ACİL TIPTA TEKNOLOJİK GELİŞMELER

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Acil Tıp AD, Kayseri

3. Ulusal Ail Tıp Kongresi, 2007

Sunum Planı

- Acil Tıp uygulamalarında kullanılan aletlerin geçmişi ve bugünü
- Gelecekte neler olabilir??

- Hemen her zaman acil servise hasta girer girmez yapılan ilk işlem?

- Hastanın vital bulgularının alınması:
  - Kan basıncı
  - Nabız
  - Solunum
  - Ateş
  - SpO_2
  - EKG monitorizasyonu (Gerektiğinde)

Monitorler için iletici sistem, Telemetri ileticileri (Transmitters for Life Scope monitors)

Uygun parametreyi monitorize etmeye olanak sağlayan, kablosuz veri iletimi sağlayan, küçük ve hafif vericiler:

EKG, Solunum, SpO_2, NIKB, IKB,Vücut sıcaklığı, CO_2

Hasta monitorizasyon sistemleri

Hasta monitorizasyon sistemleri

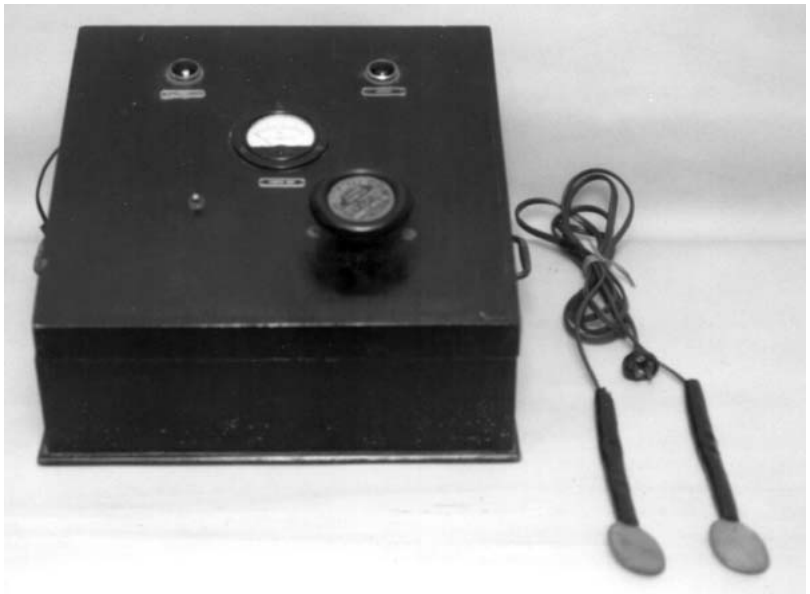
- Dokunmatik ekran
- EKG monitorizasyonu
  - Aritmi tespiti, 2 derivasyon takibi, ST ölçümü
- Solunum
- SpO_2
- Vücut sıcaklığı
- IKB veya CO_2

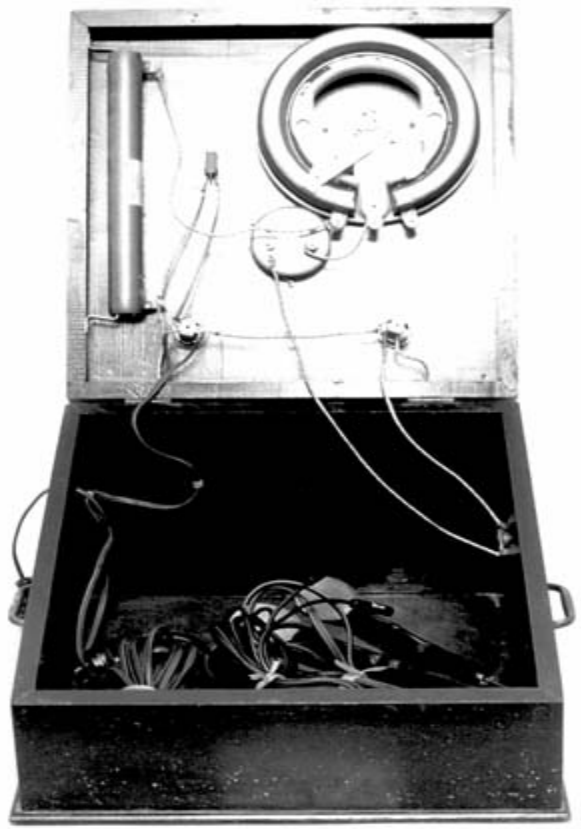
EKG

- Dijital
- LCD ve dokunmatik ekranlı
- EKG analizi
- Veri depolama ve PC’ye transfer
- Hasta bilgilerinin girilmesi

1947 - Claude Beck

Defibrilatörü geliştirdi ve defibrilasyon ile bir insanı kurtardı. (Açık toraks uygulaması için)





1956- Paul Zoll

Kapalı göğüs defibrilasyonu yapan aleti buldu (Eksternal defibrilatör)

Defibrilatörler

- Monofazik (+ AED) multiparametre
- Bifazik (+AED) multiparametre

Defibrilatörler

- AED, multiparametre monitorizasyonu: SpO_2, CO_2 ve defibrilator
- AED, multiparametre monitorizasyonu: SpO_2, CO_2, NIKB, 12 derivasyonlu EKG analizi ve defibrilatör

Otomatik eksternal defibrilatör (AED)

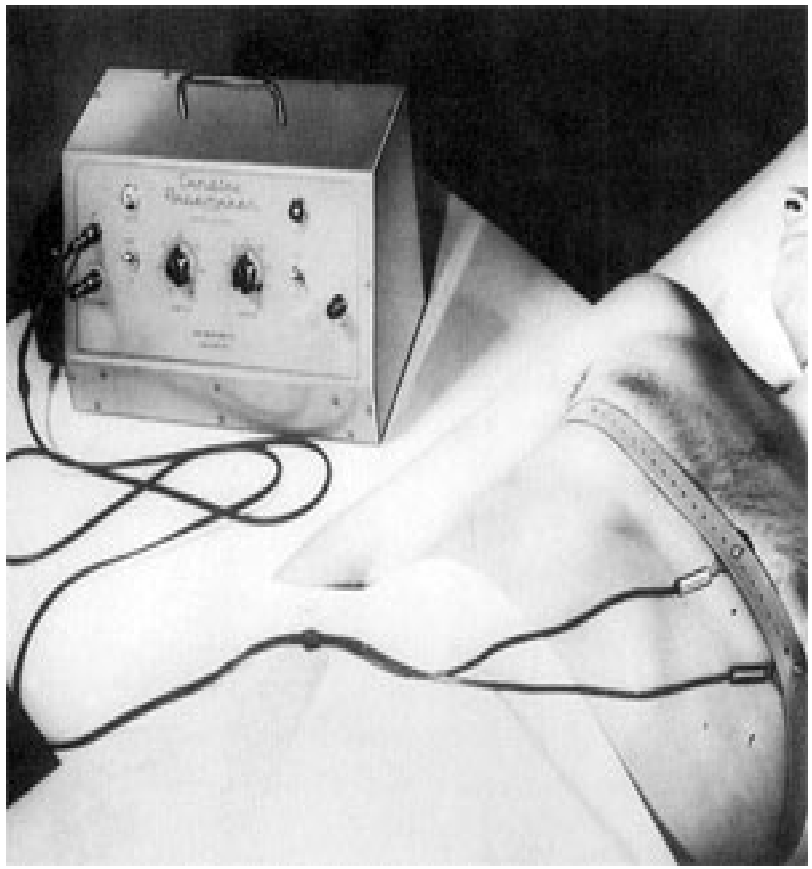
Otomatik eksternal defibrilatör (AED)

- AED kardiyak arrest oluşan hastalarda normal kalp ritmini tekrar sağlamak amacıyla kullanılan taşınabilir aletlerdir.
- Hastanın vücut yüzeyine uygulanır, kalp ritmini analiz eder ve kurtarıcıya normal kalp ritmini sağlaması için şok gerekip gerekmediği konusunda fikir verir. Gerekiyorsa kalbe defibrilasyon uygular.

"Pencils?" "Check." "Pads?" "Check." "Stapler?" "Check."
"Automated external defibrillator?" "Check."

Gelecekte defibrilatörler, Amaç:

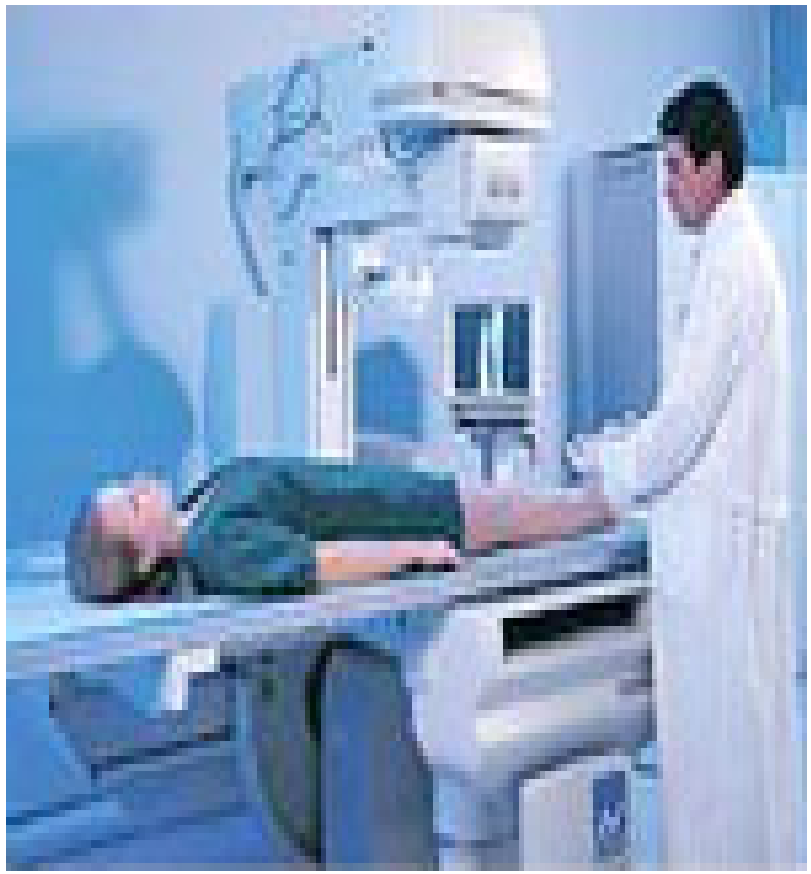
- Daha güvenli ve etkin defibrilasyon.
- Batarya ömrünün uzun olması
- Hastanın vital fonksiyonları konusunda daha fazla ve net bilgi vermesi (sensörleri artırarak)

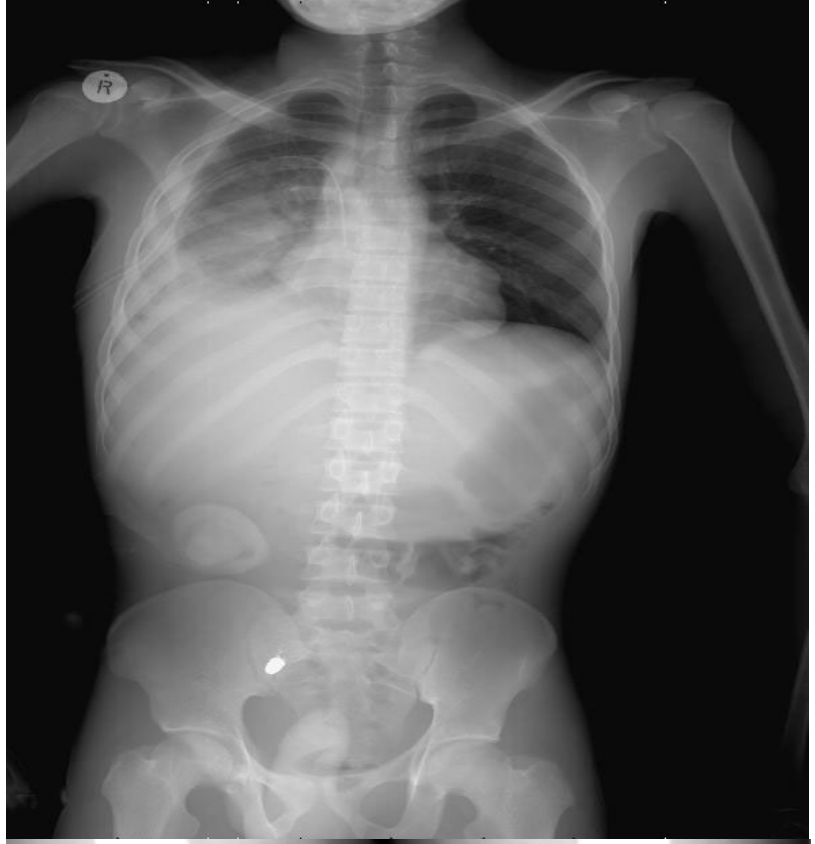


- **1953- Paul Zoll**
  İlk eksternal uygulanan pacemaker

Röntgen cihazları

Dijital röntgen




Dijital röntgen

- Digital röntgende görüntü filmde değil bilgisayar ortamında oluşturulur. Üst düzeyde görüntü elde edilebilmesi nedeniyle, artık gelecekte tüm röntgen ve radyoloji uygulamalarının digital ortamlarda yapılmasını gerektirmektedir. Digital teknoloji ile film tekrarları en aza inmekte ve hastalar çok daha az ışın almaktadırlar.
- Ayrıca bu teknolojinin şu anda son noktası olarak yaklaşık 13 saniyede tüm vücut dijital olarak taranmakta ve istenilen tüm bölgeler ayrı ayrı ya da bütün olarak bilgisayar ekranından görülebilmekte ve hatta monitörde doz ve netlik ayarı bile yapılabilmektedir.

Acil (Dopler) Ultrasonografi

- Yatakbaşı dopler USG

FAST (Focused Abdominal Sonography for Trauma)

- İntraabdominal sıvı ya da kanamaları göstermek amacıyla 4 bölgede yapılır:
  - posterolateral her iki toraks altı yan bölgeler
  - subksifoid ve
  - suprapubik

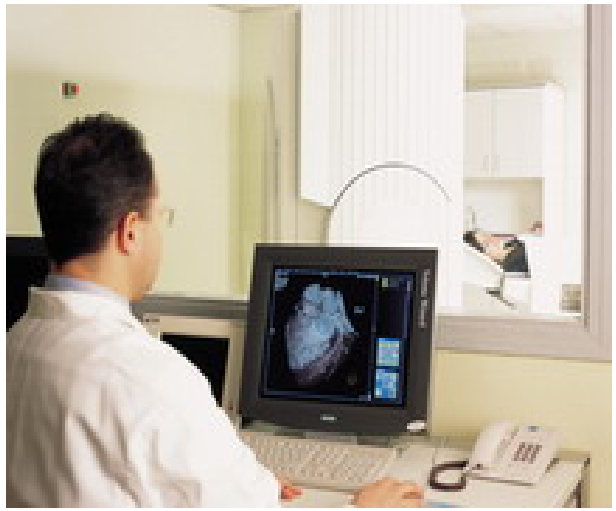
Bilgisayarlı Tomografi

- Konvansiyonel CT
- High resolution 3D CT

- Spiral CT

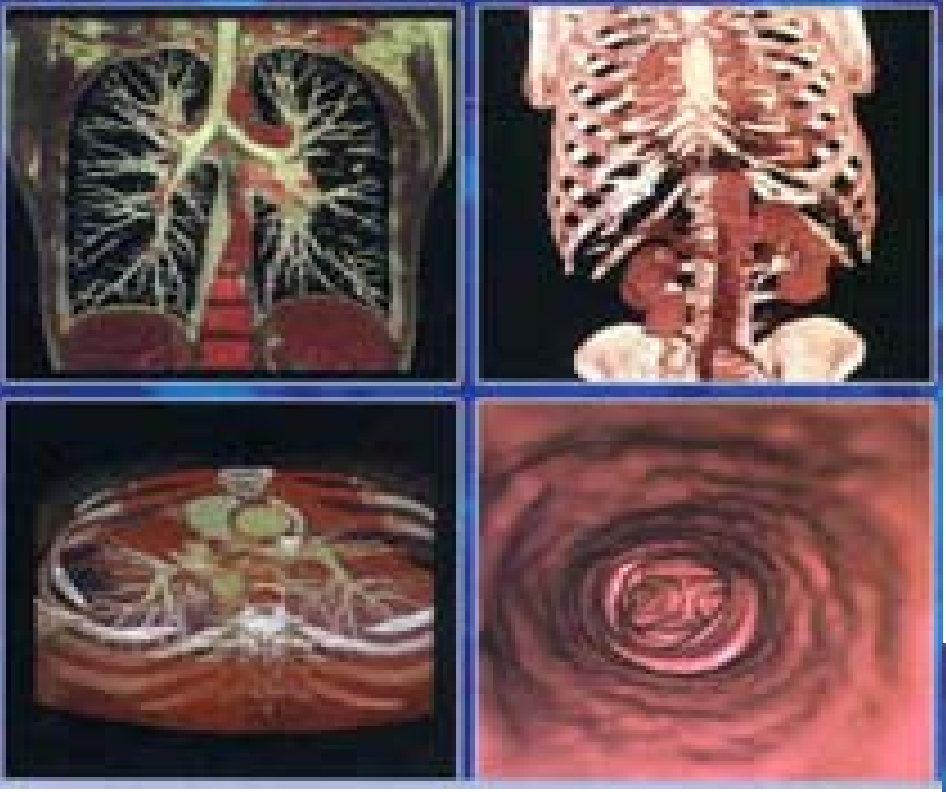
Bilgisayarlı Tomografi

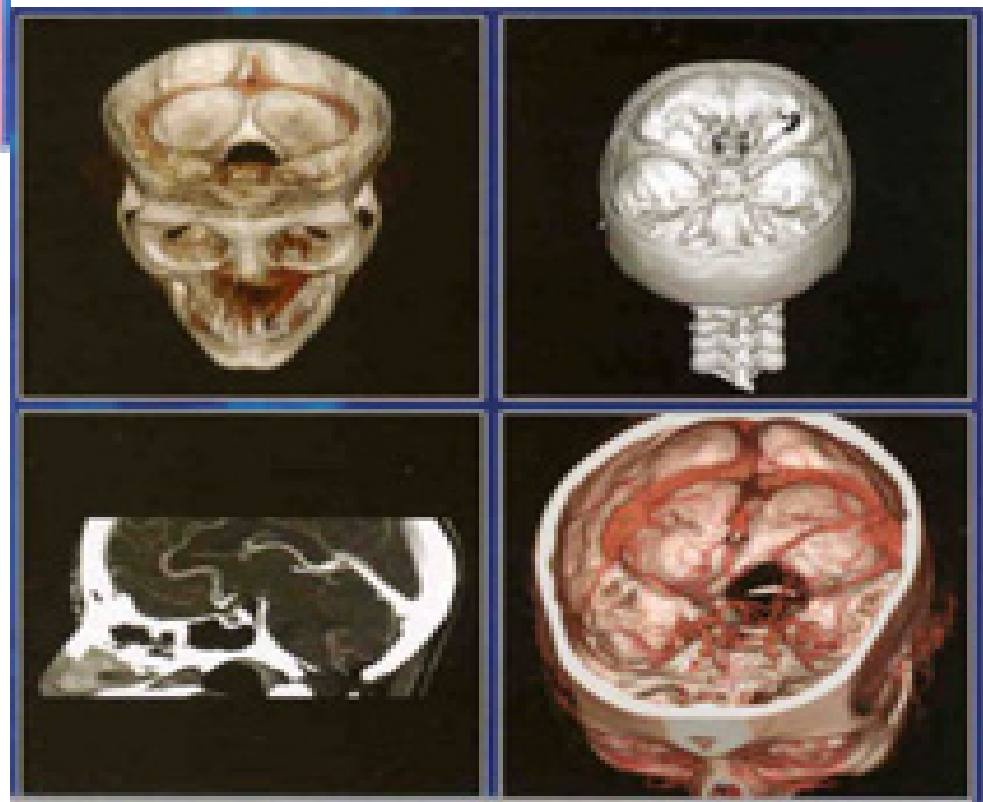
- Multi-slice CT



64 SLICE MULTİDEDEKTÖR CT

- Daha hızlı çekim, daha ince kesitler ve daha yüksek çözünürlük.
- Tüm toraks ve batın tetkikleri tek nefes tutma süresinde tamamlanabilmektedir.
- Elde edilen çok ince kesitler rekonstrüksiyon yöntemleriyle 3 boyutlu olarak aksiyel, koronal ve sagital planlarda değerlendirilmekte.
- Dört boyutlu (real time 4-D) koroner anjiografi
- Aortik anevrizma, renal arter darlığı, pulmoner emboli gibi birçok hastalığın kesin tanısı hızlı ve kolay konabilmekte.
- Pulmoner emboli tanısında "Multislice CT" altın standarttır. Sintigrafik anomalinin oluşmadığı çok erken evrede bile trombüsü ve yaygınlığını göstermekte.





Manyetik Rezonans Görüntüleme

- Açık MR cihazı

- En önemli özelliği kapalı alan korkusu, aşırı kilosu olan, yüksek ses düzeyinden rahatsız olan hastalara uygun.

Manyetik Rezonans Görüntüleme

- **Ekstremite MR cihazı**

- C - Scan Orto CINE MR
- El, el bileği, ayak, ayak bileği, diz, dirsek gibi rutin çekimler yapılabilmekte.
- Bu cihazda inceleme esnasında sadece çekim yapılacak alan, coil ve cihazın içine yerleştirilmekte, vücudun diğer bölümleri cihazın dışında kalmaktadır.
- Bu sayede klostrofobisi olan hastalar rahatlıkla incelenebilmekte, sonuçta da hasta konforu artmakta.

VITAPHONE

- Three-button mobile phone
  - Vitaphone 1100
- Heart monitoring
  - Vitaphone 100 IR
  - Vitaphone loop 3100 BT
  - Vitaphone 2300
- Emergency mobile phone
  - Vitaphone 1300

Three-button mobile phone Vitaphone 1100

- Yolculuk sırasında ve günlük yaşam sırasında hızlı, hemen yardım sağlamak amacıyla kullanılan sistemdir. Vitaphone servis merkezi telefon konsültasyonu ile kişinin acil durum yardım planını uygular.
- Diğer cep telefonları gibi Vitaphone 1100'ün de kendi telefon numarası vardır ve ulaşılabilir konumdadır.

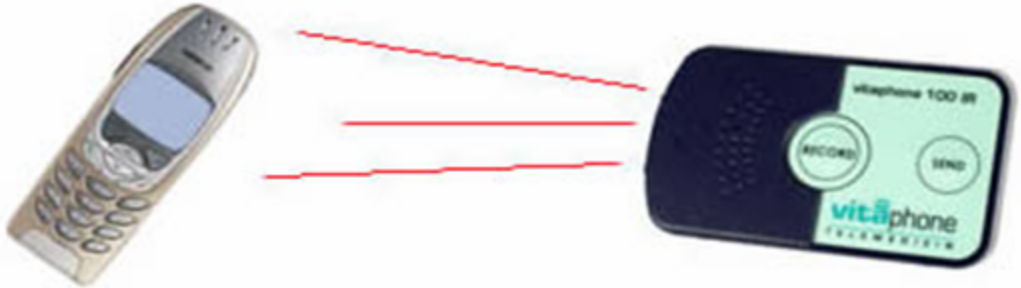
Kalp monitorizasyonu

- Vitaphone 100 IR
- Vitaphone loop 3100 BT
- Vitaphone 2300

Vitaphone 100 IR

1. Place the Vitaphone 100 IR on your bare chest.

2. At a press of a button (record) up to 3 ECGs are recorded.



3. The card transmits the ECG-data per infrared-data-transmission to the mobile phone included with the set (press send).

4. Your doctor receives the ECG per Email or Fax for evaluation.

Vitaphone 2300

- Vitaphone 2300 (heart mobile phone) riskteki hastalar için hayat kurtarıcı bir telefondur.
- Telefonun “Acil” düğmesi ile direkt olarak Vitaphone Medikal servis merkezi ile bağlantıya geçilir. Buradaki uzman hekim grubu hastaya yardım etmektedir ve gerektiğinde hastanın acil bkımı ile de ilgilenmektedir.
- Hastanın yeri GPS ile tespit edilmektedir.

Vitaphone loop 3100 BT

- Kalp hastası için günlük hayatta bir defa EKG kaydı yapan alet, aritmi gibi patolojik durumları yazılımı syesinde değerlendirebilmekte ve dökümente edebilmektedir. 40 dakikalık sürekli kayıt mümkündür. Hafızası dolduğunda alet baştan itibaren silip kayda devam etmektedir.

- Gelecekte neler olacak?

2001 Proceedings of the 23rd Annual EMBS International Conference, October 25-28, Istanbul, Turkey

MULTIPURPOSE HEALTH CARE TELEMEDICINE SYSTEM

E. Kyriacou[1], S. Pavlopoulos[1], D. Koutsouris[1]
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Abstract- **In this study we present a multipurpose health care telemedicine system, which can be used for emergency or patient monitoring cases. Ambulances, Rural Health Centers (RHC) or other remote health location, Ships navigating in wide seas and Airplanes in flight are common examples of possible emergency sites, while critical care telemetry and telemedicine home follow-ups are important issues of patient monitoring. The telemedicine system is a combined real-time and store and forward facility that consists of a base unit and a telemedicine (mobile) unit. The telemedicine unit (patient site) allows the transmission of vital biosignals (3-12 lead ECG, SPO2, NIBP, IBP, Temp) and still images of the patient from the incident place to the base unit (consultation site). The transmission is performed through GSM, Satellite links or POTS. Using this device a specialist doctor can telematically "move" to the patient site and instruct medical personnel when handling a patient. The consultation site is equipped with a multimedia database able to store and manage the data collected by the system. The system was validated in four different countries using a standardized medical protocol.**

Keywords – **Emergency Health Care Telemedicine, GSM, Satellite, POTS**

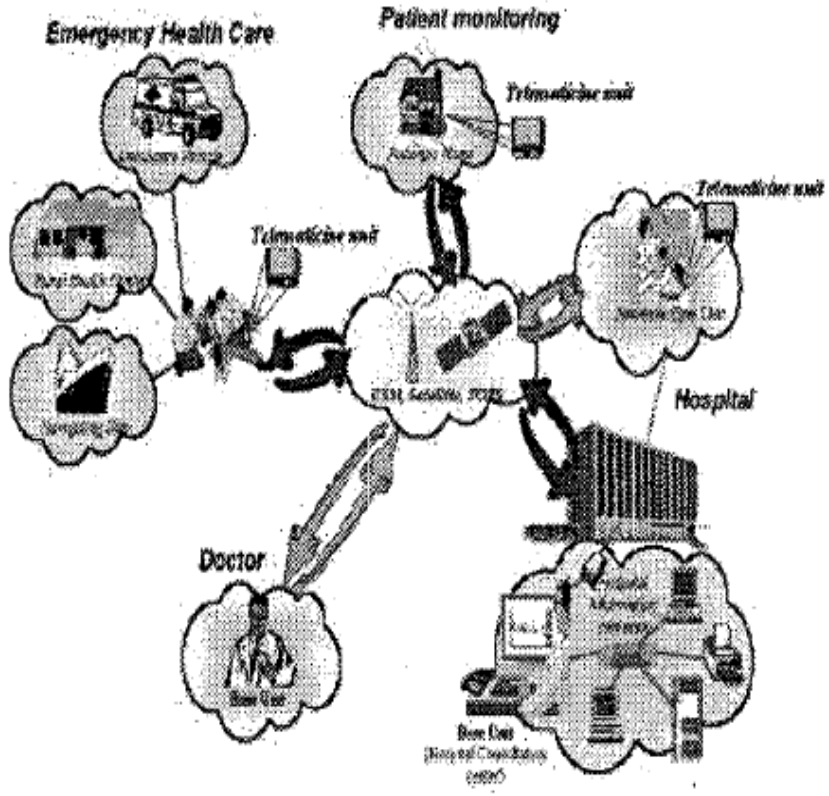

Fig 1. Overall system architecture

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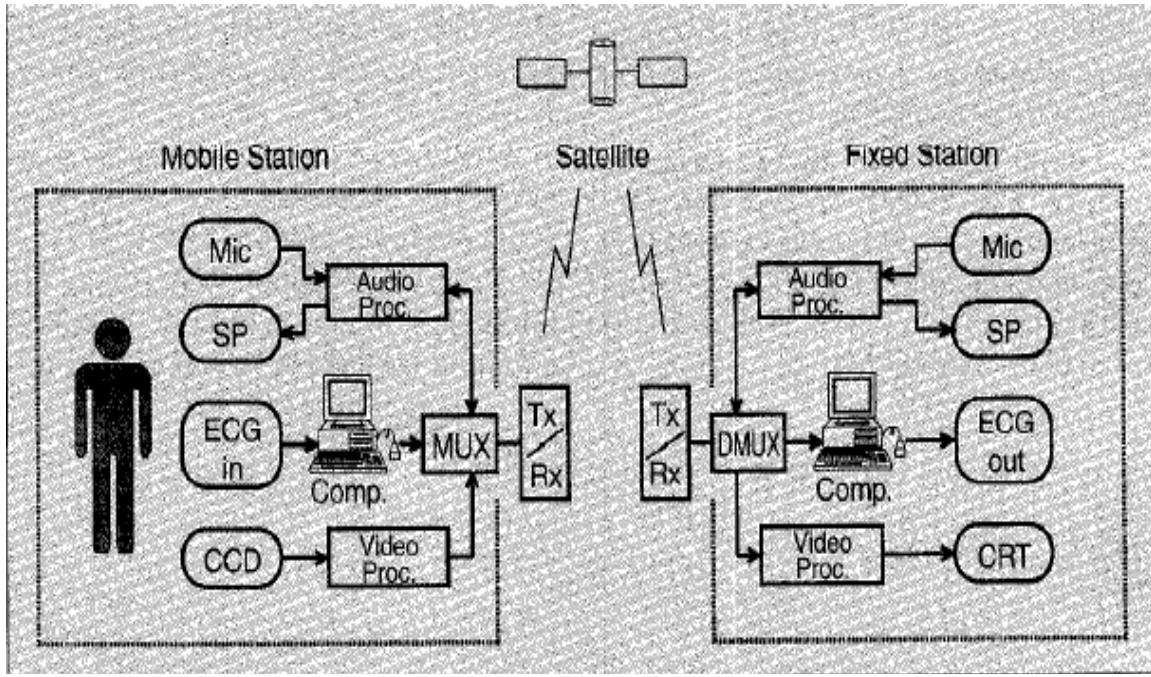
Telemedicine by Mobile Communication

Techniques for Multiple Data Transmission from Moving Vehicles in Emergency Medicine Situations

There have been many studies that have proved the feasibility and usefulness of telemedicine [1-3]. Remote diagnosis of an ECG through a telephone network is a well-known example [4]. Telemedicine is a useful technique and has been used in such applications as medical care in remote rural areas and aftercare for pacemaker-implanted patients. However, the use of telemedicine has not spread as extensively as other commonly used engineering techniques, such as medical imaging. This is not because



A Study on Nationwide Emergency Medical Network for Ambulances via HEOs

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Koredianto Usman[1]
Tokai University Institute of Medical Sciences[1]
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Abstract--**We have studied specifications for satellite transponder to perform nationwide emergency medical network for ambulance over Japan. If it is possible to send in real-time a large volume of biological data (such as when a thrombolytic dose is administered to a patient suffering acute cardiac infarction being conveyed in an ambulance, based on his or her 12 leads electrocardiogram data and cardio-echogram with compressed motion picture, for early treatment for removal of a coronary occlusion) and color video images (such as light reflex images and video images of the airway) from an ambulance to a triage center to receive instructions from a doctor, more patients will be saved and medical expenditures for emergency medicine will ultimately be reduced. We investigate required specifications as follows;**
1) Channels, 2) Bandwidth, 3) Frequency, 4)Footprints, 5) Technical limitations of the transponder others.

Biosignal Monitoring System for Mobile Telemedicine

D. K. Jung[1,5], K. N. Kim[1], G. R. Kim[1], D. H. Shim[1], M. H. Kim[2,5], B. C. Choi[3], D. J. Suh[4,5]

Abstract-This paper describes the design of a prototype integrated mobile telemedicine system that is compatible with existing public mobile telecommunication network, CDMA 1xEVDO. The mobile telemedicine system consists of two parts. One is a physiological signal measuring part, and the other is a PC system for the signal processing and telecommunication. The system uses NetMeeting to transmit video, audio and patient biosignals from a moving ambulance to a hospital and delivers to the personal computer of the doctor. The patient biosignals are noninvasive blood pressure (NIBP), arterial oxygen saturation (SpO_2), respiration pattern, electrocardiogram (ECG), heart sound, body core temperature and blood glucose concentration. For the emergency medicine, vital signs are focused and the remote medical monitoring, consulting, and health care are intended. The mobile telemedicine system was implemented, and tested for real time medical consultation during ambulance transport. This PC based mobile telemedicine system is flexible enough to accommodate newer components in wireless communication and portable sensing technologies. The present study suggests that the mobile telemedicine system using CDMA 1xEVDO is aids to patient monitoring and diagnosis as well as a convenient means of communications in the ambulance for the emergency medical care.

Design of a Telemedicine System Using a Mobile Telephone

B. Woodward, *Member, IEEE*, R. S. H. Istepanian, and C. I. Richards

Abstract—This paper describes the design of a prototype integrated mobile telemedicine system that is compatible with existing mobile telecommunications networks and upgradable for use with third-generation networks. The system, when fully developed, will enable a doctor to monitor remotely a patient who is free to move around for sports medicine and for emergency situations.

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Shanghai, China, September 1-4, 2005

3G Networks in Emergency Telemedicine – An In-Depth Evaluation & Analysis

Konstantinos Perakis[1], Konstantinos Banitsas[2], Georgios Konnis[1], Dimitris Koutsouris[1]
[1]Biomedical Engineering Laboratory, National Technical University of Athens, Greece
[2]E&CE, School of Engineering and Design, Brunel University, West London, England

Abstract: **The evolution of telecommunications technologies in connection with the robustness and the fidelity these new systems provide, have opened up many new horizons as regards the provision of healthcare and the quality of service from the side of the experts to that of the patients. The purpose of this paper is to evaluate the third generation telecommunications systems that are only recently being deployed in Europe, as well as argue on why a transition from 2G and 2.5G to 3G telecommunications systems could prove to be crucial, especially in relation to emergency telemedicine. The experimental results of the use of these systems are analyzed, the implementation of a tele-consultation unit is presented and their exploitation capabilities are explored.**

Keywords: **3G, GSM, GPRS, Telemedicine, Teleconsultation, Wireless.**

physicians to provide pre-hospital care more effectively, as critical biosignals (ECG, BP, HR, SpO2, Temperature) and still images of the patients would be sent from the portable device to a base station situated either in a hospital or a medical centre [3]. The deployed GSM networks limit the functionality of the device, providing a bandwidth of up to 9.6 Kbps. Nevertheless, the recently deployed 3G networks maximize the capabilities of this device and provide the means for more accurate and reliable telediagnosis.

In the following paragraphs the authors attempt to provide the readers with an overview of the wireless networks deployed as far, present them with the results of the trials conducted and emphasize on why the telecommunications evolutions should be indissolubly related to telemedicine.

Proceedings of the 2005 IEEE
Engineering in Medicine and Biology 27th Annual Conference
Shanghai, China, September 1-4, 2005

Vital Signs Monitoring and Patient Tracking Over a Wireless Network

Tia Gao, Dan Greenspan, Matt Welsh, Radford R. Juang, and Alex Alm

Abstract— **Patients at a disaster scene can greatly benefit from technologies that continuously monitor their vital status and track their locations until they are admitted to the hospital. We have designed and developed a real-time patient monitoring system that integrates vital signs sensors, location sensors, ad-hoc networking, electronic patient records, and web portal technology to allow remote monitoring of patient status. This system shall facilitate communication between providers at the disaster scene, medical professionals at local hospitals, and specialists available for consultation from distant facilities.**

Keywords – emergency, vital signs, sensors, mote, triage

hospital care reports and then converting the reports into electronic format.

- Pre-hospital patient care software with algorithms to continuously monitor patients' vital signs and alert the first responders of critical changes.
- A secure web portal that allows authenticated users to collaborate and share real-time patient information.

II. METHODOLOGY

During health emergencies, when time is of the essence,

Proceedings of the 26th Annual International Conference of the IEEE EMBS
San Francisco, CA, USA • September 1-5, 2004

Design considerations and implementation of a cost-effective, portable remote monitoring unit using 3G wireless data networks

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Abstract— **This paper describes the design and implementation of a light-weight, autonomous, patient-centric, portable medical unit that allows for anytime/anywhere monitoring and can find use in many monitoring scenarios like home-care, hospital wards, emergency help and disaster relief. The proposed unit called "*TelePatient*" achieves portability by exploiting a PDA and allows mobility through the use of cellular technology, enabling complete ubiquity. The design is based on open standards and is cost-effective. We incorporate transcoding software to fit data to limited bandwidth, as well as conserve energy on the power constrained PDA. We validate our design over real network 3G CDMA conditions and also test its use over WLAN802.11b, which can together cover a number of Telemedicine scenarios.**

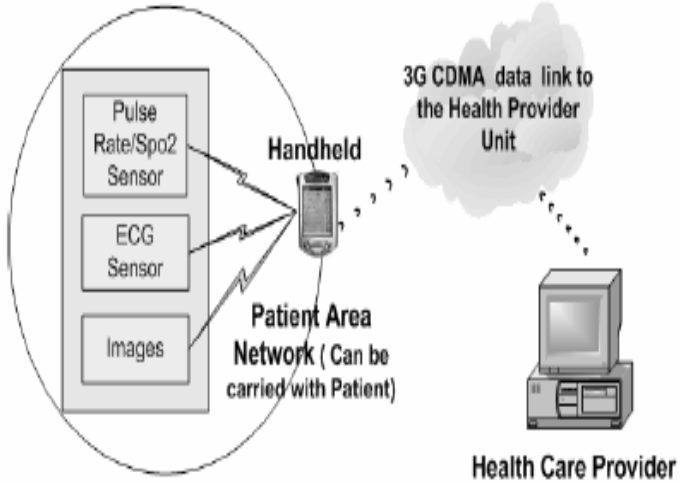

Figure 1: 24/7 Remote Monitoring Set-up

The main contribution of this paper is the design of such a unit, which is made challenging due to the reasons mentioned earlier. The aim is to shift medical acquisition

A PDA-based Flexible Telecommunication System for Telemedicine Applications

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Abstract - **Technology has been used to deliver health care at a distance for many years. Telemedicine is a rapidly growing area and recently there are studies devoted to pre-hospital care of patients in emergency cases. In this work we have developed a compact, reliable, and low cost PDA-based telecommunication device for telemedicine applications to transmit audio, still images, and vital signs from a remote site to a fixed station such as a clinic or a hospital in real time. This was achieved based on a client-server architecture. A Pocket PC, a miniature camera, and a hands-free microphone were used at the client site and a desktop computer running the Windows XP operating system was used as a server. The server was located at a fixed station. The system was implemented on TCP/IP and HTTP protocol. Field tests have shown that the system can reliably transmit still images, audio, and sample vital signs from a simulated remote site to a fixed station either via a wired or wireless network in real time. The Pocket PC was used at the client site because of its compact size, low cost and processing capabilities.**

In the U.S. and many other countries most of the government-funded programs have supported the creation of "hub and spoke" telemedicine systems linking an academic medical center at the hub with primary care clinics at the spokes. These demonstration programs, paralleling the evolution of U.S. health care systems, have been beneficial in proving the efficacy and effectiveness of telemedicine [2].

Telemedicine is to improve the quality, increase the efficiency, and to expand access of the health-care delivery system to the under-staffed, remote, hard-to-access, or under-privileged areas where there is a paucity of medical practitioners and facilities. It seems reasonable to envision that a telemedicine facility could significantly impact areas where there are needs for uniform healthcare access such as under-served populations of rural areas, developing countries, space flights, remote military bases, combat zones, and security health-care facilities. Mobile patient

2001 Proceedings of the 23rd Annual EMBS International Conference, October 25-28, Istanbul, Turkey

ADVANCES IN TELEMEDICINE USING MOBILE COMMUNICATIONS

R. S. H. Istepanian[1], B. Woodward[2] and C. I. Richards[2]
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Abstract – **Future telemedicine systems will exploit mobile communications technology so that patients who are free to move around at home or at work, or in emergency medical situations, can be monitored in a hospital. At present, the GSM mobile telephone cellular network is limited to 9.6 kbps, but with the introduction of the third generation (3G) network, data rates of 144 kbps will be available, giving scope for the transmission of much more biomedical data as well as voice and video data if required. The paper discusses some of the issues involved and outlines the types of systems that will be viable with the new technology.**

Keywords – **Telemedicine, communications**

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Shanghai, China, September 1-4, 2005

The Trauma Patient Tracking System: implementing a wireless monitoring infrastructure for emergency response

Jonathan S. Maltz[1], Thomas S.C. Ng[1], Dustin J. Li[1], Jian Wang[1], Kang Wang[1], William Bergeron[2], Ron Martin[2] and
Thomas F. Budinger[1]

Abstract-**In mass trauma situations, emergency personnel are challenged with the task of prioritizing the care of many injured victims. We propose a trauma patient tracking system (TPTS) where first-responders tag all patients with a wireless monitoring device that continuously reports the location of each patient. The system can be used not only to prioritize patient care, but also to determine the time taken for each patient to receive treatment. This is important in training emergency personnel and in identifying bottlenecks in the disaster response process. In situations where biochemical agents are involved, a TPTS may be employed to determine sites of cross-contamination. In order to track patient location in both outdoor and indoor environments, we employ both Global Positioning System (GPS) and Television/ Radio Frequency (TVRF) technologies. Each patient tag employs IEEE 802.11 (Wi-Fi)/ TCP/IP networking to communicate with a central server via any available Wi-Fi basestation. A key component to increase TPTS fault-tolerance is a mobile Wi-Fi basestation that employs redundant Internet connectivity to ensure that tags at the disaster scene can send information to the central server even when local infrastructure is unavailable for use. We demonstrate the robustness of the system in tracking multiple patients in a simulated trauma situation in an urban environment.[1]**

A Wireless PDA-Based Physiological Monitoring System for Patient Transport

Yuan-Hsiang Lin, I-Chien Jan, Patrick Chow-In Ko, Yen-Yu Chen, Jau-Min Wong, and Gwo-Jen Jan

Abstract—This paper proposes a mobile patient monitoring system, which integrates current personal digital assistant (PDA) technology and wireless local area network (WLAN) technology. At the patient's location, a wireless PDA-based monitor is used to acquire continuously the patient's vital signs, including heart rate, three-lead electrocardiography, and SpO_2. Through the WLAN, the patient's biosignals can be transmitted in real-time to a remote central management unit, and authorized medical staffs can access the data and the case history of the patient, either by the central management unit or the wireless devices. A prototype of this system has been developed and implemented. The system has been evaluated by technical verification, clinical test, and user survey. The evaluation of performance yields a high degree of satisfaction (mean = 4.64, standard deviation—SD = 0.53 in a five-point Likert scale) of users who used the PDA-based system for intrahospital transport. The results also show that the wireless PDA model is superior to the currently used monitors both in mobility and in usability, and is, therefore, better suited to patient transport.

Proceedings of the 39th Hawaii International Conference on System Sciences - 2006

Transmission of Emergency Messages in Wireless Patient Monitoring: Routing and Performance Evaluation

Upkar Varshney

Abstract

Patient monitoring is becoming a requirement for offering a better healthcare to an increasing number of patients in nursing homes and hospitals. During the monitoring, vital signs of patients could fluctuate significantly and/or match certain undesirable patterns and therefore "alerts" or emergency messages must be delivered to healthcare professionals. There has been some work in using infrastructure-oriented wireless networks for transmission of emergency messages, however, the network coverage and reliability of message delivery have not been satisfactory. To overcome these, we propose that ad hoc networks can be formed among patients' devices for improved transmission of emergency messages. We also propose several design enhancements to improve the quality and coverage of patient monitoring. The performance results for the proposed ad hoc network based architecture show that reliable message delivery and low monitoring delays can be achieved by using multicast or broadcast-based routing schemes.

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Optimum Design of Remote Patient Monitoring Systems

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Abstract— **Remote patient monitoring (RPM) of physiological measurements offers the potential to provide high quality care to elderly, chronically and acutely ill people in their home environment, while making effective use of healthcare resources. However, despite its clearly demonstrated potential, RPM has not become an integrated part of patient care so far. In this paper, we undertake an extensive systematic literature review to identify the typical set-up of RPM projects and services in the UK. We then propose a solution for a clinically and organizationally more integrated service, which is based in primary care. Key to the design is the involvement of other healthcare services such as social care, the emergency department of a hospital, and out-of-hours General Practitioner services, and also the involvement of the patient and their carer/s. This allows a team-based approach with information-sharing across different healthcare sectors, and offers maximum continuity of care for the patient.**

provide an alternative to hospital monitoring, as it can facilitate early discharge of patients from hospital, or as a substitute for hospital care. It can also help to identify hospitalisations by detecting deterioration early. This can reduce the number of unnecessary admissions and enable prompt emergency admissions [3]. In addition, it can allow healthcare professionals to manage a greater number of patients with long-term conditions, since they are able do so from their offices (see e.g. [4]).

In a move to prepare the health service for these challenges, the UK government aims to make telecare available to all homes requiring it by 2010 [5]. It is hoped that this will allow elderly and disabled people to live independently for longer, and so prevent or postpone their institutionalised care [5].

SICE-ICASE International Joint Conference 2006
Oct. 18-21, 2006 in Bexco, Busan, Korea

Development of Mobile Units and Integrated System for Emergency

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Abstract: In this study, we developed six types of mobile units and an integrated system which can manage vital signs from each unit using Bluetooth wireless communication. The six kinds of mobile unit were so designed that each has different function to be applied according to the condition of patient properly. The mobile units can measure ECG signal of single or 12 channel, blood pressure, pulse and SpO2 signal from a patient. Also, to reduce the uncomfortable measurement, several types of units such as belt type, wrist type and necklace type were designed. Our proposed system can integrate and monitor several biological signals from different patients by using Bluetooth wireless communication simultaneously. The developed system was evaluated in the simulated emergent situation and showed the system can monitor 6 patients in maximum according to the data quality. It showed the possibilities that the developed system can be used effectively for emergency situation or in- or out-hospital transport of patient. In future, with the combination of mobile communication technique, a patient who is in emergency situation can be provided with proper first-aid and a doctor can pile the information of patient and give better diagnosis and treatments.

A Mobile Care System With Alert Mechanism

Ren-Guey Lee, *Member*, *IEEE*, Kuei-Chien Chen, Chun-Chieh Hsiao, and Chwan-Lu Tseng

Abstract—**Hypertension and arrhythmia are chronic diseases which can be effectively prevented and controlled only if the physiological parameters of the patient are constantly monitored, and the health education and professional medicine care is fully supported. In this paper a role-based intelligent mobile care system with alert mechanism in chronic care environment is proposed and implemented. The roles in our system include patients, physicians, nurses, and health care providers. Each of the roles represents a person that uses a mobile device such as a mobile phone to communicate with the server set up in the care center so that he or she can go around without restrictions.**

For commercial mobile phones with Bluetooth communication capability attached on chronic patients, we have developed physiological signal recognition algorithms that were implemented and built-in in the mobile phone without affecting its original communication functions. It is thus possible to integrate several front-end mobile care devices with Bluetooth communication capability to extract patients' various physiological parameters (such as blood pressure, pulse, SpO_2 and ECG), to monitor multiple physiological signals without space limit, and to upload important or abnormal physiological information to health care center for storage and analysis or transmit the information to physicians and health care providers for further processing. Thus the physiological signal extraction devices only have to deal with signal extraction and wireless transmission. Since they don't have to do signal processing, their form factor can be further reduced to reach the goal of microminiaturization and power saving.

An alert management mechanism has been included in back-end health care center to initiate various strategies for automatic emergency alerts after receiving emergency messages or after automatically recognizing emergency messages. Within the time intervals in system setting according to medical history of a specific patient, our prototype system can inform various health care providers in sequence to provide health care service with their reply to ensure the accuracy of alert information and the completeness of early warning notification to further improve the health care quality. In the end, with the testing results and performance evaluation of our implemented system prototype, we conclude that it is possible to set up a complete intelligent health care chain with mobile monitoring and health care service via the assistance of our system.

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Development of a remote handheld cardiac arrhythmia monitor

Swaroop S. Singh and Henry S. Hsiao

Abstract—

In this paper we present the design and development of a real-time remote handheld cardiac arrhythmic monitoring system (RCAM). A client-server model based on Internet protocols was used. ECG data was transmitted from the remote handheld client to a centralized server, where the QRS and premature ventricular contraction detection algorithms were implemented and graded depending on the number and pattern of PVCs present. The QRS sensitivity and specificity on ECG records from Physionet archives in absence of arrhythmia was 100% and 99.62%, while in presence of arrhythmia was 99.34% and 99.31%. The average 'negative time' measured on ventricular tachyarrhythmia records was 92 seconds. The RCAM can provide remote detection of cardiac abnormalities and give specific diagnosis and recommendations of actions to be taken immediately. The limitation due to the inability of the PDA to perform complex computations was overcome by the use of the remote server.

mortality rates and subsequent arrhythmic events.

Studies[3] have shown that remote ECG monitoring from pre-hospital setting results in reduced response time, improving patient outcome. It was also used to assess the probability of cardiac event, stratify risk and to guide therapy. The primary attributes of remote monitoring systems[4] are: (a) Record key information at the point of care, eliminating errors and duplication of effort and providing completeness of data (b) Automate processes and information sharing (c). Provision for clinical decision support (d) Ensure secure acquisition and storage of patient data. (e). Provide reliable performance (f) Assist patients in management of their own health.

ECG signal recording in a non-hospital setting can be

A Vision of Ambulance Telemedicine Services Using the Quasi-Zenith Satellite

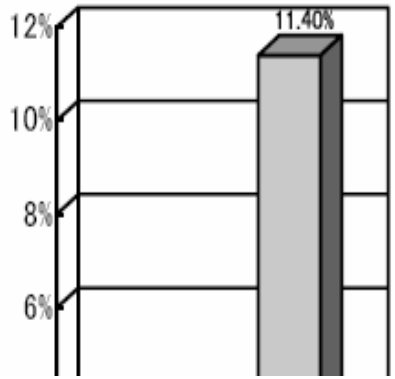
Yoshiko Yamada, Sumio Usui, Motoyuki Kohn, and Masahiro Mukai

Abstract—**This is a vision of ambulance telemedicine and disaster applications using the Quasi-Zenith Satellite (QZS). It describes Japanese social requirements for advanced medical care in ambulances and then provides an overview of the Quasi-Zenith Satellite System (QZSS) and of ambulance telemedicine services using the QZS. Also discussed are plans to realize the services.**

The QZSS will capitalize on its high elevation in Japan to target mainly mobile users through a star-type network centered on a gateway. Ambulances will be connected to the gateway through the QZS, triage centers will be connected to the gateway through a land-based network, and hospital emergency rooms will be connected to the triage centers by landlines. Using the QZS, appropriate and expedient medical care can be rendered in ambulances, shortening ambulance transport time, enhancing the time for preparation by the receiving hospital, and realizing more effective patient triage overall. Ambulance telemedicine services will contribute to saving more lives.

After detailed examination, the Law Concerning EMTs is being revised. EMTs in Japan will be permitted to perform *tracheal intubation* under doctor's specifications effective July 1, 2004 [3].

By spring 2006, Japanese EMTs will also be able to inject *epinephrine* under some conditions, again, however, only under doctor's orders. And the possibility of EMTs being allowed to inject other medicines is being investigated [4].



Proceedings of the 26th Annual International Conference of the IEEE EMBS
San Francisco, CA, USA • September 1-5, 2004

Mobile Telemedicine System for Home Care and Patient Monitoring

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[1]Laboratório de Informática em Saúde, Pontifícia Universidade Católica do Paraná, Curitiba, Paraná, Brazil
[2]Programa de Pós-Graduação em Tecnologia em Saúde, Pontifícia Universidade Católica do Paraná, Curitiba, Paraná, Brazil

Abstract— **Home care services are growing up in the past years. Contemplating the patient/family pair, it represents a solution to the medical problems of the modern life. With the social trends, the senior population has been increasing in the last years. However, as living is more stressful than ever, there are more cases of chronic diseases. The difficulties of transport in the big cities and the scarcity of hospital streambeds turn the home care an attractive solution. However, its routines can be switched by telemedicine. This paper describes the implementation of a telemedicine system for patient monitoring using mobile telephony. The major aspect about this application is its generality, which allows the use of any patient monitor with a RS-232 interface. The system proved to be quick and reliable. Therefore, it represents an applicable solution to telehomecare.**

2001 Proceedings of the 23rd Annual EMBS International Conference, October 25-28, Istanbul, Turkey

A New Magnetic Device for the Identification of Endotracheal Tube Position

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[1]Joint Research Center for Biomedical Engineering, Department of Biomedical Engineering, Zhejiang University, Hangzhou, China

[2]Department of Anesthesia, Shaoxing No.1 Hospital, Zhejiang, China

[3]Joint Research Center for Biomedical Engineering, Department of Electronic Engineering, The Chinese University of Hong Kong, Hong Kong SAR, China

[4]Department of Anesthesia, Shaoxing No.4 Hospital, Zhejiang, China

Abstract- **A new device for detecting the position of endotracheal tube is presented in this paper. This device consists of a high sensitive linear Hall-effect sensor and a newly designed endotracheal tube in which two small magnets are embedded. The Hall-effect sensor can be placed on the skin of neck over the vocal cord to detect the position of endotracheal tube by measuring the strength of its magnetic field when the magnet on tube passes through the glottis during intubation. The results of our clinical tests on 38 cases of endotracheal intubation and 15 controls of esophageal intubation show that the device is sensitive to verify the esophageal intubation, and that it provides a useful means for clinician to control the inserted length easily. Due to its unique principle of operation, the detector can be applied to all kinds of patients, especially in pre-hospital sites.**

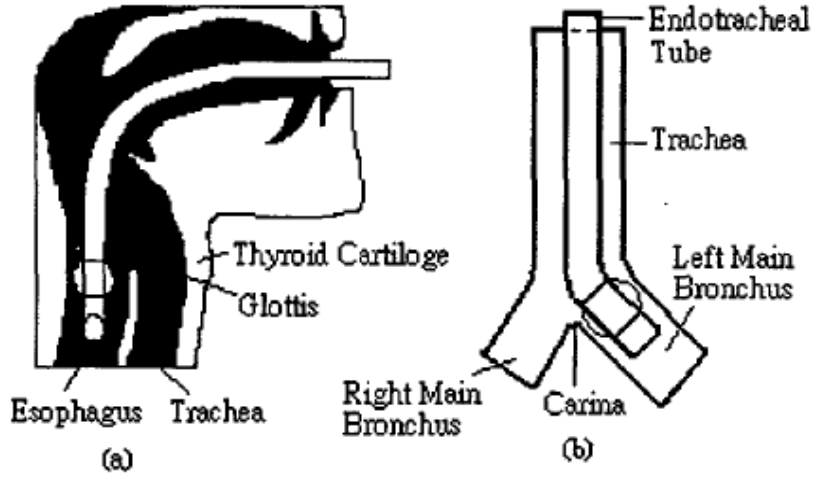

Fig.1 Improper endotracheal intubations (a) going into the esophagus, and (b) passing over the carina.

There are several methods and devices to detect

Proceedings of The First Joint BMES/EMBS Conference **Serving Humanity, Advancing Technology** Oct. 13-16, '99, Atlanta, GA, USA

MEASUREMENTS OF PRESSURE BETWEEN LARYNGOSCOPE BLADE AND UPPER AIRWAY TRACT DURING OROTRACHEAL INTUBATION

S. Hashimoto*, S. Manabe*, S. Kaku*, T. Wang** and R. Tanaka**

*Electronic Engineering, Osaka Institute of Technology,

Abstract Pressure generated between the laryngoscope blade and the upper respiratory tract tissue during orotracheal intubation was measured with a chromo-film. Orotracheal intubation was performed in 20 cases with Wis-Foregger or with MacIntosh laryngoscope, on which the chromo-films were attached. Pressure applied on the blade was determined by colorimetric assessment of the film. The results show that the pressures were 1.2 ± 0.6 MPa on the base of the epiglottis, 0.8 ± 0.4 MPa on the surface of the tongue, and 0.11 ± 0.03 GPa on the edge of the upper incisor, and that the mucous membranes of the base of the epiglottis were traumatized by the pressure of > 1.6 MPa.

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Detection of One Lung Intubation by Monitoring Lungs Sounds

L. Weizman, J. Tabrikian and A. Cohen
Department of Electrical and Computer Engineering, Ben Gurion University of the Negev, Beer-Sheva, Israel

Abstract— **Analysis of lungs sounds for monitoring and diagnosis of pulmonary function is well known. One of the applications of this method is detection of One Lung Intubation (OLI) during anesthesia or intensive care. In this paper, an algorithm for detection the One-Lung ventilation situation from the lungs sounds is presented. The algorithm assumes a MIMO (Multiple Input Multiple Output) system, in which a multi-dimensional AR (Auto-Regressive) model relates the input (lungs) and the output (recorded sounds). The unknown AR parameters are estimated, and a detector based on the estimated eigenvalues of the source covariance matrix is developed, in order to detect one lung ventilation situation. Testing the algorithm on real breathing sounds, which were recorded in a surgery room, shows more than 90% accuracy in OLI detection.**

of respiratory sound signals, in application to diagnosis and monitoring of pulmonological malfunctioning, is well known in the literature [4],[5],[6]. This technology, when applied to anesthesia and intensive care, has the potential of providing reliable, direct, easy to apply and relatively inexpensive solution to the OLI problem. The concept of this technology is presented in this paper.

II. Experiment Structure

In order to examine the suggested method and to check the possibility of developing a monitoring tool in the future, a database of recorded breathings was established. The database was composed of 24 patients which were recorded

An Acoustical Guidance and Position Monitoring System for Endotracheal Tubes

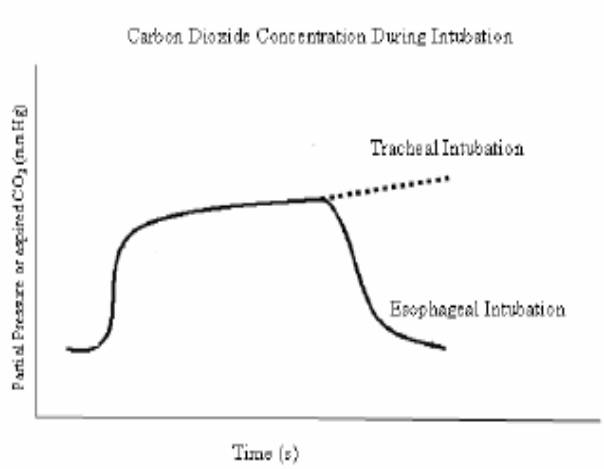
Jeffrey P. Mansfield, Robert P. Lyle, William D. Voorhees, and George R. Wodicka

Abstract—**A prototype instrument to guide the placement and continuously monitor the position of an endotracheal tube (ETT) was developed. An incident audible sound pulse is introduced into the proximal ETT and detected as it travels down the ETT via a miniature microphone located in the wall. This pulse is then emitted from the tube tip into the airways and the reflected signal from the airways is detected by the microphone. A well defined reflection arises from the point where the total cross sectional area of the airways increases rapidly, and the difference in timing between detection of the incident pulse and this reflection is used to determine ETT position or movement. This reflection is not observed if the ETT is erroneously placed in the esophagus. The amplitude and polarity of an additional reflection that occurs at the ETT tip is used to estimate the cross-sectional area of the airway in which the ETT is placed. This combined information allows discrimination between tracheal and bronchial intubation and can be used to insure an adequate fit between the ETT and trachea. The instrument has proven extremely reliable in multiple intubations in eight canines and offers the potential to noninvasively and inexpensively monitor ETT position in a continuous manner.**

Capnography-Guided Intubation

Vadim Pinskiy*, Neil Mori*, Harsh Shah*, Poonam Dudhat*, Glen Atlas[#]
*Stevens Institute of Technology, Biomedical Engineering / Hoboken, NJ 07030
[#]Dept. of Anesthesiology, University of Medicine and Dentistry of New Jersey / Newark, NJ 07103

Abstract—**The device uses capnography to guide intubation for more effective airway management. The carbon dioxide concentration is conveyed to the anesthesiologist through an audible signal, which is used to direct the endotracheal tube into the trachea. The process significantly speeds up procedure time in difficult airway cases while reducing the risk of improper tracheal tube placement.**



I. INTRODUCTION

A. Background

Intubation is a commonly performed medical procedure in which an artificial airway is established in a patient to provide proper gas exchange. It depends on the proper insertion of the endotracheal tube into the trachea instead of the esophagus. The placement of the endotracheal tube into the esophagus

1995 IEEE-EMBC and CMBEC
Theme 3: Clinical Engineering/Medical Informatics

MONITORING OF BREATHING TUBE POSITION AND PATENCY IN SITU USING REFLECTED SOUND

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Abstract— **A new technique that acoustically interrogates an intubated breathing tube to yield clinically useful patency and position information was developed. A miniature speaker connected to the proximal tube end generates a sonic pulse that propagates down the tube, and the resulting echoes from within the tube and airways are measured by a miniature microphone. During intubations of anesthetized canines, the technique: 1) reliably differentiated between tracheal, bronchial, and esophageal intubations; 2) accurately quantified tube movements; 3) provided the location and degree of lumenal obstructions; and 4) detected extubation or disconnection from the ventilator hose. This technique offers an inexpensive and noninvasive mechanism to monitor breathing tubes *in situ*.**

Keywords— **Endotracheal tube, Acoustical monitoring, Respiratory care**

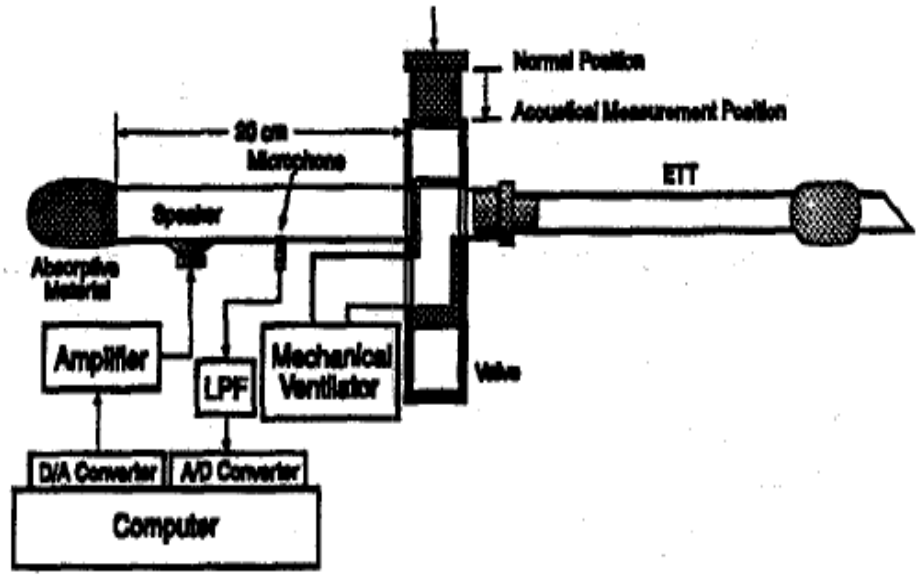


Fig. 1. Acoustic reflectometry system.

Miniature Acoustic Guidance System for Endotracheal Tubes

Eduardo J. Juan*, Jeffrey P. Mansfield, and George R. Wodicka, *Fellow, IEEE*

Abstract—**Ensuring that the distal end of an endotracheal tube (ETT) is properly located within the trachea, and that the tube is not obstructed by mucus deposition, is a major clinical concern in patients that require mechanical ventilation. A novel acoustic system was developed to allow for the continuous monitoring of ETT position and patency. A miniature sound source and two sensing microphones are placed in-line between the ventilator hose and the proximal end of the ETT. Reflections of an acoustic pulse emitted into the ETT lumen and the airways are digitally analyzed to estimate the location and degree of lumen obstruction, as well as the position of the distal end of the tube in the airway. The system was evaluated through *in vitro* studies and in a rabbit model. The system noninvasively estimated tube position *in vivo* to within roughly 4.5 mm, and differentiated between proper tracheal, and erroneous bronchial or esophageal intubation in all cases. In addition, the system estimated the area and location of lumen obstructions *in vitro* to within 14% and 3.5 mm, respectively. These findings indicate that this miniature technology could improve the quality of care provided to the ventilated adult and infant.**

Index Terms—**Acoustic reflections, biomedical acoustics, biomedical monitoring, microphones, respiratory system.**

is performed as a preventative measure. The most common complications associated with suctioning include hypoxia and respiratory tract tissue trauma [3].

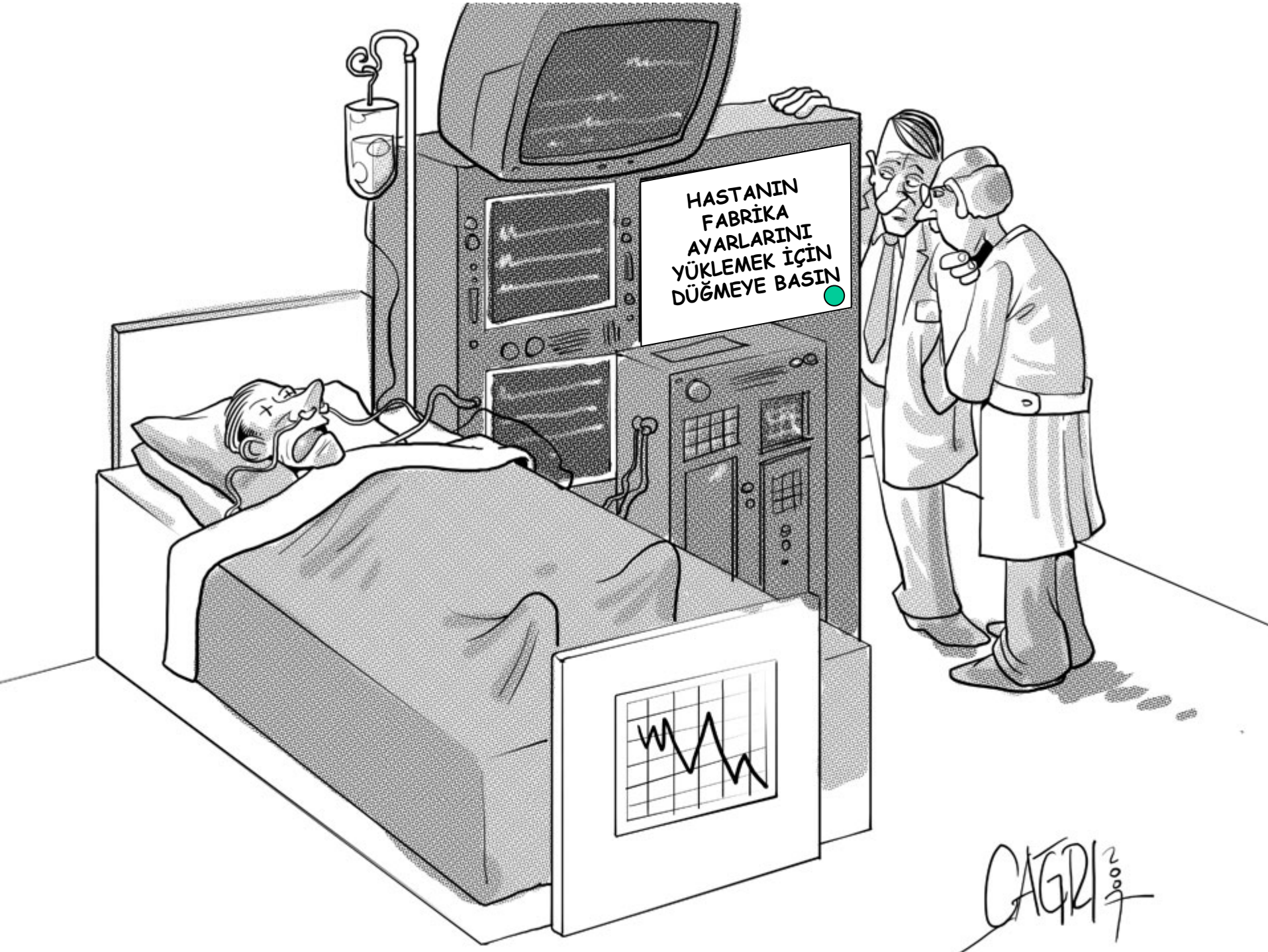
Real incidence rates of intubation complications are difficult to ascertain from the literature since most intubation mishaps that do not result in serious clinical complications, and presumably some that do, are not reported [4]. Some scattered studies, however, provide an estimate of the rate of such complications. The most common complication, and perhaps the most potentially harmful during the intubation procedure, is unrecognized esophageal intubation. A study performed at the University of California-Davis Medical Center [5] showed that esophageal intubation occurred in 33 (5.4%) out of 610 patients that were intubated by emergency medicine residents. Eight (24%) of the 33 cases resulted in immediate complications. Moreover, an analysis of the American Society of Anesthesiologists Closed Claims Project [6] revealed that unrecognized esophageal intubation accounts for about 6% of all anesthesia related malprac-

Ultra Low Power Electronics for Medicine

Rahul Sarpeshkar
Analog VLSI and Biological Systems Group
Research Laboratory for Electronics (RLE)
Massachusetts Institute of Technology
Cambridge, MA 02139

Abstract

We discuss how programmable analog electronics may be used to lower overall lpower consumption over traditional A-to-D-then-DSP architectures in portable medical applications. One example includes a bionic ear processor for the deaf whose power consumption is an order of magnitude below the best designs today, that will be unbeatable even at the end of Moore's law, and which will enable 30 year operation on an implanted 100mAh rechargeable battery. Another example includes an ultra low power portable pulse oximeter for measuring oxygen saturation, an important vital sign. I will discuss implications for future medical applications that are battery free and that operate by rectifying ambient RF energy, for example for cardiac monitoring. Medical applications in the future are likely to benefit greatly from ultra low power electronics especially in implanted, home care, surgical, and emergency monitoring.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