Controlled Inquiry Rates of Clinical Interviews in Telehomecare

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Abstract: Conceived to acquire personal information for an electronic medical record, the clinical interview contains probing questions. The number and type of inquiries are assumed to fulfill medical protocols, and therefore are deemed essential for treatment — but the rate can and should be controlled. High rates of inquiry merely intimidate the patient and affect replies. The purpose of this paper is to mathematically formulate permissible rates of clinical interviews held during telehomecare virtual visits and designed to avoid patient anxiety. Mental stress is derived as a function of the weight of importance assigned by the patient, virtual visit duration, and the rate of questioning in the direction of greater sensitivity. Two operations are of interest: Collecting and recording information by the provider, and maintaining synchrony of questions and answers by the patient. The Lorentz transformation yields the patient's view of the operational rates. Conservation of information momentum is postulated and applied before and after replies are recorded. It is shown that the weight of importance designated by the patient to collecting and recording personal information is driven by a singularity that depends on the rate of questioning. The findings should serve as a guideline in interviewer training programs.

Keywords: Clinical interviews, controlled inquiry rates, telehomecare, telemedicine, theoretical/ mathematical

1. INTRODUCTION

Telehomecare is a remotely controlled healthcare service available to a patient at home or to an assisted living resident. It is one of many solutions to the paucity of professional caregivers in regions where there are no major hospitals. Elderly who wish to remain in familiar surroundings during treatment may prefer to subscribe. The concept of delivering health services remotely by controlled technologies appears promising for the aged, retarded, physically handicapped, and those requiring post surgical care and rehabilitation after alcohol or drug abuse.

In general, telehealth networks utilize technologies that are interchangeable, compatible, scaleable, accessible, and reliable. The intervention of telehomecare entails automated interactive audio and video equipment and monitored medical devices. Enabling technologies allow the patient to hold home videoconferences, receive educational materials over the Web, upload physiological measurements, view data records from archives, respond to automated alerts and reminders, receive instructions in electronic mail concerning medication, and share personal experiences with other patients, in group discussions [1-3]. A typical communication network consists of homes, hospital, workstation, and offices of medical specialists — great distances possibly separate one entity from the other. Remote data control centers are linked from outlying districts to the electronic workstation. Each workstation contains the basic components of healthcare: a vital sign monitor, knowledge-based software, and patient databases stored under unique identifiers.

Satisfaction with telehomecare focuses on whether the patient's health condition improves, costs are affordable, and service is free of problems. The telemedicine program has been successfully implemented in cases of diabetes, congestive heart failure, chronic obstructive pulmonary disease, and chronic wound healing [4]. Sustained success will depend on fulfilling patient and provider satisfaction criteria [5,6]. Although feedback and information filtering mechanisms inherently present in face-to-face interviews are noticeably absent, there are clear advantages evoked by automation. Data can be accessed from remote locations for the purpose of consultation. Duplications of prescriptions and tests are avoided. Moreover, routine tasks of completing health insurance claim forms, patient tracking and billing are easily implemented. Further, health care reform is hastened by eliminating unwieldy collection of paper files. Costs, payments, and patient scheduling are automatically added to the patient's database [7,8].

One of the most important attributes is the accessibility of consultants. Specialists affiliated with a regional hospital, perhaps located in a distant city, or country, can observe, hear, review, and analyze data streaming from the center and the personal data repository in the workstation, and issue instructions to the medical center staff attending the patient. In a few cases, surgery has been conducted remotely using robotics and videoconferencing technologies [8].

Concomitant disadvantages are related to possible violation of privacy. The risk of occurrence is higher in telehomecare because of the extent to which medical care is computerized. In addition, a case management nurse directs the process from a remote workstation and therefore the system is subject to human error and misjudgments. An ongoing concern of the payer is whether treatment was covered by insurance, and, if so, whether it was absolutely essential and cost-effective.

There are many demands made on personal information by professionals. Health providers, regional hospitals, insurance carriers, social institutions, government departments, researchers, employers, pharmaceutical houses, law enforcement agencies, credit card companies, and banks are examples. Data are frequently disseminated, distributed, and shared. The fact that a computer network is involved with its many access points increases the possibility that information can be inadvertently released to unscrupulous organizations or individuals resulting in dire consequences for the patient. At the very onset of medical attention the patient has concerns about how many people know intimate details and what they plan on doing with this knowledge.

Conceived to acquire personal information for an electronic medical record, the clinical interview contains probing questions. The number and type of inquiries are assumed to fulfill medical protocols, and therefore are deemed essential for treatment — but the rate can and should be controlled. Clinical interviews are an important phase of a regimen. If designed well, they would focus on the direction of increased and gradual sensitivity. The management nurse conducting the interview would allow ample time for reflection and reply. As presumed here, high rates merely intimidate the patient and affect replies. Patient concerns are exacerbated. Fear and worry turn into anxiety and aggravate a medical condition. As a defensive measure, the patient exaggerates the importance of every subsequent question being asked and begins to fantasize and perhaps mislead.

The purpose of this paper is to mathematically formulate permissible rates of clinical interviews held during telehomecare virtual visits and designed to avoid patient anxiety. Information sources, data flows, clinical interviews, and disclosure provide a background for the personal database. Discussions on anxiety, information controls, and development of the mathematical model follow. An expression for mental stress is derived. A Lorentz transformation determines the relationship between rates of provider inquiries and patient replies.

2. PERSONAL DATABASE

2.1 Information sources

Outcomes of clinical interviews, laboratory and radiology tests, medical treatment that includes protocols, dispensed pharmaceuticals, ordered images, regulated physical therapies, and diet controls are valuable sources of personal information. Other origins encompass educational and evaluation sessions held by the case management nurse.

Personal particulars are found in the electronic patient records and health cards. Information can be traced to the home in telehomecare, hospital admission, discharge, transfer units, emergency room, intensive care ward, archives, and outpatient clinics. Documents include clinical notes, previous files, recorded observations of physicians, nurses, social workers, specialists, and other consultants. Patient appointments, scheduling, and access to records establish the basis of a search for independent sources.

Monitors reveal vital signs of patients in an intensive care unit. These patients are under round-the-clock surveillance by remotely controlled high resolution video cameras that have pan, tilt, and zoom capabilities. A decision support system and expert system guide the practitioner in treatment regimens. Prompts may caution inappropriate choices of drug, dosage, and examination.

Credit rating affects the ability to pay for medical treatment or surgery. Payment records and account balances are scrutinized. There is an input from credit reporting agencies regarding credit-worthiness, credit score, and usage. These financial factors determine whether specialized and expensive treatment can be applied during hospital confinement.

2.2 Data flows

Video, audio, physiological data, and coded electronic records are transformed into packets of useful information, encrypted, and stored in the databank [8]. Data are kept in tape drives, storage arrays, and servers. The servers contain middleware that integrates electronic patient record programs installed on personal computers, and allows data entry. An asynchronous transfer mode (ATM) uses optical fiber to a local area network (LAN). Ethernet connections join the LAN with computers and imaging workstations. Wireless LAN and Ethernet are ATM replacements.

Within the hospital network, instructions transmitted over dedicated virtual LAN are encrypted when the information leaves the hospital and decrypted at the medical center. In the event of data dropout, there is a backup system of integrated services digital network (ISDN).

2.3 Clinical interviews

A principal source of personal data, clinical interviews are held during telehealth sessions. Questions and their replies are influenced by the existing database. An attending physician calls on the patient during first and last encounters of a regimen. At the initial session, the physician reaches a diagnosis, prescribes treatment, and estimates cost to the patient. Assessment of improvement in the state of health is determined during the final encounter, along with a prognosis that includes further treatment. Between face-to-face visits, virtual calls are made electronically using automated audio and video equipment. If the rates of questioning are not judiciously controlled, the patient may feel pressured in unwittingly revealing information.

Classification of data according to the degree of sensitivity is imperative in a well-designed interview. A basic level includes name, gender, current address, social security number, occupation, date and place of birth, name of health insurer, and current predispositions. This group of facts may be supplemented by marital status, the number of children, identifiable dental records, scars and vaccinations.

Directly relevant to a medical condition are recent laboratory tests and findings, imaging from echocardiograms, electrocardiograph (ECG) signals, X-rays and magnetic resonance, recorded diagnoses, previous illnesses and treatments, blood type, prescription drugs and dosages, drug allergies, prostheses, and discharge summaries. More susceptible to attitudes are race, religion, the use of alcohol, drugs, tobacco, military service record, and detailed medical histories of immediate family members and ancestry. Evocative data refer to preferred lifestyle, personal hygiene, and any deviant behavior. Even higher levels of sensitivity contain biometrics, deoxyribonucleic acid (DNA) data and other genetic information and coupling to potential disease.

2.4 Disclosure

Under pressure, the patient may reveal too much personal information, which opens the possibility of unwittingly transferring sensitive knowledge to third parties. Every individual has the inalienable right to protect privacy that includes medical data and details of past illnesses. This protection may be violated however when the person seeks telemedical treatment.

Once an individual becomes a patient, information is electronically shared with health providers, insurance payees, and other third parties, notwithstanding controls, institutional codes, and public policy aimed at preventing information abuse. The patient wishes to regulate the amount and kind of information transferred to a health worker and expects that the provider will maintain confidentiality. In following medical protocols, provider and third parties exercise a prerogative to inquire into the personal affairs of the patient and make use of information that involves participation in data exchanges.

Identity theft is a growing concern. A third party can fraudulently use an identifier to establish credit and then run-up unauthorized bills.

Personal information is legally shared with companies and institutions for the purpose of marketing health services and products at the request of the patient. Data are also disseminated within a network of affiliated third parties whose products are assumed to be of interest. In addition, personal information is reported to government agencies handling Medicare and Medicaid programs in order to meet legal requirements.

Inadvertent or intentional breach of confidentiality, however, may lead to permanent infringement with irreversible, unpredictable, and damaging repercussions. Once the data have been electronically recorded, the case of an unscrupulous organization or some individual gaining access to personal files is a distinct possibility, which may have long-term dire consequences. Higher insurance premiums, insurance refusal, and permanent medical preconditions are possible eventualities. Decisions may be taken as to whether an individual is hired, can secure licenses, or run for public office. He or she may be subjected to credit card fraud, junk mail, annoying telephone calls, social disgrace or reproach. What is worse, a person is usually unaware of what and how the information was learned, processed, and disseminated [9].

3. ANXIETY

Anxiety is a feeling of apprehension, fear, and worry often accompanied by pulmonary and cardiac manifestations [10]. The condition varies from behavioral anomalies such as panic disorder to neurological syndromes, or other primary psychiatric illnesses, which include depression and psychosis. For example, patient care in oncology should include recognizing the onset of distress in clinical interviews. Oncologists often fail to detect these symptoms in patients receiving disconcerting news [11]. Addressing this problem, clinical interviewing effected through diagnostic screening questionnaires has been successfully computerized [12].

During remote contact sessions, complete rapport with the patient cannot be achieved. Whether the patient has enough time to discuss symptoms in detail is an issue that must be seriously considered. In response, the provider may not have an opportunity to rephrase questions or provide empathy. Effective body language is also not possible. For these reasons, clinicians interviewing the patient by remote means may not recognize early signs of distress.

Touching sensitive issues sets disharmony between the right to privacy and the need-to-know. A conflict occurs when the interviewer elicits information at a disturbing rate that breaches what the interviewee regards as his or her personal domain of privacy, possibly resulting in anxiety. What aggravates angst is the knowledge that every word spoken in response to questions may automatically enter the personal electronic medical record stored in a computer network.

Unbeknown to the patient, third parties may be contacted in the process to verify the information given by the patient. The patient envisages certain risks in replying truthfully and may not answer. Under duress, the patient exaggerates the importance of the questions being asked and may unwittingly reveal intimate information — to his or her subsequent regret. If the telehomecare program is to be successful, it is important to promote patient satisfaction by reducing the frequency and depth of encroachment on protected privacy.

In a recent investigation, the outward signs of anxiety resulting from lymphoma, renal cell carcinoma, and malignant melanoma were analyzed [13]. Detection tools were compared and demographic, oncological, and psychosocial relationships were identified. Screening performed by a questionnaire isolated and assessed superficial anxiety manifestations successfully, however the disruptive and more serious types of abnormal anxiety were overlooked. There seem to be few determinants that could be used in practice to detect abnormal patterns and particularly their effect on the quality of life.

4. INFORMATION CONTROLS

Security measures require a login, password, and report on who entered the system, at what time, and which terminals were used to gain access. Under authorization given to selected physicians, only a corresponding data subset of the electronic patient record can be reviewed. Control at the patient level may prevent data from being read, copied, modified, deleted, or transmitted by unauthorized parties without legitimate need-to-know. Several tools are available from user authentication in the forms of encryption, digital signatures, biometrics, audits, and health cards to consent forms.

Any consent agreement must be fully understood by the patient as to exactly what personal data are requested, who are the recipients, and over what period of time will the information be utilized. The patient must not be coerced into signing an agreement that entails more information than what is necessary for treatment and payment. A set of identifiers, names and codes for laboratory tests precludes duplication, and an independent set of identifiers is applicable to findings. Messaging standards are referenced for the exchange of information between hospitals and connecting digital imaging equipment and devices, such as X-ray, computer aided tomography, and ultrasound. Other standards cover prescriptions and laboratory protocols.

Public policy decisions should provide legal protection for medical records. There must be oversight and active enforcement to ensure compliance. The most realistic threat, however, arises when there are deliberate exchanges between payee and third parties, and amongst third parties. Name, address, social security number, other identifiers, and credit history are regarded as nonpublic information. Company employees are directed to obtain this information so that they can offer products and services, process and service accounts and records, and administer the healthcare business.

Legislation may ensure confidentiality, while health professionals access medical records and participate in free exchanges. There must be supervision of personal information that is legally shared with companies and institutions for the purpose of marketing health services and products.

5. MATHEMATICAL MODEL

5.1 Mental stress

Consider an information region within $\mathbf{E} = \mathbf{R}^3$. A correspondence is established between directed personal data and points of the closed subset. For mathematical convenience, the continuum hypothesis is invoked. Discrete values can be chosen from the results over the positive integers.

Suppose $dB\ n_j$ denotes an infinitesimal element of the boundary of the information region, where vector n_j is the unit normal, considered positive if pointed outward in the direction of increasing sensitivity. In the course of interviewing the patient, the case management nurse requests personal information at velocity u_j. This process is restricted to approach the boundary at rate $u_j n_j$, where Cartesian tensor notation is used and a repeated Latin subscript is therefore summed over 1,2, and 3. A cognition and practical limit c exists to this rate so that $c \geq u_j n_j > 0$. The volume of personal data collected, or, correspondingly, the intrusion posed in the time interval dt is

$$dI = u_j n_j\, dB\, dt. \qquad (1)$$

Let the duration of virtual visits necessary for the provider to acquire a unit volume of information be given by ν. It can easily be converted into the nearest number of sessions. The duration of a single virtual visit is usually fixed according to an equitable schedule followed by the interviewer. Many more than the average number of calls are required in cases of severe illness or problematic communication. Then the infinitesimal duration is

$$dD = v\, u_j\, n_j\, dB\, dt. \tag{2}$$

If m signifies the weight of importance per unit duration associated with an encounter

$$dU = m\, v\, u_j\, n_j\, dB\, dt \tag{3}$$

is the infinitesimal urgency sensed by the patient.

Information momentum for a clinical interview is defined as the product of importance and the rate of intrusive questioning. With the infinitesimal change of information momentum given by

$$dM_k = m\, v\, u_j\, n_j\, u_k\, dB\, dt \tag{4}$$

the patient feels impulse

$$dJ_k = s_k\, dB\, dt. \tag{5}$$

Hence, the measure of emotional stress is

$$s_k\, n_k = m\, v\, u_j\, n_j\, u_k\, n_k. \tag{6}$$

The longer time spent in virtual visits, or equivalently the greater number of visits required, the higher the level of emotional stress. Higher rates of inquiry into sensitive matters imply much greater angst. Finally, what the patient views as urgent adds to mental discomfort.

Urgency however is not assigned independent of the rate of inquiry. In order to obtain this relationship, reference is made to the Lorentz transformation, which in addition provides insight into the relative difference between patient and provider concerns.

5.2 Lorentz transformation

Patient and health professional view the interviewing process quite differently. Let the original space be covered by a set of Cartesian axes (x_1, x_2, x_3). To this set, a fourth axis $x_4 = i\, c\, t$ is added in a Minkowski 4-space, where $i = \sqrt{-1}$. Time scale $t \geq 0$ is measured from interview initiation. The relation

$$x'_\mu = a_{\mu\lambda}\, x_\lambda \tag{7}$$

corresponds to a rotation. It is used to equate the experiences of provider and patient alike

$$x'_\mu\, x'_\mu = a_{\mu\lambda}\, x_\lambda\, a_{\mu\kappa}\, x_\kappa = x_\lambda\, x_\lambda \tag{8}$$

inasmuch as

$$a_{\mu\lambda}\, a_{\mu\kappa} = \delta_{\lambda\kappa} \tag{9}$$

is the Kronecker delta. The Lorentz transformation is an orthogonal mapping on the Minkowski space covered by the set of axes (x'_1, x'_2, x'_3) whose origin moves at constant speed $u_j\, n_j$. The repeated Greek subscript is summed over 1, 2, 3, and 4. Initially, ordinary spatial rotations are invoked so the axes x_1 and x_2 are parallel to x'_1 and x'_2, respectively. In addition, the velocity of gathering information by provider and moving towards the boundary of protected privacy $u_j\, n_j$ is fixed in the x_3 direction. This last condition can always be met by ordinary spatial rotations of the x_3 axis. Simplifications from arguments dealing with invariant and independent directions yield

$$a_{11} = a_{22} = 1 \tag{10a}$$

$$a_{12} = a_{13} = a_{14} = 0 \tag{10b}$$

$$a_{21} = a_{23} = a_{24} = 0 \tag{10c}$$

$$a_{31} = a_{32} = 0 \tag{10d}$$

and

$$a_{41} = a_{42} = 0. \tag{10e}$$

The four unknown components of the Lorentz transformation matrix are obtained from the simultaneous solution of the orthogonality conditions

$$a_{33}^2 + a_{34}^2 = 1 \tag{11a}$$

$$a_{43}^2 + a_{44}^2 = 1 \tag{11b}$$

$$a_{33}\, a_{43} + a_{34}\, a_{44} = 0 \tag{11c}$$

and the restriction that the origin $x'_3 = 0$ is moving with uniform speed $u_j\, n_j$ along the x_3 axis so that at time t

$$x_3 = u_j\, n_j\, t = -\, i\, \alpha\, x_4 \tag{11d}$$

where $u_j n_j / c = \alpha$.

Substituting these results in Eq. (7)

$$x'_1 = x_1 \tag{12a}$$

$$x'_2 = x_2 \tag{12b}$$

$$x'_3 = (x_3 - \alpha\, c\, t)/ \sqrt{(1 - \alpha^2)} \tag{12c}$$

and

$$t' = (t - \alpha\, x_3/ c)/ \sqrt{(1 - \alpha^2)}. \tag{12d}$$

The positive square root is chosen because $|a_{\mu\lambda}| = +1$. When the rate is low, the transformation reduces to that of Galilean.

Differentiating Equation (12d) with respect to t

$$\sqrt{(1 - \alpha^2)}\, dt'/ dt = 1 - \alpha\, v_3/ c. \tag{13}$$

This relation will be used to determine the temporal derivative according to the patient's time scale. It follows that the relationships between velocity components are given by the following equations

$$v'_1 = v_1 \sqrt{(1 - \alpha^2)}/ (1 - \alpha\, v_3/ c) \tag{14a}$$

$$v'_2 = v_2 \sqrt{(1 - \alpha^2)}/ (1 - \alpha\, v_3/ c) \tag{14b}$$

and

$$v'_3 = (v_3 - \alpha\, c)/ (1 - \alpha\, v_3/ c). \tag{14c}$$

The magnitude of the velocity v' satisfies

$$v'^2 = v_1'^2 + v_2'^2 + v_3'^2. \tag{15}$$

In Eqs. (14a) - (14c), the sign of $\alpha\, c$ is reversed and the prime and unprimed quantities are interchanged to obtain the reciprocal relations

$$v_1 = v'_1 \sqrt{(1 - \alpha^2)} / (1 + \alpha v'_3 / c) \quad (16a)$$

$$v_2 = v'_2 \sqrt{(1 - \alpha^2)} / (1 + \alpha v'_3 / c) \quad (16b)$$

and

$$v_3 = (v'_3 + \alpha c) / (1 + \alpha v'_3 / c). \quad (16c)$$

Now the contraction factor transforms as

$$\sqrt{(1 - v^2 / c^2)} = \sqrt{(1 - v'^2 / c^2)} \sqrt{(1 - \alpha^2)} / (1 + \alpha v'_3 / c) \quad (17)$$

with magnitude of the velocity v fulfilling

$$v^2 = v_1^2 + v_2^2 + v_3^2. \quad (18)$$

Queries of the clinical interview are asked at rate αc. Assuming no delay in response, the reply from the patient is seen by the provider to be transmitted at rate $v'_3 = |\alpha c|$. What sign to employ depends on which one of two operations is being considered. The first involves information gathering and recording and is performed by the provider, while the second process maintains synchrony or zero delay between question and answer and is executed by the patient. In order to describe the first, the positive sign is used, $v'_3 = \alpha c$, and information is therefore transmitted at rate $2\alpha c$. The negative sign is used in the second operation, $v'_3 = -\alpha c$. Irrespective of application, the remaining components are $v'_1 = v'_2 = 0$, so that by Eq. (15) the provider views the rate of response as $v' = \alpha c$.

As stated by Eq. (16c), the patient envisages information rates quite differently. The subjective disparity stems from the dependence on $\alpha c v'_3$ the product of query and response rates. The third components of the two operational velocities are determined from Eq. (16c) using the appropriate sign. Hence,

$${}^1v_3 = 2\alpha c / (1 + \alpha^2) \quad (19)$$

and

$${}^2v_3 = 0. \quad (20)$$

Each operation is marked by the left super-numeric. The rate of information transmission is reduced, but any rate arouses concern.

It follows immediately from $v'_1 = v'_2 = 0$ and Eqs. (16a) and (16b) that ${}^1v_1 = {}^1v_2 = 0$. Inserting these results in Eq. (18), information gathering and recording is characterized by the patient at rate

$${}^1v = 2\alpha c / (1 + \alpha^2) \quad (21)$$

a process managed by the provider.

Once again, Esq. (16a) and (16b) are employed to give ${}^2v_1 = {}^2v_2 = 0$. When these restrictions are substituted in Eq. (18), to maintain synchrony or zero delay between question and answer, as regulated by the patient

$${}^2v = 0 \quad (22)$$

the null condition is retained.

5.3 Information momentum

Information momentum is defined as the product of importance and velocity. The patient assigns a weight or analogous mass of importance to each of the two sets of operations in a session. Subjective factors affect the first because the provider controls these actions.

A conservation of information momentum is posited as

$$({}^1m + {}^2m)\, \alpha c = {}^1m\, {}^1v + {}^2m\, {}^2v. \quad (23)$$

Setting $v'_3 = 0$, which occurs before replies are received, ${}^1v_3 = {}^2v_3 = \alpha c$. The term on the left applies just prior to a response to the sequence of questions asked, and the rate therefore is that of inquiry. Terms on the right are a function of both question and answer rates in which the two weights of importance are retained. Then

$${}^2m / {}^1m = ({}^1v - \alpha c) / (\alpha c - {}^2v). \quad (24)$$

Using the results of Eqs. (21) and (22)

$${}^2m / {}^1m = (1 - \alpha^2) / (1 + \alpha^2). \quad (25)$$

This conclusion can be related to the two velocities as envisaged by the patient, from the transformation Eq. (17). The variation of m from m_o at the zero velocity level becomes

$$m = m_o / \sqrt{(1 - \beta^2)} \quad (26)$$

for which ${}^1m = m$, ${}^2m = m_o$ and $\beta = 2\alpha / (1 + \alpha^2)$. The value of m_o is consistent with the provider's point of view. Hence, the weight of importance designated by the patient to collecting and recording personal information is driven by a singularity that itself depends on the rate of questioning.

5.4 Allowable rates

Returning to the expression for emotional stress induced by intense questioning related to sensitive issues, Eq. (6), a dimensionless grouping is

$$S_o = s_o / m_o\, v\, c^2 \quad (27)$$

where s_o is a threshold parameter set by the healthcare worker based on stress tolerance

$$s_k\, n_k \leq s_o. \quad (28)$$

The dimensionless measure of anxiety can be controlled by the rate of collection in the direction of greater data sensitivity. If m_o has the units of physical mass, s_o would have the physical units of pressure. Parameter v is an indicator of interview efficiency, which depends on the patient general state of health, and language aptitude — whether the questions asked are clear and simple — and the skill of the interviewer.

Define

$$S = \alpha^2 / \sqrt{[(1 - \beta)(1 + \beta)]} \quad (29)$$

recalling that $\beta = 2\alpha / (1 + \alpha^2)$ is a function of the rate of questioning αc.

Combining Eq. (29) with the preceding inequality, the condition to obviate anxiety is expressed by

$$S \leq S_o. \quad (30)$$

The inequality fixes the range of permissible rates of inquiry of a clinical interview. A breach of confidentiality however may be imminent under a policy of indiscriminate and uncontrolled rate of questioning because the S function then becomes unbounded and S_o is easily surpassed.

6. CONCLUSIONS

There are many demands made on personal information in a telehomecare service. Typical sources are health providers, regional hospitals, insurance carriers, social institutions, government agencies, researchers, employers, pharmaceutical houses, law enforcement, credit card companies, and banks. A natural flow of data that are disseminated, distributed, and shared continually occurs. The fact that a computer network is involved with its many access points increases the possibility that information can be inadvertently released to unscrupulous organizations or individuals resulting in dire consequences for the patient. At the very onset of medical attention patients have concerns about what others will learn about them.

Conceived to acquire personal information for an electronic medical record, the clinical interview contains probing questions. The number and type of inquiries are assumed to fulfill medical protocols, and therefore are deemed essential for treatment — but the rate can and should be controlled. Clinical interviews are an important phase of a regimen. If designed well, they would focus on the direction of increased sensitivity. The management nurse conducting the interview should allow ample time for reflection and reply. As presumed here, high rates merely intimidate the patient and affect replies. Patient concerns are exacerbated. Fear and worry turn into anxiety and aggravate a medical condition. As a defensive measure, the patient exaggerates the importance of every subsequent question being asked and begins to fantasize and perhaps even lie. Attitudes, fears, expectations, demeanor, training, and experience of both interviewee and interviewer influence the data taken and therefore ultimately the clinical conclusions reached.

The longer time spent in virtual visits, or equivalently the greater number of virtual visits required in telehomecare, the higher the level of emotional stress is inferred from a mathematical model. Higher rates of inquiry into sensitive matters imply greater angst. Finally, what the patient views as urgent adds to mental discomfort.

A sense of urgency is not independent of the rate of inquiry. In order to obtain this relationship, reference is made to the Lorentz transformation, which in addition provides insight into the relative difference between patient and provider concerns.

An orthogonal transformation of Minkowski space, the Lorentz transformation, is formulated. The transformation is one of rotation in a plane that includes an imaginary axis. Two coordinate systems in relative and uniform motion are assigned to patient and provider, respectively. Orthogonality conditions for a pure Lorentz transformation are invoked and the four unknown matrix elements are determined utilizing the origin as initial state. Differentiation of the Lorentz components is performed with respect to either one of two subjective time scales to determine velocities. The analysis concentrates on patient's sense of rates when observing actions taken by provider and patient.

Two operations are of interest: Collecting and recording information by the provider, and maintaining synchrony of questions and answers, an action executed by the patient. Assuming no delay, results are given for rates of the two operations as seen by the patient. Conservation of information momentum is postulated and applied before and after replies are recorded. A measure for the sense of urgency leading to an inner contradiction is determined. With the introduction of the contraction factor transformation, the metric simplifies to an expression containing a singularity. The result states that the weight of importance attributed by the patient to collecting and recording personal information is driven by this singularity, which depends on the rate of questioning.

Permissible rates of clinical interviews can serve as a guideline in training programs for the case management nurse or healthcare interviewer. Moreover, these ideas are applicable within an emergency room setting where rates are usually hurried because there is little time to acquire essential data needed for prescribing correct treatment.

In the future, automated questionnaires may become the accepted norm, and in this connection the designed rate of inquiry will be of vital importance, but difficult to implement in every case.

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