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A SURVEY OF TELECARDIOLOGY PROJECTS IN ITALY

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ABSTRACT
It is estimated that in Italy there are about three million people affected by chronic heart failure. Cardiology is the health care field currently getting the largest benefits from telemedicine. Transmission, using wireless devices, makes possible to achieve virtual hospitalization: it is possible to anticipate the time of discharging and the patient can be remotely controlled by the central station in the ICU of the department of Medicine. Teleconsulting (i.e. a distance consulting between physicians) is applied in telecardiology, it allows the realization of a consulting between cardiology departments and remote services in the same hospital or among far-away hospitals.
In this paper some of the most significant cardiac telemonitoring projects in Italy are described. Also reported, the projects involving the applications of implantable cardiac devices which can be controlled remotely.
In conclusion, we sketch out the future prospects of telecardiology research and its applications in Italy.

KEY WORDS
Telemedicine, Health Care Information Systems, Telecardiology, Heart Failure.

1. Introduction

Wireless health care is a new health care delivery paradigm enabled by technologies and services (better described as solutions) whereby patients can have nearly continuous access to health care information, expert advice, or therapeutic interventions enabled by ubiquitous telecommunication networks. Basic functions for pervasive health care with respect to home care include emergency detection and alarm, disease management, as well as health status feedback and advice. The digital Agenda for Europe 2020 (a strategy for fast, sustainable and inclusive growth) includes, as objective, the deployment of e-health technologies for sustainable health care, information and communication technologies (ICT)-based support for dignified and independent living, including remote places. There are about three million people affected by chronic heart failure (5% of the population) in Italy. Slightly less than 1/3 of them hold a confirmed diagnosis.
This work sketchs out the current status of cardiac care in Italy and highlights how telecardiology can support general practitioners in the diagnosis and management of acute and chronic cardiac disease, as well as provide the potential for screening opportunities in particular for risk patients. It is also presented the achievement of recent trials of a telecardiology service in our country.
Patients affected by heart failure (HF) cannot be properly and adequately controlled, despite the increasing number of ambulatories, especially because of the long waiting lists for cardiology visits both in hospitals and at local health units.
The hospital emergency room, then, is often used as a "shortcut" for the assistance, and, for legal problems (the so-called "defensive medicine") it tends to be used also in non-critical situations, causing a waste of economic resources.
Heart Failure accounts for 1 to 2% of total health expense in Italy. The main factors causing such costs are: hospitalizations, representing the largest component (about 70%), medications, outpatient specialist visits and mechanical cardiac support devices.
Cardiology is the field of health care currently getting the largest benefits from telemedicine.
Telecardiology makes possible to achieve a virtual hospitalization: it is possible to anticipate the time of discharging and the patient can be remotely controlled by realizing cardiac telecare at home.
Teleconsulting (i.e. a distance consulting between physicians) is widely applied in telecardiology, allowing the realization of a consulting between cardiology departments and remote services in the same hospital or other hospitals.
This approach is particularly useful and used mainly by private medical care that can't benefit of a specialist cardiology service available 24/7. It is also used in tourist resorts medical center or in remote communities, nursing homes or rest homes.
The main applications of remote monitoring are:

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1) Cardiovascular monitoring systems. These systems require the presence of medical practitioners or nurse specialists in the place where they are being provided.
2) Respiratory monitoring systems. The main parameters are: peak flow of breath and volume per second of forced respiration that can be transmitted by means of a flowmeter to a unit center, via telephone.
3) Blood glucose monitoring systems. There is a significant set of information for planning and conducting a monitoring organization: insulin doses to be administered, composition of meals, general metabolic status and lifestyle.

An important application of telemedicine is in the field of cardiovascular emergencies. Actuallytelecardiology has definitely become part of the integrated management system of patients with acute coronary syndrome, as prescribed by all major national and international guidelines.

The timing required for the treatment of myocardial infarction with ST-segment elevation makes necessary to implement procedures that ensure integrated collaborative care spread evenly throughout the region.

Although telecardiology is still in its infancy, data suggest that patients with congestive heart failure draw the largest benefit from current technology.

2. Telemonitoring

Many Italian regions have well organized systems for the diagnosis and management of the acute coronary syndromes, such as Apulia with "RETE IMA" project, Lombardy with "PROVA e TRASPORTA" and "GEST IMA" project, Latium with "INFARTO.NET" project. Lombardy is the only Italian region that has managed to integrate telemedicine with the healthcare national system. "Telmed Platform" is one of the most relevant achievements. It is a health care platform supporting telemedicine services realized by HTN [1]. HTN (Health Telematic Network) is a company working in Brescia (Northern Italy) since the 1990s, able to implement efficient and effective telemedicine services. By means of Telmed Platform it is possible:

- to enable health care operators on the territory to access health information,
- to integrate hospital information systems for data exchanging,
- to acquire data from devices and monitoring systems,
- to allow interoperability with local-based structures for administrative and reporting tasks,
- to manage interaction with patients,
- to perform teleconference.

Terminals are set up in universities and public hospitals, functionally linked with the Service Center, and configured in order to share application programs of the central station with onsite and online licences. The service centre provides technological and organizing support, while healthcare activity is carried out by the hospital's cardiologists and nurses.

This platform is accessible by any web browser and can be customized according to local needs. It can support all different phases of patient management, i.e.:

- acquisition of vital parameters,
- contact with a call center operator,
- referring to the specialist physician with automatic access to clinical data,
- archiving of information and biosignals,
- report generation,
- communication to external systems (e.g. local health systems, hospital information systems) of relevant information.

HTN is also able to offer wireless solutions in modular systems composed by three elements:

1. "HTN Bee-P Mobile", an application installed on a mobile phone transmitting the patient's vital parameters to the telemedicine service centre.
2. "Bee-P Services" acquiring such data by mobile gateway. 3. "Bee-P Web" for optimal data visualization. It is a web integrated system inside the Service Center platform.

The "Lancisi" hospital in Ancona has been carrying on a project on HF and telecardiology aimed to the palliative treatment of patients not eligible for transplantation [2]. The project is focused on remote monitoring and follow-up of patients at home.

Four different cardiology units are able to monitor the patients 24/7. A teleconsulting service offering a second opinion is also available. Patients with an implantable cardioverter defibrillator or a pacemaker are remotely monitored also by an arithmologist.

Data collected are also used for statistical and scientific purposes.

This approach guarantees a high appropriateness in the supply of medical care. Obviously, the online teleconsulting shortens waiting time and increases the percentage of patients treated with beta-blockers and angiotensin-converting enzyme (ACE) inhibitors according to guidelines.

Another supported application is home care featuring inotropic therapy in selected patients in need of palliative care.

The "San Giovanni-Addolorata" hospital in Rome, is also offering a telemedicine service providing patients with a briefcase, containing biomedical equipments. In such a way, a sort of "virtual hospital bed" is realized at patients' home [3] and also at patient's prison.

The case is equipped with a blood pressure measurement system (BPMS), a 12-lead electrocardiograph, a pulse oximeter and a blood glucose metre connected to a palmtop computer. The use of a palmtop computer allows patients to be trained step by step in self monitoring.

Such computer acts not only as a data collector to be sent to the server, but also provides a series of information to patients among which their current treatment or the measurement protocol can be carried out.

3. Implanted devices

In the last five years many Italian biomedical companies have focused their efforts in research and development in order to realize implantable remotely controlled cardiac devices. These new tools, allowing remote monitoring of implanted patients, are referred as Remote Patient Management (RPM).

In 2006, the Heart Rhythm Society recommended to develop devices for cardiac rhythm management using wireless technologies and remote monitoring in order to:

- immediately identify abnormal behaviour of the device;
- reduce the incomplete reports of the device malfunctioning, checking more often and more accurately the state of its functions [2].

RPM has been shown to have positive effects on clinical outcomes and economic management of patients with HF. An analysis, conducted by the New England Healthcare Institute, estimated that the probability of re-hospitalization in patients followed with RPM, are down to 32% compared to patients followed within normal standards [4].

In the prevention of re-hospitalization also weight monitoring has proved useful. Some researchers demonstrated the existence of a statistically significant correlation between weight gain and hospitalization due to cardiovascular failure ($p < 0.001$) [4][5].

The Medtronic CareLink® Network is the leading Internet-based system to help physicians and patients to manage in better ways chronic cardiovascular disease treated by implantable device therapy, such as pacemakers and implantable cardioverter-defibrillators (ICDs).

ICDs are intended to provide ventricular antitachycardia pacing and ventricular defibrillation for automated treatment of life threatening ventricular arrhythmias. ICDs with atrial therapies are also intended to provide atrial antitachycardia pacing and atrial defibrillation treatment in patients who have, or are at risk of developing, atrial tachyarrhythmias. CareLink® Network consists of three components: the Carelink® Monitor, the CareLink® Website, and Carelink® Server. Using CareLink® Connecting implanted cardiac device data to the electronic health record (EHR) and into a personal health record (PHR) via a single, easily-managed interface, can help healthcare practices maximize efficiency in workflow, potentially and significant time and money saving.

For non-wireless telemetry devices, the data transmission can only be achieved with the participation of the patient who must perform a sequence of simple steps to complete the process of data transmitting. Such transmission is called "manual transmission".

Wireless telemetry devices, can perform a “manual transmission” or "automatic transmission" that may not require any action by the patient.

The “automatic transmission” can be put up for periodic check in specific situations and for programmable DCI alarm. Two different kind of automatic transmission exist: scheduled and triggered by an alarm event. This second type is referred as Transmission CareAlert.

CareLink® Network was activated in the United States in August 2002, while in Italy was introduced for the first time in December 2006 in a limited number of centers, through a pilot project, which involved a small number of patients with biventricular ICD [5][6]. The project's aim was to test the feasibility of remote monitoring via Carelink® Network and evaluate the usability of the Carelink® Monitor by the patient, as well as the satisfaction and acceptance of the CareLink® Network system both by the patient and the medical staff. To evaluate the follow-up remotely service system some hospitals were involved: the Department of Management of “Politecnico” in Milan, the “San Raffaele” hospital IRCSS in Milan, the “Niguarda Ca 'Granda” hospital (Milan), the “San Carlo Borromeo” in Milan, the “Policlinico San Matteo” in Pavia and the “San Filippo Neri” hospital in Rome.

In Italy, CareLink® Network has been adopted by about 150 hospital-structures with more than 7,000 patients followed in remote mode. Each month there are about 350 new patients.

LATITUDE® system produced by Boston Scientific S.p.A. from 2009 is available in Europe and it is currently used in Italy. LATITUDE® Patient Management system allows to monitor in remote mode patients assisted by ICD or Cardiac Resynchronization Therapy-Defibrillator (CRT-D). CRT-Ds are recommended to patients with moderate up to severe HF (NYHA III/IV) who remain symptomatic despite stable, optimal HF drug therapy, and still have ventricular dysfunction (EF $\leq$ 35%) and QRS duration $\geq$ 120 ms. LATITUDE® incorporates a scale and a blood pressure monitor, both wireless and therefore can meet the Class 1 ESC recommendations for HF [7]. Daily made measurements using balance and blood pressure are recorded and sent to the database of the patient. These data are recorded into the daily report regarding the patient health. The progression of HF involves drastic health consequences and constitutes a burden over the healthcare system.

LATITUDE® collects data regarding HF from various sources (i.e. external sensors for the assessment of the weight and pressure) that helps to prevent the onset or the progression of HF to determine the moment where action is needed.

Diagnostic tools from implantable devices provide information about:

- Level of activity, accurately monitoring the percentage of patient's daily activities, useful prognostic indicator in patients undergoing CRT [8].
- Heart Rate Variability (HRV), with measurement of heart rate average, minimum and maximum on a daily basis. These parameters are used to identify changes that may have a significant impact on the health of patients. An increase in the average heart rate (HR) is associated with poor outcome in patients with HF [9].
- SDANN -Standard Deviation of the Averages of NN (Normal Sinus to Normal Sinus) Intervals-, to better

monitor the heart in patients with HF. Patients with lower SDANN indexes are at increased risk of cardiac events, hospitalization and mortality [10][11].

- HRV footprint, to provide a clear visual assessment of HRV in the long term. HRV footprint proved to be a significant prognostic indicator of mortality in correlation with the SDANN [12].

Taken individually, the values of these parameters are not the same as when evaluated together in the prevention of HF, reducing costs and time of hospitalization and improving quality of life for patients.

The LATITUDE system allows physicians to schedule remote check-ups of implantable cardiac devices to monitor specific device information and patient heart health status. It can also detect clinical events between scheduled follow-up visits and send relevant data directly to physicians. This regular in-home monitoring offers convenience and peace of mind for patients.

4. Future prospects

The future of home telemonitoring will consist in an easier approach through the use of wereable units allowing multiparameter telemonitoring.

In the National Research Council laboratories, researchers are studying the realization of wearable devices equipped with sensors and a microprocessor on which can be implemented mathematical models able to simulate/to reproduce a series of physiological and pathological conditions for a certain set of human physiological organs [13][14].

Numerical models that could be implemented on the microprocessor are:

- Numerical models of the cardiovascular system.
- Numerical models of the respiratory system.
- Numerical models of liver.
- Numerical model of kidney.
- Metabolism of bilirubin.
- Metabolism of glucose.
- Glucose-insulin control system.
- Models to study the drug effects on different circulatory districts [15].

Some numerical models can be used to evaluate the drugs effects in different pathological conditions. Other models (developed at Institute of Clinical Physiology CNR) as the numerical models of the cardiovascular system allow to analyze the interaction between the heart and circulatory system and to study the pathophysiological conditions of a patient. These models, created as research tools have evolved to be used in clinical and educational environment (“Sapienza” University, Department of Cardiovascular, Respiratory, Nephrological and Geriatic Sciences, Rome). In a clinical setting they are used to reproduce the pathological condition of a patient from easily non-invasively measurable parameters. The realization of personalized modular numerical models allows:

- to implement accurately the districts affected by cardiovascular disease afflicting the patient under observation,
- to use easily numerical implementation to simulate "non-pathological" districts.

It follows that the parameters measured on a patient may vary according to the type of pathology. The measured parameters can be used to estimate, through the use of numerical models, parameters of clinical interest that are not easily and directly measurable.

A possible application of the use of numerical models of the cardiovascular system is that can be achieved for patients affected by chronic left ventricular (LV) failure due to idiopathic or ischaemic dilated cardiomyopathy associated with electromechanical dyssynchrony [14][16][17]. This pathology causes irregular muscle contractions in the heart resulting in inefficient pumping of blood. Cardiac Resynchronization Therapy (CRT) improves the coordination of the contractions using technology similar to that used in pacemakers and implantable cadioverter devices.

Regular (daily or even continuous) transmittal of data regarding heart rate, blood pressure, ECG, weight, body temperature, oxygen saturation, or transthoracic impedance (for control of fluid overload) can provide a basis for disease management decisions of patients affected by described pathology.

All these data together with data regarding pacemakers temporization could be measured using integrated sensors into device (T-shirt of hypoallergenic material, band, belt or otherwise) worn by patient. The same support could be equipped with a microprocessor in which a simple numerical simulator of the cardiovascular system could be implemented. The simulator could estimate some haemodynamic parameters (not directly measurable) from measurements performed on the patient. In addition, the implemented simulator could estimate, using the measured data, the best pacemaker temporization [16][17]. The measured and predicted data may be sent to a Medical Center Unit (MCU) where trained physicians could use complex simulator of the cardiovascular system to identify the best therapy for patients from the parameters measured and simulated [18][21]. This approach can produce a significant reduction in the median time for clinical decision for cardiac resynchronization therapy-defibrillator and implantable cardioverter-defibrillator patients when monitored remotely.

5. Conclusion

Telematics application must ensure the electronic medical service quality. The task of measuring the quality according to certain technical parameters relates to the validity of the transmission of signals over telephone or via satellite.

It must be also considered that the chain allowing the connection between two computers is a complex system

consisting of connectors, cables, interfaces, routers, bridges, radio, data acquisition systems data, software, telecommunications and other components. Therefore, to ensure the quality of the overall system, it is necessary that each component of the system is able to ensure the desired level of performance: just one link in the chain could be sufficient to degrade the entire system. Moreover, it is necessary to adopt standards to enable interoperability of heterogeneous systems [22].

Telemedicine applications, in general, and telecardiology in particular, have their own specific clinical application field, which, of course, is limited not only to technological issues concerning data transmission. Other parameters must be taken into account and can be formalized [23].

The International Standards Organization (ISO) has developed a grid of six key factors (split into different characteristics) which a telemedicine/telecardiology service must provide [24]:

a. Trustworthiness (Maturity, Error tolerance, Recoverability, Availability, Degradability).
b. Efficiency (Operation time, Operation of the resource).
c. Portability (Adaptability, Instability, Compliance, Substitutability).
d. Features (Appropriateness, Accuracy, Interoperability, Compliance, Security, Traceability).
e. Employability (Intelligibility, Learnability, Operability, Clarity, Flexibility, Attraction, Clarity, Utilities, Ease of use).
f. Maintainability (Analyzability, Variability, Stability, Testability, Feasibility, Re-usable).

It is now clear that telecardiology, enabling a better interaction between hospital and territory by means of teleconsulting, telemonitoring, telecare and remote access to clinical information, improves the quality of the whole health system. However, it cannot and should not replace the essential home care services, but it should be integrated properly and profitably with them.

The evaluation of the operational scenario of telecardiology must be made by studying and identifying the parameters and technology models which are most appropriate to the various clinical situations and therefore more useful for medical and cardiological intervention.

Patients with advanced chronic HF and/or abnormal heart rhythms, also monitored with implanted devices, represent the most appropriate categories to include in programs of continuous cardiac telecare.

Remote monitoring of devices allows clinicians to quickly and thoroughly review the status of a patient’s heart condition and any changes occurred since the last in-person appointment or remote transmission.

The implementation of such integrated system between general medicine and cardiology medicine can represent a relevant way of assessing cardiac patients over time and avoid inappropriate hospital admissions.

Finally, the general practitioner and medical personnel, in any way involved in the system, may see their level of specialist education increased, whereas patients and their families can learn to collaborate in the management of their disease by having the opportunity of understanding the clinical significance of different symptoms and of executing, even if under medical/nursing control, medical acts such as simple detection of blood pressure, heart rate and blood oxygen saturation of O2, ECG performance, blood chemistry testing.

Telecardiology is also highly relevant in emergency services. In fact, by enhancing communication, it can help the treatment of patients with chest pain/STEMI quickly preserving in most cases the patient's life and drastically reduce the acute and chronic complications. The ability to shorten the response time is a very significant factor, even more than a better resource management.

In conclusion, we can say that it is definitively proved the validity of telecardiology in terms of reducing health expenditure for cardiovascular disease, since there is a significant reduction of days of hospitalization and cut of improper and/or surplus medical acts. It is also evident the improvement of patient's life both in clinical and psychological factors [25].

References

[1] M. Mazzù, S. Scalvini, A. Giordano, E. Frumento, H. Wells, K. Lokhorst, F. Glisenti, Wireless accessible sensor populations for monitoring biologic variables, *J Telemed Telecare, 14*, 2008, 135-137.

[2] M. Mazzanti, F. Padiglione, V. Gullà, G. Libertini, A. Badaloni,, M. Bramucci, G.P. Perna, Ospedali Riuniti di Ancona, *La Telecardiologia* (F. Fedele, I. Genuini, C. De Lazzari, D.M. Pisanelli (eds.): Rome-SEU, 2010), 207-229. R.E. Moore, *Interval analysis* (Englewood Cliffs, NJ: Prentice-Hall, 1966).

[3] G. Scaffidi, M. Bartolo, “S.Giovanni Addolorata” Azienda Ospedaliera, *La Telecardiologia* (F. Fedele, I. Genuini, C. De Lazzar*i*, *D.M. Pisanell*i (eds.): Rome-SEU, 2010), 231-253.

[4] Recommendations Report by the Heart Rhythm Society Task Force on Device Performance Policies and Guidelines 2006, September 28.

[5] V. Fleishman, I.S. David, Remote Physiological Monitoring: Innovation in the Management of Heart Failure. New England Healthcare Institute, 2004.

[6] S. Ellery, T. Pakrashi, V. Paul, S. Sack, Predicting mortality and rehospitalization in heart failure patients with home monitoring-the Home CARE pilot study. *Clin Res Cardiol, 95(3)*, 2006, 29-35.

[7] S.I. Chaudhry, Y. Wang, J. Concato, T.M. Gill, H.M. Krumholz, Patterns of weight change preceding hospitalization for heart failure, *Circulation, 116(14)*, . 2007, 1549-54.

[8] M. Santini, R.P. Ricci, M. Lunati, M. Landolina, G.B. Perego, M. Marzegalli, et al., Remote monitoring of patients with biventricular defibrillators through the CareLink system improves clinical management of arrhythmias and heart failure episodes. *J Interv Card Electrophysiol, 24(1)*, 2009, 53-61.

[9] M. Marzegalli, M. Lunati, M. Landolina, G.B. Perego, R.P. Ricci, G. Guenzati, et al., Remote Monitoring of

CRT-ICD: The Multicenter Italian CareLink Evaluation-Ease of Use, Acceptance, and Organizational Implication, *PACE, 31*, 2008, 1259-1264.
[10] C. Masella, P. Zanaboni, F. Di Stasi, S. Gilardi, P. Ponzi and S. Valsecchi, Assessment of a remote monitoring system for implantable cardioverter defibrillators, *Journal of Telemedicine and Telecare, 14*, 2008, 290–294.
[11] Task Force for Diagnosis and Treatment of Acute and Chronic Heart Failure 2008 of European Society of Cardiology, Dickstein K, Cohen-Solal A et al. ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure 2008: the Task Force for the Diagnosis and Treatment of Acute and Chronic Heart Failure 2008 of the European Society of Cardiology. Developed in collaboration with the Heart Failure Association of the ESC (HFA) and endorsed by the European Society of Intensive Care Medicine (ESICM). Eur Heart J. 2008;29:2388–2442.
[12] Kadhiresan VA, Pastore J, et al. Pacing therapies in congestive heart failure. A novel method--the activity log index--for monitoring physical activity of patients with heart failure. Am J Cardiol. 2002;89:1435–1437.
[13] C. De Lazzari, D. Neglia, G. Ferrari, F. Bernini, M. Micalizzi, A. L'Abbate, M.G. Trivella, Computer Simulation of Coronary Flow Waveforms during Caval Occlusion. *Methods of Information in Medicine, 48(2)*, 2009, 113-122.
[14] C. De Lazzari, Interaction between the septum and the left (right) ventricular free wall in order to evaluate the effects on coronary blood flow. Numerical simulation, *Methods in Biomechanics and Biomedical Engineering, Aug 2011* as DOI: 10.1080/10255842.2011.597354, 1-10.
[15]C. De Lazzari, A. L'Abbate, M. Micalizzi, M.G. Trivella and D. Neglia, Effects of Amlodipine and Adenosine on coronary haemodynamics: in vivo study and numerical simulation, in press on *Methods of Information in Medicine.*
[16] C. De Lazzari, A. D'Ambrosi, F. Tufano, L. Fresiello, G. Garante, R. Sergiacomi, F. Stagnitti, C.M. Caldarera, N. Alessandri, Cardiac Resynchronization Therapy: could a numerical simulator be a useful tool in order to predict the response of the biventricular pacemaker synchronization? *Eur. Rev. Med. Pharmacol. Sci., 14(11)*, 2010, 969-978.
[17] C. De Lazzari, N. Alessandri, Energetic Ventricular Balance During Cardiac Resynchronization Therapy: Numerical Simulation. (723-115). *Proc. of the 8TH IASTED International Biomedical Engineering, Innsbruck*, 2010, 104-109.
[18] J. Nolan, P.D. Batin, et al., Prospective study of heart rate variability and mortality in chronic heart failure: results of the United Kingdom heart failure evaluation and assessment of risk trial (UK-heart), *Circulation, 98*, 1988, 1510–1516.
[19] B. Adamson, A.L. Smith, et al, Continuous Autonomic Assessment in Patients With Symptomatic Heart Failure: Prognostic Value of Heart Rate Variability Measured by an Implanted Cardiac Resynchronization Device, *Circulation, 110,* 2004, 2389-2394.
[20]C. Kouakam, Usefulness of device-based analysis of heart-rate variability in patients with cardiac resynchronisation therapy, *La Lettre du Cardiologue, 424*, 2009, 21–29.
[21] A. Swearingen, J. Schafer, D. De Lurgio and J. Stone, SDANN as a Predictor of Heart Failure Hospitalizations in Cardiac Resynchronization Therapy Patients, *Journal of Cardiac Failure, 12,* 2006, S113-S114.
[22] F.R. Gilliam, J.P. Singh, et al, Prognostic value of heart rate variability footprint and standard deviation of average 5-minute intrinsic R-R intervals for mortality in cardiac resynchronization therapy patients, *J Electrocardiol, 40*, 2007, 336–342.
[23] F. Palumbo, "Integrazione tra ospedale e territorio e programmazione sanitaria Ministero della Salute" *Camogli (GE)*, 2006, 29-30.[23] G. Molinari, G. Reboa, M. Frascio, M. Leoncini, et al., The role of telecardiology in supportino the decision-making processo f general practitioners during the management of patients with suspect cardiac event, *Telemed, Telecare, 8,* 2002, 97-101.
[24] P. Lavezzo, CONSIP (Concessionaria Servizi Informativi Pubblici) SpA-MEF: Programma di razionalizzazione degli acquisti per le pubbliche amministrazioni: strumenti innovativi e progetti specifici per la sanità. *I servizi di telecardiologia*, Cernobbio, 8 Novembre 2005.
[25]Raccomandazioni all'uso della Telecardiologia (G Ital Cardiol 2009; 10 (Suppl 1-1): 5S).