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Original Article

Medical teleconsultation to general practitioners reduces the medical error vulnerability of internal medicine patients

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ABSTRACT

Background: e-Health strategies are supposed to improve the performance of national health systems. Medical teleconsultation (MT) is an important component of such e-Health strategies.
Objectives: The outcome of MT was evaluated with regard to the impact on the medical error vulnerability (MEV) of internal medicine patients.
Methods: A team of internal medicine doctors plus a network of forty specialists was set-up in one health district belonging to a unified and universal national health system of a country of Western Europe, in order to provide free-of-charge MT to support general practitioners in solving internal medicine cases. In this observational study, the case series of 2013 is reviewed.
Results: a) Only 21% of the MT fell short to the general practitioner's expectations about the case solving focus; b) throughout the medical care process of the patient, 49% of the cases met with one or more of the five MEVs, namely: 1) clinical test mishandling; 2) inaccurate differential diagnosis; 3) inadequate information flow between health providers at different levels of care (transition care); 4) poor coordination between health providers; and 5) poor reconciliation of medications or hazardous therapies. c) MT canceled or prevented MEVs in 56% and mitigate MEVs in 15% of the cases; d) MT canceled or prevented 85% of MEV caused by poor information exchange in transition care, therefore improving patient referral and counter-referral.
Conclusions: MT reduces MEV and therefore, whenever implemented to a large extent, may improve the quality of health care delivery and the performance of national health systems.

1. Introduction

In the World Health Report 2000, the World Health Organization (WHO) made an effort to rank the performance of the national health systems worldwide. [1]. WHO's ranking system is based on three groups of indicators: 1) population's health status, estimated through life expectancy, mother mortality rate, mortality rate for children under five, etc.; 2) responsiveness to the fair and realistic expectations of the population, therefore capacity of delivering an effective medical care to individuals; and 3) countries' financial commitment in health and sustainability [2,3].

More recently, in 2013, Bloomberg issued a ranking system pretty similar to WHO's, by basing on slightly different indicators, [4].

All the highly placed health systems of Western Europe have the strong advantage of their being unified (one management structure for both private and public services) and universal (providing health care and financial protection to all citizens) [5]. Actually, such a health system model enables prevention policies and strategies to be smoothly implemented countrywide, the largest health coverage and patient centeredness to be attained and a good share of the gross domestic product to be allocated for health.

With regard to the health care delivery to individuals, the unified and universal health systems are arranged in three major levels of complexity: 1) the primary health care, delivered by general practitioners

Abbreviations: GP, General practitioner; ICT, Information and communication technologies; MEV, Medical error vulnerability; MT, Medical teleconsultation; WHO, World Health Organization; ITU, International Technology Unit.

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(family doctors); 2) the secondary health care (intensive and/or specialist medical care in ambulatory outreaches, health centers and district hospitals); and 3) the tertiary health care, delivered by university hospitals of high specialization [6].

Whenever the health problem of the patient cannot be managed and solved at primary health care level, the patient is processed through levels of higher complexity in a sequence of referral and counter-referral events (transition care). Although this pattern of medical care enables almost any health problem to be solved, it is commonly observed that transition care may be causing vulnerability for medical error, discontinuity of care and even conflicts between medical care providers. Sometimes, in transition care, specialists' over requesting of diagnostic tests and drug prescriptions occur with no global knowledge or understanding of the clinical history of the patient [7]. Such medical error vulnerability (MEV) and conflicts are often perceived by the patient as a poor performance of the whole health system, undermine the patient's trust and satisfaction and therefore badly affects the above-mentioned indicator no. 2 of WHO.

Nowadays, the WHO and the International Technology Unit (ITU) are encouraging countries to make use of information and communication technologies (ICT) increasingly. Indeed, ICT are supposed to improve the performance of the national health systems (e-Health strategies) [8,9]. Of the several ICT tools of e-Health, one is medical teleconsultation (MT).

In 2010, we set-up the De Martinis Telemedicine Panel (Dematepa), which is made up of a network of internal medicine doctors and specialists of various medical disciplines. Dematepa is an MT system providing free-of-charge counseling, second opinion and support to applying GPs in internal medicine case solving.

By reviewing the case series of Dematepa, the purposes of this observational study are to evaluate: 1) the effectiveness of MT in responding to the requests of GPs; 2) the occurrence of MEVs; and 3) the capacity of MT in controlling MEVs.

2. Materials and methods

The core team of Dematepa is made up of eight professionals, namely: a) four internal medicine specialists jointly covering all the levels of medical care complexity (two practicing physicians, experienced in primary health care, one experienced in district hospital care and one with a background and understanding of highly specialist care); b) one pediatrician; c) one radiologist; d) one pathologist; and e) one computing and telecommunication engineer. An additional network, made up of forty specialists of different medical disciplines, supports Dematepa upon request (internal specialists). Dematepa gives the opportunity to authenticated GPs to apply for being counseled about the diagnosis, therapy, and follow-up of their patients. The application reserves the privacy of the patient to the fullest extent [10]. In fact, Dematepa members are kept unaware of the patient's identity throughout the whole process [11].

The applying GP has to make clear the focus of his request of MT (f.i. doubts regarding the specialist-issued clinical report, interpretations of the X-ray or laboratory tests, identification of qualified consultants, quick access to further clinical tests, recommendations regarding treatments, etc.) and the expected results from his application. Since it is well known that MT can be successful to varying extents according to various pathologies [12], Dematepa accepts the application only if its members believe that such an MT is likely to result in some benefit and provide the expected results with regard to the focus.

As in literature one can read plenty of papers about big series of on-line issued reports of clinical tests like X-rays, magnetic resonance imaging, ECG etc., even in extreme and remote areas and under emergency conditions [13], we focused on MT to solving problems of chronically ill patients, whose clinical processing may involve all the levels of care complexity. Indeed, chronic diseases are making up the heaviest workload of the health systems of Western Europe countries. Thus, improving the health care management of such patients at large extent is supposed to affect the overall performance of the health system.

Upon approval of the GP's application, clinical reports/documents/data about the patient are collected, converted into digital format, filed anonymously and shared by emailing within the Dematepa member network. Within 5 days' time and in accordance with the established focus, Dematepa members are called to an MT virtual meeting (teleconference) with the applying GP, the relevant internal specialists and, whenever necessary, with the patient.

For teleconferencing, Dematepa makes use of open-source applications. They are chosen as the user-friendliest ones, to enable also external participants, who may not be familiar with sophisticated applications, to log in. These applications are multitasking and include slide presentation, video streaming, chat room, webcam, and multichannel audio.

During the MT teleconference, the GP presents the anamnesis, the clinical signs and the relevant documentation of the medical case, while keeping concealed the identity of the patient. According to the good practices of the clinical method, a differential diagnoses diagram is drawn-up immediately, whenever not yet done at an earlier stage [14,15]. The rank of differential diagnoses is in accordance with the a-priori probability of the Bayes theorem [16]. Simultaneously, any differential diagnosis is matched with the appropriate actions to solve.

By basing on such a diagram and in agreement with the GP, Dematepa members make a plan of patient processing actions. It may include: a) broadening the knowledge by reviewing scientific literature; b) integrating the physical examination of the patient by teleconferencing along with the GP; c) driving and helping the GP in booking other clinical tests with various services (radiology, biochemical laboratory, cytology etc.); and d) proposing more qualified specialists (internal or external to Dematepa) to consult. In the following days, the plan of action is implemented and the patient undergoes the planned clinical tests.

As soon as the patient processing is over, a final debriefing is held asynchronously (by e-mail exchange) or synchronously (by teleconferencing within all the involved health professionals). Recommendations are issued to the GP and/or the patient.

The GP follows-up the patient and feeds back Dematepa members. After a convenient period of time of follow-up, the clinical case is filed in a database. By holding a teleconference more, the following parameters are monitored and evaluated, according to a Boolean variables choice (on/off, positive-negative):

1) Full or incomplete achievement of the expected results with regard to the focus. In case of failure, causes are investigated according to three groups: a) Technical; b) Human (GP, patient, specialist); and c) Methodological.
2) By going through the entire history of patient processing [17], the occurrence of one or more of the five medical error vulnerabilities (MEVs), namely:
   a) Execution of unnecessary clinical tests (laboratory, X-rays etc.) and/or their duplication and/or wrong interpretation (*clinical test mishandling*);
   b) Missing or inaccurately-drawn differential diagnoses diagram by the GP or by other health care providers (*inaccurate differential diagnosis*);
   c) Inadequate information flow among the different health care levels in care transition (*inadequate information flow*);
   d) Lack of a final decision-making coordination meeting among health care providers (*poor coordination*);
   e) Incorrect recommendation to the patient to undergo ineffective or hazardous treatments and/or occurrence of adverse drug reactions poorly monitored and challenged by the health care providers (poor reconciliation of medications — *hazardous therapy*).

Such taxonomy of medical errors was taken from Dovey and co-workers, while focusing only on the medical care errors in family practice

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[18] and re-arranged according to the cognitive psychology and knowledge management theories of Kahneman [19] and Baron [20].

Moreover, the number of specialists involved in teleconsultation and the health system services having supported the patient processing were estimated.

Fig. 1 portrays the entire method.

Of the entire case series, the results of 80 (eighty) cases, attended all over 2013 and followed-up for a minimum of one year's time, are reported.

3. Results

40 males and 40 female made up the whole series of 80 patients. The mean age of the patients was 54 +/− 21 (minimum 1, maximum 89). 4 cases (5%) were below 12 and 26 (32%) over 65 years old. All the applications were submitted from countries of Western Europe.

6 patients (7%) died within 12 months' follow-up. At the time of the MT, all of them had poor prognosis because of malignancies, but one of them (thymoma in elderly) died earlier than expectedly.

In 20 patients (25%) no additional specialist was called to challenging the focus. In the remaining 60, the average of specialists called was 1.3 per patient. The maximum for a single patient was 5 specialists consulted.

The kind of specialists called for opinion and the number of calls is displayed in Table 1. The anatomo-histopathologist is top-ranking in calls.

In Table 2 the services that were requested of additional tests or treatments in patient processing are listed. MT recommended surgery in 8 patients (10%).

In 17/80 patients (21%), the *outcome of MT was below the expected results* with regard to the focus. In 13, failures were of human causes (poor adherence to the recommendations by patients and/or the GP). In the remaining 4 cases, the failure was caused by methodological teleconsultation procedures. No technical problem prevented teleconsulting.

Throughout patient processing, MEVs were observed in 39/80 patients (49%). Many of these patients met with more than one MEV. Clinical test mishandling occurred in 6 patients (7%); inaccurate differential diagnosis in 17 (21%); inadequate information flow in 15 (19%); poor coordination in 12 (15%); and hazardous therapy in 10 (12%).

Table 1
Specialists consulted for opinion.

	Specialist	No. of consultations
1	Anatomo-histopathologist	17
2	Endocrinologist	9
3	Cardiologist	8
4	Radiologist (different sub-specialties)	8
5	Oncologist	6
6	Neurologist	5
7	Dermatologist	4
8	Urologist	3
9	Cytologist	3
10	Orthopedist	3
11	Pediatrician	2
12	General surgeon	2
13	Neurosurgeon	2
14	Ophthalmologist	2
15	Psychiatrist	2
16	Gastroenterologist	2
17	Physiatrist	1
18	Throat specialist	1
19	Family and community epidemiologist	1
20	Nutritionist	1
21	Anesthetist	1
22	Thorax surgeon	1
23	Neurologist	1

Out of these 39 patients, in 22 (56%) MT practice managed to cancel, or even prevent, such MEVs. In 6 patients more (16%), MT contributed only to mitigating them. In the remaining 11 (28%), MT had no significant impact. The inadequacy of information flow was the only kind of MEV that was challenged successfully in over 80% of cases.

4. Discussion

Notwithstanding the care Dematepa took with handling the clinical problem and weighing the chances of success, the human variable (poor

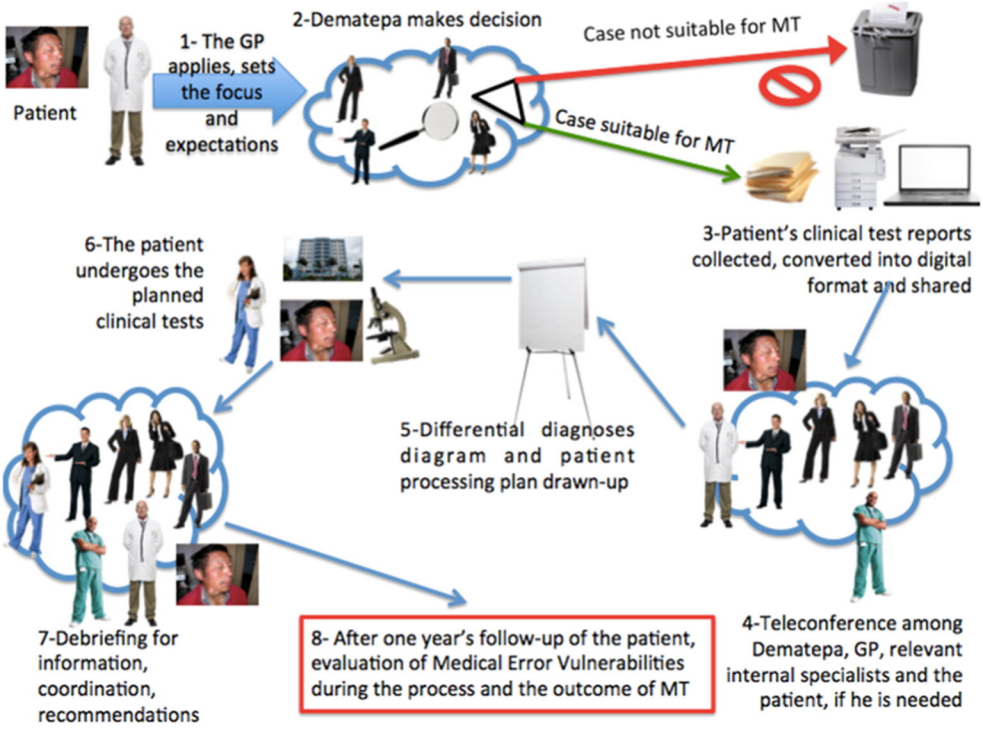

Fig. 1. The process of medical teleconsultation: from the GP's application to the evaluation.

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Table 2
Additional clinical tests and treatments.

1	Surgery	8
2	Radiology	4
3	Cytology	3
4	Cardiology	3
5	Biochemistry laboratory	1
6	Cystoscopy	1

adherence of the patient and/or the GP) caused the majority of failures during follow-up. Perhaps, the use of ITC tools and virtual consultation are not yet so welcome as conventional consultation is and the GP's central role inside the health system and patient follow-up capacities have been weakening over the latest years [21]. Technological barriers in remote contexts might be an additional challenge [22], but, actually, we experienced none. Conversely, Dematepa implemented ineffective methodological approaches in five cases and that means that clinical methodology through ITC still has to be improved. Thus, raising awareness and knowledge of users, expanding digital literacy, and strengthening methodology are still needed in order to achieve better results.

In 25% of the cases no specialist was called. In the remaining 75%, the average of 1.3 specialists consulted per case means that most of the cases were kept within the remit of internal medicine and the clinical cases were not fragmented into too many disciplines. Actually, in today's medical practice, the GP is often excessively appealing to specialists (defensive medicine). Meanwhile, having frequently consulted the anatomo-histopathologist suggests that many of the submitted cases were neoplastic diseases.

In 49% of the cases, MEVs were easily recognized from the clinical history of the patient. The scientific literature often reports about such MEVs, chiefly in transition care, and proposes solutions [23,24]. Medical errors often occur owing to inadequate information exchange following discharge from hospital, when the responsibility for health care providing returns to the GP (counter-referral). Vawdrey and co-workers tested a computerized patient handoff application, synchronized with the patient's electronic health record. They gave evidence that much time is saved and clinical management improved through greater accuracy of information flow [25]. Thus, making use of additional ICT tools beyond MT, such as the patient's electronic health record, could improve the outcome.

In our study, MT, as a part of e-Health strategies, reduces MEV in 71% of cases. The drawing up of a complete and shared differential diagnoses diagram at an early stage of the clinical process even prevents MEV from occurring. Thus, an early MT helps the GP in improving the quality of the plan of patient processing, even if he makes the decision of referring the patient conventionally.

Since the appearance of the digital world, in scientific literature, one can find plenty of papers focusing on the issuing of reports of clinical tests in single disciplines (the so called "store-and-forward technics" [26]), such as teleradiology [27,28], telecardiology [29], and telepathology [30]. Conversely, and unfortunately, the pioneering experience, made by Conrath and his Canadian team in 1977, has not been so replicated as it ought to [31]. Conrath made use of telecommunication systems in counseling primary health care professionals and therefore he really addressed internal medicine problems to a fairly large extent.

Actually, MT in internal medicine is not so easy to perform as the asynchronous telecommunication of the "store-and-forward technics" is. Strict clinical methodologies, team discipline and check-list based rules are mandatory for efficient synchronous teleconferencing in internal medicine. The setting-up of a team in MT is time-consuming and also expensive in practicing, even though we experienced a free-of-charge MT.

Furthermore, although in scientific literature many countries have been reporting about strategies, plans and actions to support primary health care professionals' decision-making processes through ICT tools [32–36], in the design of such reports we remark that: a) the specific focus on internal medicine patients in primary health care, as in the above-mentioned Conrath's study, is weak; b) the follow-up of patients and the feed-back about results are poor; and c) the asynchronous or synchronous telemedicine events are usually reported jointly without going through the objective of such events (f.i. clinical test report issuing, monothematic focus, specialist diagnosis and treatment, etc.). Thus, as the many telemedicine events are not comparable one to another and they do not make up a homogeneous series, the telemedicine system evaluation design is poorly developed and it is not possible to infer about the impact on the overall health system performance. Thereafter, we could not compare our results to the ones from other similar studies.

Although, after 2000, other research institutes, like the Health Consumer Powerhouse, proposed new sophisticated and interesting methods for health system performance evaluation [37], WHO's criteria must be still held as the landmark, because only they are applicable to any health system globally. Moreover, despite the criticism arisen against WHO for its methodology by some countries who perceived to be degraded, WHO's indicators keep on being valuable targets for countries to improve.

Focusing on WHO's criteria, the first group of indicators is summarized in the global health status of the population, which is mostly dependent on public health actions. Thus, it is hard to infer that MT, even if implemented countrywide, might have an effective and visible return on such a group of indicators.

Conversely, MT might positively affect the responsiveness to the fair and realistic expectations of the population (WHO's group of indicators no. 2), as the patient is supposed to perceive and welcome the improvement of coordination among his health care providers.

Focusing on health system expenditure (WHO's indicator no. 3), MT is supposed to reduce the costs by cutting the duplication of clinical tests. However, the scientific literature about costs of MT is puzzling, because of differences and biases in the design of the studies. Actually, we will not say that MT, implemented at large extent, reduce medical care costs, because in such conditions MT cannot be free-of-charge, as we did in our research. Indeed, Wallace and co-workers confirmed such a hint. In a randomized trial covering two English hospitals' catchment areas, they found that the health system was paying more for patients in virtual outreach consultations than in standard outpatient consultation, despite the fewer clinical tests performed [38].

5. Conclusions

MT, implemented on a large scale, may positively affect the responsiveness to the fair and realistic expectations of the population. However, more actions are needed to terminating MEV, such as the full implementation of the patient's electronic health record [39,40], which is supposed to bring transparency in patient clinical management [41] and improve reconciliation of therapies in transition care [42].

Conflict of interests

The authors state that they have no conflicts of interest.

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