), clustering data according to physiological and clinical characteristics of each subject.

To tackle this challenge a TS construction was started in 2015 whose methodology and current status is set out in the next section.

Once the TS has been constructed, the technological bases will be given to innovate in nIml BP estimates from the PPG while using ML in the context of Big Data.

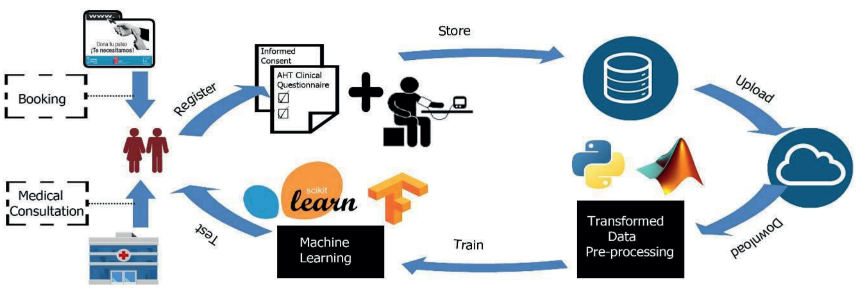

Figure 1: Schematics to build up the Training Set for nIml BP estimates using Machine Learning for Big Data

2. Materials and Methods

Data Acquisition details on cardiovascular recordings to build up TS, is found in [14]. Input vectors are signals processed from raw PPG. Bionomadix modules BN-PPGED are used. Target Vectors are BP signals or values, measured with Finapres NOVA. In [14]; fractional derivative is used to fit PPG to fiAP. Part of the used data is available in Physionet [15]. The complete, minimally documented TS, is under Creative Commons License [16].

The file "Training_Set_nIml_estimates" at nimi.uv.cl, is organized in eight primary sub- files containing nearly 250 dissimilar second-dary sub- files with non-structured, non invasi-ve Cardio Vascular Data (CVD) obtained either from Healthy subjects, or Patients affected by Parkinson Disease (PK) or Diabetic Neuropathies (DN) and their controls.

The eight primary sub-files are named and contain CVD in different sessions. Data from:

24H: Healthy subject during 24 hours; DNC/DNP: Diabetic Neuropathic Control/ Patient; HGP: Healthy subject during Hand-grip (HG); HMH: Healthy subject during a session with HG/ Movie seeing/ HG; PKC/ PKP: Parkinson disease Control/ Patient, TOC: Healthy subject Toc occlusion.

CVD format use TXT and ACQ®, from BIOPAC extensions.

Data structure is an array of 12 column and n rows. Each row corresponds to the instant i (with $0 \leq i \leq n$), of a Cardiovascular waveform or trend evaluated within each heartbeat.

Waveforms are two PPG recorded at external body locations, a single ECG channel, and the recorded finger BP or the reconstructed Brachial BP waveform.

PPG is continually recorded using BIOPAC System and BP waveform is continually recorded using "volume clamp technique" [4].

Different column templates, for specific sessions, are used during recording.

The following recording parameters can be found in the different templates: Band Wide Pass filter, Body Surface Area, Cardiac Output, Windkessel Compliance, deft/non-deft hand or foot, ECG, Heart Rate, Left Ventricular Ejec-tion Time, hand/foot PPG waveform, finger/ reconstructed Brachial Blood Pressure waves, Peripheral Resistance, Respiratory Signal, sampling rate, and Aortic Impedance.

They are used per session and per subject.

Structured data is constructed through a questionnaire based upon the Clinical Guide for AHT from the Chilean Ministry of Health.

To allow massifying and parametrizing PPG recording, an Android based programmable platform, acting like Data Acquisition Module (MAD- Mas [17]) was designed and developed in Valparaíso with collaboration of the University and LOBO E.I.R.L., a small, local entrepreneur. MAD- Mas is illustrated in figure 2.

On another hand, hundreds of ML algorithms and configurations were tested. Best results were obtained using Deep Learning (DL [18]) and Extreme Learning Machine (ELM [19]) accomplishing the following intra- subjects mean square errors (15 subjects).

For DL, with a common ML architectures of 9.3±0.5% in reSYS and 12.1±3.3% in reDIA.

For ELM, with personalized ML architectures, 5.0±2.7 in reSYS and 7.0±4.0%.

This causes intersubject generalization problems, requiring to expand and clusterize TS.

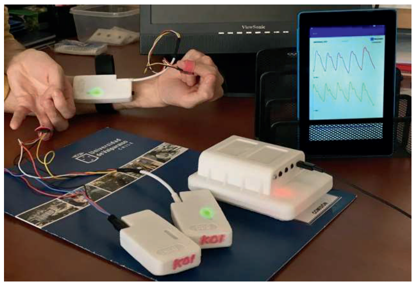

Figure 2: MAD- Mad prototype.

3. Discussion & Conclusion

Data recording spanned during 14 months between, June 2015 to December 2016.

Subjects: 31 healthy volunteers and 17 patients with Parkinson and Neuropathic diseases.

Estimated continuous recording time: equivalent to more than 98 hours that can be clusterized, in app. 483,000 heartbeats.

Currently analysed data: 36,900 heartbeats of 15 healthy subjects, no cluster analysis.

Hundreds ML types and architectures tested.

Imagine… cardiovascular data recording cabins, in 100 movie theatres, with 21 film exhibitions per week, and/or clinical cases.

After 10 years... Hornik DCC will be fulfilled?

Which are the costs and the benefits?

Acknowledgements

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Compliance with Ethical Requirements

Authors declare having no conflict of interest. Informed Consents are being obtained with subjects for data acquisition since 2015. Clinical Essays have been approved by UV, Bioethics Institutional for Research and SSVSA (Chile) Scientific Ethical Committees.

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Biographies

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Early Identification of Complex Foot Problems with Adaptive Artificial Intelligence

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1. Introduction

Regardless of vital part in human body, foot is the least cared part in the human body. Due to this reason, it is normal human tendency to visit a doctor or a podiatrist only when the problem gets severe. The delay between detection of early symptoms to the complicated foot problem act as a deterrent for problem identification. This lag increases the treatment time and handling costs. To avoid this, an efficient autonomous approach for early identification of the complex foot problems is necessary.

The reason for the foot problems are enormous and depends on their back ground like age, type of work, health condition etc. There exist different foot problems such as diabetic foot ulcers, diabetic neuropathy, gangrene, over pronation, plantar fasciitis, turf toe etc. Several approaches such as [1] [2] exists for identification of foot problems. They either use foot pressure patterns or foot temperature. A combination of foot temperature and foot pressure based foot problem identification was proposed in [3]. But most of the researchers used a rule based programming, statistical models or a simple Artificial Intelligence (AI) and concentrate on a unique problem through a specific pattern from the foot. Successful identification of different foot problems requires multifaceted data about the foot and an efficient algorithm.

2. Approach

Our approach of identifying foot problems comprises of hardware and software architectures. The hardware is foot insole embedded with multiple sensors such as pressure sensors, temperature sensors, pulse sensors, flex sensors, IMU's etc. and an onboard computer. The software includes the intelligence algorithm which can be divided into two phases. Initially, a complex AI based approach for the training of different foot problems. Later the trained AI algorithm is used along with an adoption engine, to compliance with the individual user behavior.

An AI based approach of classification of foot problem was given in Fig 1. Initially, the raw sensor data from foot through the developed foot sole is acquired. This data is acquired from several users ranging from a healthy person to a patient with foot problems. Later, pre-processing techniques such as filtration, normalization were performed on the obtained raw data. The preprocessed sensor data is used for feature extraction. Different features such as statistical features, mathematical features, machine learning based features were extracted from the sensor data. These features are used as an input to the AI algorithm. To obtain an efficient classification of foot problems, a supervised training will be used. For that reason, the knowledge about the acquired data is attained from the users and the knowledge about the problem is acquired from doctors and is given to AI algorithm. After rigorous training, a good classification results can be achieved. Some technique such as [4] has already provide that AI algorithms will perform well for such applications.

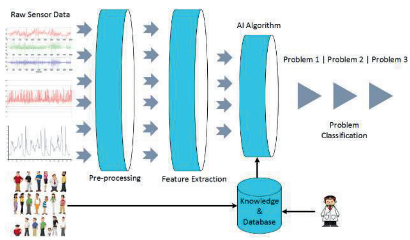

Figure 1: Artificial Intelligence based architecture of foot problem identification.

Even though AI can perform considerably good in comparison to rule based approach, it has certain limitations. A good example mentioned in [5], how sitting on couch and eating popcorn while watching a movie was identified as walking of 3 miles by a fitness tracker will clearly highlight the necessity of adaptive intelligence. [6] also mentions the need of Adaptive Artificial Intelligence (A2I) especially in medical or health care applications.

A2I will overcome the most common problem like one solution fits all approach. This is vital in healthcare applications. The concept of A2I is not new, an initial architecture for adaptive intelligent systems was developed in [7]. Modern sensors along with efficient computation resources and complex AI algorithms motivates the use of A2I techniques for foot problem identification. The proposed architecture of A2I is shown in Fig 2. The approach is a little similar to an AI approach but here the knowledge and database is replaced by the early developed AI algorithm. Additionally, an adoption engine takes the regular feedbacks from the new user to keep in pace with the changing behaviors of the user over time. This adoption engine will give its adopted factors to the A2I algorithms, where it matches the current information along with known knowledge to make an efficient problem classification which matches with the specific user behavior over time.

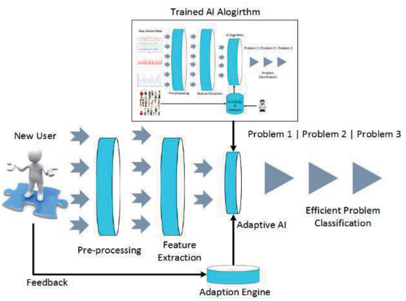

Figure 2: Adaptive Artificial Intelligence based Architecture for efficient foot problem identification

3. Discussion & Conclusion

This approach of a hardware and software based technique will provide the end user an option for early identification of foot problems effectively.

The key is no researchers has discussed which options are prime in A2I approach, it is the responsibility of the developer to identify the proper combination to work at its best. In fact, this approach will be efficient and avoid serious false positives in the identification process which is crucial in health care. The effectiveness of this approach need to be evaluated under different conditions.

If successful, this approach supports the people not only in the developed countries but also in the under developed countries where the lack of proper medical diagnosis for early identification of foot problems exists.

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Biography

Jyothsna Kondragunta, M.Sc., *was born in Gudivada, India. She has bachelors of technology degree in Electronics and Communication Engineering from Jawaharlal Nehru Technology University, Kakinada, India in 2011. Later did Master of Sciences in Electrical Engineering and Information Technology in 2015 from Otto-von-Guericke University Magdeburg, Germany. During here master thesis she gained through insights on Machine Learning and human activity recognition with biometric sensor data. After her masters, due to her interest towards artificial intelligence she gained considerable knowledge on application of machine learning in health care domain.*

Sasanka Potluri, Dipl.-Ing, *was born in Vijayawada, India. He has bachelors of technology degree in Electronics and Communication Engineering from Jawaharlal Nehru Technology University, Kakinada, India in 2009. Later did Master of Sciences in Information Technology in 2011 from Alpen Adria University Klagenfurt, Austria, He worked as a research assistant in Faculty of Computer Science in Otto-von-Guericke University Magdeburg for 3 years on Autonomous cars safety in an EU project KARYON. Since 2015, he is working as a research assistant in Institute for Automation Engineering in Otto-von-Guericke University Magdeburg. His main research focus is using Machine Learning for Cyber Security in Automation.*

Detection of emotions and speech synthesis for autism disorder using wireless EEG

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1. Introduction

Autism a pervasive neurological disorder that is observable in early childhood and persists throughout the lifespan, characterized by atypical communication, language development, and sensory experiences. The two major disabilities observed with autism are either difficulty is expressing the emotions or expressing in atypical form making difficulty in understanding.

To overcome the above disabilities EEG as a wireless helps in detecting and recording the neural pattern of the brain through which mental state of the patient can be traced. It is more of tracing the brain thoughts than reading the mind.

Human brain have spectrum of specific signals defining the particular emotions like hunger, sleep, angry which is easily detected via the neural patterns.

A brain-computer interface along with EEG helps to analyze and translate the brain pattern for speech synthesis. BCI helps in decoding continuous auditory parameters for a real time speech synthesizer from neuronal activity in motor cortex during attempted speech.

The EEG along with BMI is a combination of signal processing and machine learning technique to identify intents and translate into commands by an end user application.

2. Materials and Methods

A single-channel wireless EEG developed by Neurovigil known as iBrain can help in acquiring the brain signals. The iBrain EEG creates maps of brain activity rich in biomarkers from single channel high resolution data recording. It consists of three peel and stick electrodes, each attached to the device through 7-8 inch wires. Two electrodes are placed behind each ear and one in center of forehead as a band [1].

The recorded data is streamed real time through wireless platform and transferred through device's mini-USB port to analysis servers, where SPEARS algorithm creates maps of brain activity which can be indicative of biomarkers. The obtained signal is decoded by BMI for real time speech synthesizer with the help of specific neural network algorithm. The integration with a "speech-synthesizer" provides a more natural context to the usage of a BCI system, as it suitably augments the conventional human perception of speech [2].

The brain mapping done by iBrain gives a certain neural pattern through which specific signal spectrum is detected and according to it the emotions can be easily detected. The pre-Acquired and trained signals can be loaded in order for immediate output, so if a patient feels hungry the already loaded hungry signals matched with current and output is given.

The sound waves from patient with atypical communication is amplified and sent as FM signals into analog-to-digital converter where noises are removed, the spikes of audio signals is sorted and given to neural commander with specific algorithm for decoding audio signals. The decoded signals are thus taken as commands into speech synthesizer. The audio signals then compared with the mapped brain activity and after analyzing given as an output [3].

Figure 1: iBrain device with single channel EEG which can be worn as a band around the head. *Source: Neurogadget.net*

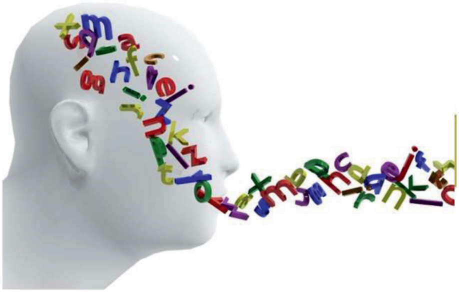

Figure 2: Representation of thoughts into speech, a single image depiction of the proposed research idea.

Source: kingsburytransforms.org

3. Discussion & Conclusion

There are many researches done on minimizing the problems of neuro disorders. Autism is one among it but with less number of contributions. The autistic Kids are mostly introverted since communication has been a huge drawback minimizing their social circle and increasing the verbal disability. It is mostly developed at early childhood so main development of this idea is for establishing a good communication and filling the gap between patients and the society.

The wireless EEG plays a major role in this as it decreases the discomfort for the user and reusable which makes a one-time investment.

The BMI interfaced with iBrain will not occupy much space and thus resulting in compact size. In future the device can be reduced to size of a mobile and receiver is moreover like a smart watch with speaker delivering the audio signals.

Each year the count of autism prevalence increases and it is stated that 1 in 45 kids are affected with autism. This device can be used approximately by 8 million people around the world in current date. When it comes to cost it can be reduced in future since it benefits for other purposes. The device can also be used for most of the neurological disorders with impaired speech motor control.

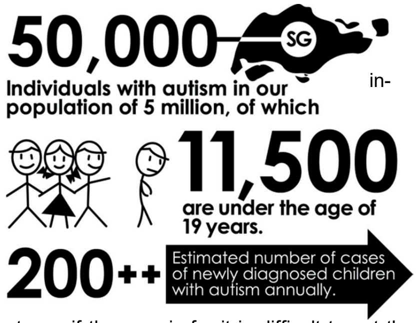

Figure 3: prevalence of autism in Singapore alone. *Source: autism.org.sg*

Application of the device is vast but there are drawbacks like giving an audible output, for instance if the user is far it is difficult to get the message. The brain mapping done might give delay signals during comparison with audio commands. However, by overcoming the issues in future it can be used widely among autism affected and other motor neuron impaired patients.

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Biography

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