THE MILANO NETWORK FOR ACUTE CORONARY SYNDROMES AND EMERGECY SERVICES.

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The usefulness of telemedicine is already widely demonstrated in the ambit of the acute coronary syndromes on the territory.
The success of this technology is mainly due to the possibility to make an early diagnosis and so to reduce the intervention time which is particularly important in the treatment of the myocardial infraction with the ST segment elevation (STEMI). In fact the main target of the STEMI treatment is to achieve an effective coronary revascularization as soon as possible.
The strategy of the connecting net between territory and hospitals, made by a centralized coordination of the emergency resources, gives the possibility to optimize therapeutic choices and so reduce the intervention time.
The telecadiology advent enabled to improve technologies able to transmit a standard 12 leads ECG (ECG12d) performed at a pre hospital time, not only to the Dispatch Centre (DC), but above all to the accepting hospital with the diagnosis confirmed by the cardiologist and a pre-alert of the hospital system.
This means an extreme reduction of decisional time and of pre and intra hospitals delays.
Already in 1994 the “National Heart Attack Alert Program” assented that “it has well been demonstrated that a patient affected by a heart attack receives a much faster treatment in the emergency department when paramedics make a ECG12d in the place and send it to the emergency department by mobile phone.”
In particular, equipping the emergency vehicles with a transmission systems able to send a ECG12d to a receiving station, together with main clinical parameters, (BP, Sat O2, Killip), allows the cardiologist inside the hospital to perform an accurate *tele refertation,* and so to suggest the operators outside, the possible intervention for a primary triage, or to an optimal revascularization strategy for the particular context.
It has been demonstrated in different experiences that ECG12d tele-transmission from the territory reduces the intra hospital times and qualifies the STEMI mortality, either for thrombolysis or for primary angioplasty.
Former experiences however have been performed in contexts surrounding a single or just few hospitals and anyway they were concerning a small number of STEMI (around 10% of total month account).
Although the organizing efforts, it has been remarked how treatment timing of patients in emergency is still longer than international guidelines recommendations.

The purpose of this work has been to verify the usefulness of pre hospital ECG transmission of patients with STEMI, to the Hub cardiologic centre in accord to reduce treatments timing in hospital in an complex urban area with a large availability of Cath Lab and advanced vehicles coordinated in network by the DC.

Methods

We developed a capillary research in the urban area of Milan due to record and analyze the pre hospital and in hospital intervention time (form call to therapy) in Patients undergoing to hospitalization in STEMI.
City of Milan and neighbourhoods are a complex and densely populated area which covers 1440 Km2, corresponding to 118 municipalities with a high concentration of

hospitals. The resident population is of 2.827.091 inhabitants to which are added 1.000.0000 commuters daily.
27 hospitals, with 23 Coronary Care Unit (CCU) and 16 Cath Labs are working in this area. All of them, with DC and Country Government Agency, are organized in a network and planned a shared protocol of STEMI management based on time of symptoms onset and risk stratification. According to this protocol the DC perform a territorially triage (treat vs. transport). Fig.1.
The structure of emergency network in this area takes advantage of the centralized coordination by the 118 DC which manages all emergency calls (around 1800 calls every day, with the despatching of ca 700 missions) and provide to allocation and utilization of critical emergency resources.
On the Milan area work 9 Advanced Rescue Unit (MSA) and a helicopter (HEMS) with a physician and a nurse working on it. All of them are endowed with monitor&defibrillator Lifepack12 (EMS Medtronic) with ECG12d that offer automatic interpretation and transmission of the ECG layout, and additionally BP and SatO2, in real time by GSM to the DC.
Moreover about 50 Basic Rescue Unit (MSB) with first-aiders on board are operating daily; all are trained according to IRC BLS-D protocols and mainly equipped with an External Automatic Defibrillator (AED).
MSA are sent, if available, under suspicion of cardiac attack or symptoms suggestive according to dispatch protocol.
Data coming from resources on the territory are transmitted to the DC trough a GSM system and viewed by the physician on a dedicated workstation, afterwards from the CO, they can be transmitted via fax or via VPN according to the protocols shared with hospital even to a farther centre able to perform primary PCI.

The STEMI protocol, as shown in Fig.1, is designed to stratify the subject for symptoms onset and global risk assessment (BP, Killip and contraindication to pharmacological treatment). Moreover the flow-chart, inspiring to recent European guidelines, holds in consideration the availability of critical resources and the possibility of MSA to perform a pre-hospital thrombolysis. The flow-chart in fact suggest that, after the ECG12d is performed and sended the MSA chooses if administrate TNK or transport the patient and so administrate anti Gp IIbIIIa (Abcximab) according to Hub Centre cardiologist's opinion.

All hospitals have also been asked to make clear a written fast-track protocol towards the Cath Labs or ER, according to reduce in hospital and decisional delay to reperfusion as much as possible.

So, for what concerns cardiologic emergencies we aim to develop a method of stay and stabilize which has to be performed as quickly as possible. In particular performing a ECG12d just takes few minutes and may dramatically change the outcome.

Starting from June 2006 we detect of timing with a four months period survey, each lasting a month.
The MoMi^2 (one **MO**nth **MO**nitoring **M**yocardial **I**nfarction in **Mi**lan) required integration of data coming from the computerised system of pre hospital emergency (EMMA – Beta 80) with data reported from single centres on an electronic CFR on all consecutive patients with STEMI referred to ER and treated (in any way) before 6 hour after hospitalization.

Information concerning demographic features (sex, age), clinical appearance (presenting symptom, AMI territory, Killip class at acceptance), modalities of admittance in hospital

(spontaneous, with MSB, with MSA with or without ECG transmission), pre hospital times (calling time, arriving and delivering time of the transporting resource), in hospital times (door to balloon, door to needle), therapy (thrombolysis. PTCA, no reperfusion therapy) and hospital outcome have been listed.
The major attention has been intended to study treatment timing (.time-to-balloon; time-to-symptoms; time-to-first medical contact).

Statistic analysis:
Data analysis concerning the first survey in June 06, was conduced in a tight collaboration with an external centre (MOX- Modelling and scientific computing - Politecnico di Milano) which had access to the blind database (anonymous data codified deriving centres).
It has been taken into consideration as a primary end point the reach of a door to balloon time of 90 min according to the AHA/ACC guidelines.
Analysis has been focused on time to treatment (time to balloon and time to needle) stratified on way to hospital admittance.
Firstly it has been performed a descriptive analysis of the data by constructing graphical comparison pictures (flanked box plots) of the distributions of the door to balloon time stratified by way to hospital admittance and by secondary covariates (i.e. fast track and working or not time of admittance).
Then non parametric and parametric analyses (Kruskal –Wallis test and ANOVA respectively) have been performed in order to catch a stochastic order between distributions.
Finally non parametric and parametric analyses (Wilcoxon test an t-test respectively) have been performed in order to give a statistical support to the considerations about the relationship between the summary statistics of the data (median, quartiles and mean) and the limit suggested by the AHA/ACC guidelines (90 min).

Results:
<u>ECG teletrasmission in Milan experience:</u>

The transmission is achieved in most cases and the ECG12d performing and transmitting time is approximately 2 minutes.
The ECG12d registration was made by the MSA about 5 minutes after arriving to the scene and was received about 5 minutes after registration.
Many transitory events, like lesion wave, atrioventricular blocks, ventricular tachycardia, have been recorded and then have regressed before the ER admittance.
For this reason, making more than one ECG12d, while delivering the patient to the hospital, has been recommended in protocols, particularly when symptoms change.
During the last years, an ECG12d havs been performed in the 58% of cases, 2 in the 28% of cases, 3 in the 9%, 4 in the 3%, till a maximum of 8 in just one case.
In about 1000 consecutive ECGs reviewed by 2 cardiologists the automatic report resulted correct in more then 80% of cases.
In the 11% of cases the ECG wasn't read for the presence of artefacts (tremors, disconnection of electrodes, rough artefacts), in the 9% of cases the automatic interpretation resulted inadequate for rhythm or conductance or repolarization disturbance, without any clinical consequence on the emergency situation.
The diagnosis of Acute Myocardial Infarction (STEMI), which appears as an automatic diagnosis, resulted wrong in just 1.1% cases; specifically false positives have been 0.3% and false negatives 0.8%.
Performing following ECGs, in case of a false negative for a minimum increase of the ST line, the report resulted correct with the evolving clinical situation.

From 2004 to 2006 7973 ECG12d have been transmitted from the MSAs (1920 in 2004; 2019 in 2005 with an average of 170 ECG/month). 10,96%. of all the transmitted ECGs, recorded a diagnoses of STEMI, 62 Ventricular Fibrillations have been converted to SR on the territory

Data from MoMi^2 experience:

During the period observed for this work (1st June 2006 – 30th June 2006) 46.691 requests of succour arrived in the DC and 22.267 first aid vehicles were sent.
In 1851 events was sent a MSA; among these, an ECG12d of the patient involved was transmitted.
Data comes from 24 CCU and 14 Cath Labs centres (over the 16 available) and refers of 90 patients accepted in the ER who were diagnosed of IMASTE and were treated within 6 hours from the ER acceptance.

The first part of explorative analysis is concentrated upon time distribution between the arrival in the ER and the eventual PTCA.
These 90 patients, who have been followed in their route either pre and intra hospital, have been divided into 4 groups depending from the presentation modality in the ER as suggested by the sub analysis of the "Cincinnati Heart Project" the vehicles influence on the medium delay inside hospital was demonstrated.

Demographic characteristics of our population: sex of these patients was mainly male (70 patients – 78%) and the average age was 65 years old (ds +/- 13). The number of patients who died is 6 (7%). All death occurred inside hospitals.
The treatment was performed, within the 6 hours of the ER admittance, in 75 cases (83%): PTCA in 62 (83%) and fibynolisis in 13 (17%). We didn't perform pre hospital thrombolysis during the month.

Presentation modalities and percent are the sequent:

- The first group admitted at the ER by themselves: 36 (40%) patients
- The second group, patients, arrived with MSB 24 (27%)
- The third group, arrived with MSA without the ECG transmission 13 (14%) patients.
- The fourth group, admitted with MSA after ECG12d tele-transmission 17 (19%) patients.

Overall, over 90 patients belonging to this work, the 60% attended to the DC; among these 54 patients, 30 (56%) were treated with the MSA.

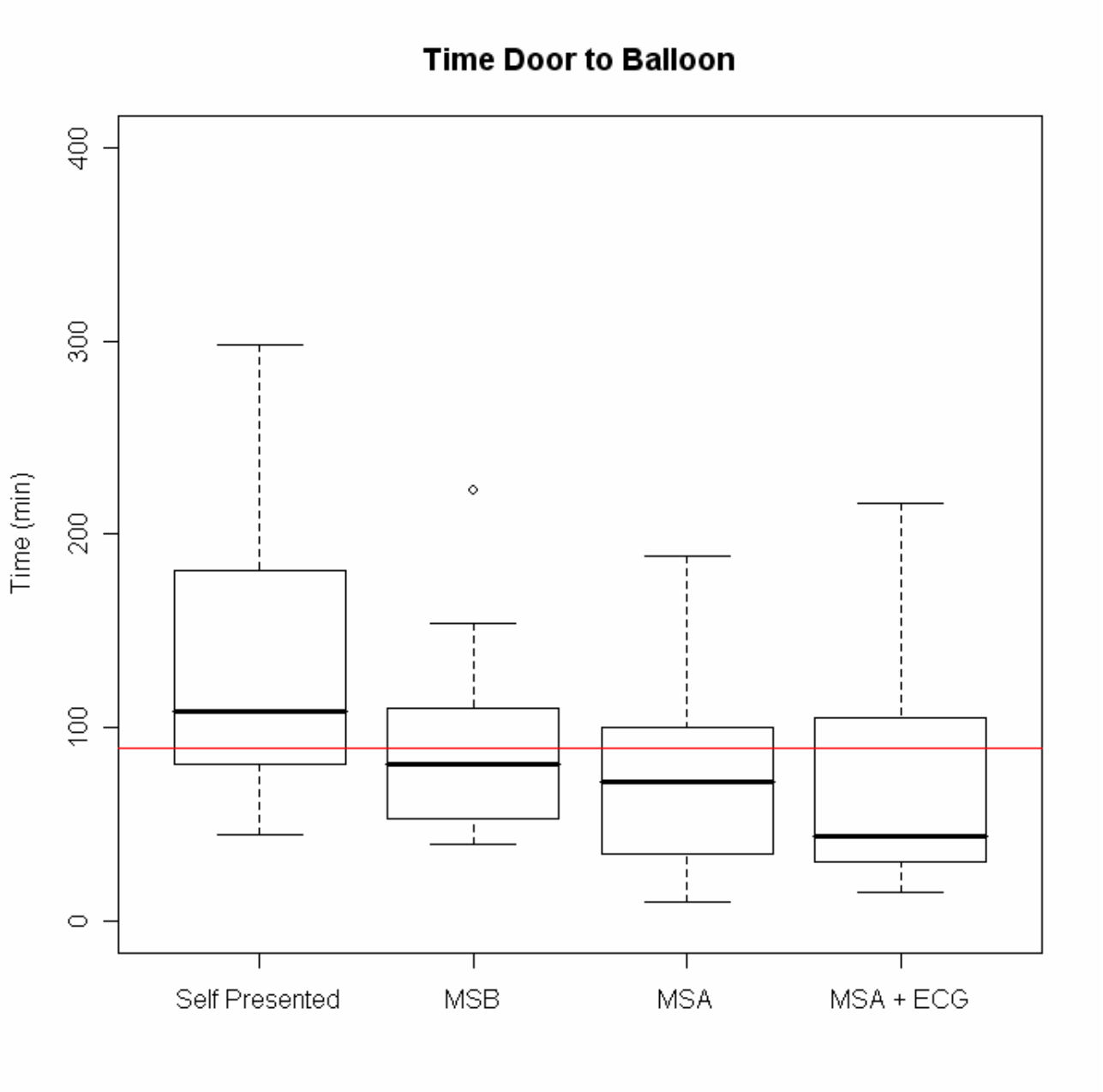
The analysis of timing expressed in minutes with median values *(25°-75° percentile)* shows the following values:

	MSB	**MSA**	**MSA + ECG**	**Self presented**
Call to rescue on site	10 (6-14)	14 (12-15)	14(11-15)	na
Staying on site	16 (14-17)	26 (24-36)	31(27-36)	na
Transport to ER	10 (5-12)	12 (9-15)	13 (7-16)	na
Door to treatment	83 (55-118)	72 (35-100)	45 (31-105)	108 (78-177)

Table 1.

In the following picture (Fig.2) the flanked box plot of the time distributions of the door to balloon, diversified by the modality of the ER access have been reported. We can observe

that the distribution of patients that seems statistically lower is the one concerned with patients transported with MSA + teleECG, and in this case, the 75 percentile is shorter than 90 minutes; this sill is indicated by literature as the limit to guarantee a high efficacy expectance for the PTCA.



The advantage of the group attended by the MSA with the ECG transmission has resulted to be:

- 27 minutes compared to the group attended by the MSA without ECG transmission
- 38 minutes compared to for the group attended by the MSB
- 63 minutes compared to the group arrived by themselves.

Discussion:

The experience of Working Group for Pre-hospital Emergency in Cardiology - City of Milan confirms that the tele-transmission of Ecg12d strongly reduce the time to first medical contact and coronary revascularisation. The set of territorial triage, pre-hospital therapy and reduction of decisional delay has allowed to treat more then 57% in the goal time (less then 90 min).
Time that MSA spent on site of rescue (to perform ECG and therapy) in comparison to MSB is greatly justified with the time gain that occurs shifting ER and anticipating the treatment. The MSA does not take any advantage upon the MSB if the EGC is not transmitted, as the time loss in place is not rewarded by an adequate pre alarm.
Data analysis suggests that the expansion of an ECG from the rescue place is an appliance that has to be privileged while organizing emergency nets.
In a complex model like that, the tele transmission of ECG, moreover during off-hours, allows a fast activation of Cath Labs with pre alarm of Labs equipe and consequent reduction of treatment time. The possibility to perform pre-hospital thrombolysis is strongly limited to the great availability of Cath Labs

In a complex urban area, the number of STEMI rescued by the DC appeared to be elevated: 60% compared to the 40% reported by literature.
It's to be underline how all the patients managed by the DC were transported to a PCI capable centre, that confirm the importance of a network organisation and justified the good values of median time to treatment.

Many other improvements are however necessary: at first has to be done appropriate walk for the patients trough the ER toward reperfusion. Consequentially an educational action at the general population could improve the number of STEMI managed of DC and avoid futile delay to reperfusion.

In our analysis the most predictive parameter to have access at early reperfusion is the possibility to perform ECG12d within 10 min after admittance. Therefore at the end of 2007 we are equipping MSB with a easy system able to transmit a ECG12d.

Conclusions:
Cardiologic emergencies need specific equipment, a specific organization and operative networks connecting every single loop of the intervention chain.
Nowadays, as we saw, technology offers adequate answers for a better problem solving, either with monitoring or treatment systems, or with data transmission systems; but technology alone is not enough.
In particular, our experience confirms the extreme usefulness of the ECG transmission in supporting the emergency system, thaw that the Milan network is trying to expand the use of this technique also to the MSB as experimental.
Working together for the realization of a shared model and a technologic structure, showed to be useful in reducing, at once, treatments timing or to be chance of cultural growth and a chance to improve relationships between cardiologic departments and DC
This study showed also big importance for the evaluation of quality standards, as the simple knowledge of our performances for treatments appeared a strong incentive to monitor and improve decisional strategies.

Acknowledgements:
Following hospital cooperate at the "Working Group for Prehospital Emergency in Cardiology- City of Milan" (Centre and Coordinator)

A.O. San Paolo – G.Iapichino, F.Lombardi
A.O. Luigi Sacco – C.Antona, M.Viecca
A.O.San Gerardo - P.O.E.Bassini – F.Gentile
A.O.Fatebenefratelli – B.Brusoni
I.R.C.C.S. San Raffaele – D.Cianflone
Centro Cardiologico Fondazione Monzino – C.Fiorentini
A.O. Melegnano - P.O. Cernusco – E.M.Greco
A.O. Niguarda - Cà Granda – S.Klugmann
Istituto Auxoligico Italiano - I.S. San Luca – G.Leonetti
A.O. Melegnano - P.O. Vizzolo P. – M.Lombardo
A.O. Ospedale San Carlo – F.Casazza
Fondazione Policlinico, IRCCS – G.B.Danzi
A.O. G. Salvini - P.O di Rho Passirana – G.Rovelli
Multimedica SpA – A.S.Montenero
Istituto Clinico Humanitas – P.Presbitero
Ospedale Clinicizzato S. Donato M.se – E.Pusineri
Clinica Santa Rita – A.Anzuini
Sant'Ambrogio – P.Salvadè
San Carlo Paderno Dugnano – S.Biasi
A.O.di Legnano - S.O.Magenta Fornaroli – G.Bardelli
Ospedale San Gerardo – Monza – A.Grieco, A.Pesenti

Special thanks to doctor W.Schmidt and A.Cappelleri for precious collaboration; and to A.Pagliosa for the great pacience.

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