

Patients Assessment in Telegeriatrics Care

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Abstract Elder patients are considered to have a high degree of frailty and active multiple pathology. When access to geriatric care is very limited, diagnostic methods without face to face contact are of prime importance, especially during initial patient assessment. The goal of the paper is to present and validate telemedicine screening procedures adopted in the John Paul II Geriatric Hospital (GH), covering the neurological part of Comprehensive Geriatric Assessment (CGA). The participants of the study have been patients aged 65 and older. Three methods have been evaluated: Telephone Interview for Cognitive Assessment (TICS), Geriatric Depression Scale (GDS) questionnaire filled out during video call, and analysis of a written text. The third procedure aims at detecting cognitive skills, providing alternative to Montreal Cognitive Assessment (MoCA) and Mini Mental State Examination (MMSE). Face-to-face methods are used as a gold standard reference. High or moderate correlations have been observed in all cases, i.e. in TICS versus reference MMSE scores (Spearman's $R = 0.7955$), in face-to-face GDS versus videoconference Tele-GDS (Spearman's $R = 0.7148$), and in the written text versus MoCA. (Spearman's $R = -0.6649$). The results of this study presume that TICS can be applied as a reliable method of remote diagnostics. In the two latter cases, the use of telegeriatrics has not been excluded, and further research is planned. Comprehensive assessment has been considered to be crucial for delivering geriatric care. Work in the field of telemedicine-based comprehensive assessment of geriatric patient should be continued.

Keywords Telegeriatrics · Telemedicine · Comprehensive geriatric assessment · MoCA · MMSE · GDS · Analysis of writing

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1 Introduction

Access to experienced physicians, psychologists and psychotherapists specialized in gerontology is becoming increasingly necessary for both medical and non-medical facilities aiming at provision of effective diagnosis and treatment of patients at advanced age. Yet, in practice, the access to geriatric care in some countries is very limited, for example there were only 333 specialists of geriatrics in Poland in 2014 [31] (i.e. 0.9 specialist per 100,000 citizens). The ratio of beds per 100,000 citizens in Poland is also low: 1.8 [22], especially when compared to neighboring Slovakia (14 beds [10]) or Belgium (with the highest ratio of over 100 beds per 100,000 citizens [9]). It is expected that fast access to powerful diagnostic procedures could nevertheless be secured with the use of telegeriatric-based solutions. In recent years, various initiatives have been started in the field of telemedicine in geriatric care (telegeriatrics). Levine et al. [19] shows that smartphone applications can assist in chronic, non-cancer pain treatment. Lichstein et al. [20] uses Skype to help insomniac patients. Rajasekaran et al. [25] employs remote monitoring of patients during drug therapy. Many projects are dedicated to helping diabetics and people with vascular diseases [32]. Mixed, traditional and telemedicine-based, services are provided for selected patients [3]. However, the available solutions are mostly dedicated to patients already diagnosed, and lack comprehensive approach needed during initial contact with various gerontological specialists.

The geriatric diagnostic process begins with a thorough history taking and physical examination, which are aimed at separating the natural signs of aging from existing diseases and defining the person's functional capacity. Diagnosis in geriatrics is difficult because one patient may suffer from many overlapping diseases [7]. This may lead to severe and immediate disabilities, such as stroke, as well as progressive disabilities that slowly erode the ability of the elderly to care for themselves.

When it comes to geriatric diagnostics, besides laboratory testing and imaging, different scales and tests are being used, such as Barthel index, ADL scale (activity of daily living) [8] or Vulnerable Elder Survey [29]. Selected patients are subjected to further functional and physiological evaluation with the use of complex and interdisciplinary tools such as comprehensive geriatric assessment (CGA) [30].

The CGA includes a number of screening tests as well as evaluation of daily living activities, social support, cognition, mood, gait and falls, nutrition, sensory impairments, incontinence, polypharmacy, biochemical results, abuse of the elders, pressure ulcers, pain and advanced directives [6].

Our recent projects have been focused on developing a telemedical counterpart of comprehensive geriatric assessment (CGA), comparable with the traditional approach. Expected benefits include increased access to geriatric care and extended coverage of screening procedures.

2 Materials and Methods

Telemedicine procedures included in the paper are intended as a remote counterpart of the neurological part of CGA. The primary use scenario involves geriatric specialists consulting patients who stay at medical or non-medical facility. The subjects remaining under care of trained staff are examined by means of telecommunication devices by a specialist who controls the procedure.

For the purpose of the study, during evaluation of each of the three verified procedures, first the group of possible candidates was selected from John Paul II Geriatric Hospital in Katowice (GH) patients, on the basis of medical documentation. The groups of patients selected for each procedure might have overlapped, but they were not the same. The patients (or, in specific cases, legal guardians) were asked to participate, and their initial consent was obtained. In the next step, the staff of GH was instructed to talk with the patients, outline the details of the procedure and provide necessary information.

The proposed set of procedures evaluated in GH has been chosen on the basis of relevance versus the traditional face-to-face neuropsychological part of CGA. The methods do not cover the whole examination, yet provide powerful screening capabilities.

All the presented work has been approved by the Bioethics Commission of the Academy of Physical Education in Katowice, Poland (resolution 1/2010, with amendments).

The first procedure tested has been the Polish version of TICS (Telephone Interview for Cognitive Assessment). In its original version, the observed screening abilities have been comparable [26, 28] with the face-to-face Montreal Cognitive Assessment (MoCA) [11, 12] and Mini-Mental State Examination (MMSE) [23] examinations. However, this had not been confirmed before for all the local versions of TICS. In the study, a Polish version of the TICS has been evaluated. The Polish version of TICS evaluated in GH follows the version of the tests presented in English [2, 16, 33] in both the type of questions and the grading. The cut-off level was established at 30 points. The examination was executed by performing three tests in one diagnostic session with a neuropsychologist. The gold standard MMSE and MoCA tests were performed in the usual manner—face to face in typical medical office conditions. The results of this evaluation have partially been presented in our conference paper [5].

The second procedure has been Tele-GDS (Telemedicine Geriatric Depression Scale). Remote methods of diagnosis, which is easy for patients, are considered important worldwide (cf. Gellis et al. [13]). In their telediagnostic form, Hamilton Depression Rating Scale (HAM-D) [14] and Brief Psychiatric Rating Scale (BPRS) [24] were among the first methods to be evaluated [17] by comparison of results of face to face and video consultation/examination. In 2001, Menon [21] presented a similar evaluation of Geriatric Depression Scale (GDS) [35] and Hamilton Depression Rating Scale, over a low quality video link. In this paper, the procedure has been evaluated using high quality video. GDS, in the form proposed by Yesavage

[34, 35], has been evaluated in GH using video equipment. The used variant of GDS has been graded in the range of 0–15 pts., where depression with increasing intensity has been diagnosed in case of patients with six or more points scored [35]. All the patients were informed of the purpose, the course of the study and security policy regarding the data acquired. After giving his/her consent, the patient participated in the study conducted in typical medical office conditions, with the first psychologist performing MMSE and MoCA tests (to assess cognitive functions), and standard Geriatric Depression Scale rating. In the next phase, a day or more later, a second psychologist performed Tele-GDS (the same GDS rating using video conference equipment). Additionally, in several cases, the procedures were performed in the opposite order (Tele-GDS procedure first).

The third procedure, experimental analysis of writing, aims at detecting cognitive skills providing simple and fast screening alternative to MoCA and MMSE, and replacing TICS in selected scenarios of remote diagnosis. Typical examination in MMSE takes about 20 min (no impairment or mild cognitive impairment), while MoCA is longer, with examination time of about 25 min. A typical session of TICS assessment takes 20 min. In all cases, constant supervision of the examiner is necessary to provide instructions and grade answers. During diagnostic sessions in GH, a hypothesis has been formed that a less time and resource consuming version of cognitive screening test could be proposed, which would be based solely on subject's writing and could be performed both locally or using telecommunication devices. This corresponds—to some extent—to other research, conducted on writing and mental condition, e.g. handwriting versus depression [27], handwriting in Parkinson's disease [4] etc. In this paper the procedure used in a pilot study and its evaluation has been included.

The subjects were informed about the goal of the study and they gave consent. First, the MoCA and MMSE tests were performed face to face. Next, Geriatric Depression Scale Assessment (not included in this evaluation) was performed. Finally, the subjects were asked to perform/complete two exercises with direct, face to face assistance of the examiner. In each case the examiner addressed the subject directly (in Polish) and waited for the completion of the task:

1. Three sentences will be read aloud and then dictated to you. Write them down on a blank piece of paper. These are the sentences: I am at hospital. I have received a blank piece of paper and then a pen. I am writing the text down on the paper received.
2. I am going to read to you twice a single sentence. Please write it down on the received piece of paper using only capital letters. This is the sentence: I wonder what the weather is going to be like tomorrow. In several cases, a third exercise was also included:
3. Draw two, similar-size circles: one over another. Mark the center of both of the circles.

During the first phase of the study, ordinary pen and white paper were used. Later, both regular and digital writing registration were employed using Livescribe Echo Pen that replaced the ordinary pen of similar size, used earlier. Such registered data

were encoded using libsmarten library and analyzed. Using the collected samples of writing, a series of writing parameters have been extracted manually and with the use of customized Matlab software. The examinations were performed in consulting room environment, with natural and artificial light.

3 Results

Three methods: TICS, GDS and analysis of writing were evaluated using statistical tools and appropriate reference methods. The results of the evaluation are presented below.

3.1 Telephone Interview for Cognitive Assessment

A group of 55 people, patients of GH, was tested. The study group consisted of 55 patients, the average age was 81.2 years, 42 patients were women (average age 81.1 years) and 13 were men (average age 81.5 years) [5]. All the tested patients agreed for the extended procedure and were interviewed on the telephone. All of them were over 75 years old, did not take drugs with pro-cognitive effects, were not diagnosed with dementia, and—among others—were able to participate in MMSE and MoCA test used here as gold standard. Various environmental and health data have been gathered. The results have been verified statistically. No correlation has been found (Spearman rank analysis) between TICS and the age of patients, education history, diabetes, depression or Parkinson's disease, etc.

Pearson correlation and Spearman rank correlation between the results of MMSE and MoCA tests were $R = 0.8085$ ($p < 0.0001$), $R_{\text{SPEARMAN}} = 0.8170$ ($p < 0.0001$), and the correlation between the results of MMSE and TICS tests was $R = 0.7867$ ($p < 0.0001$), $R_{\text{SPEARMAN}} = 0.7955$ ($p < 0.0001$) between MoCA and TICS tests: $R = 0.7741$ ($p < 0.0001$), $R_{\text{SPEARMAN}} = 0.7684$ ($p < 0.0001$). Figure 1; i.e. high correlation has been observed between the gold standard MMSE and MoCA and TICS tests.

As pointed out by the subjects, fatigue was noticeable during TICS part, as all the tests: MMSE, MoCA and TICS were performed in one go.

3.2 Geriatric Depression Scale Assessment (Tele-GDS)

25 patients were examined during the evaluation. The first group of 17 patients participated in the study in 2014 (partial results have been discussed in our previous paper [1]), while the second group of 8 patients was additionally examined in 2015.

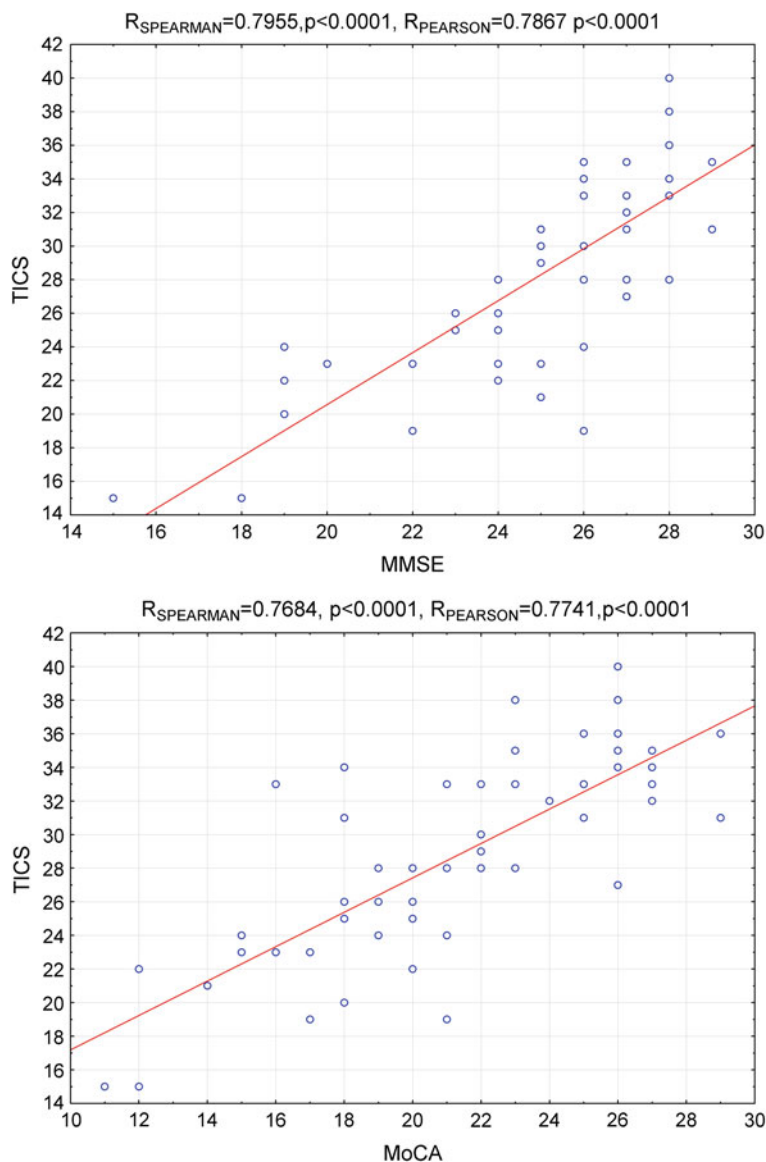


Fig. 1 Correlation between results of MMSE versus TICS test (*top*) and MoCA versus TICS test (*bottom*)

In 21 cases, the traditional face to face examination preceded the Tele-GDS, while in 4 cases the order was reversed. Statistical evaluation has been performed.

The mean GDS result for reference face-to-face assessment was 4.3 pts (SD 3.3 pts) and for videoconsultation Tele-GDS—3.5 (SD 2.6 pts.) Pearson correlation

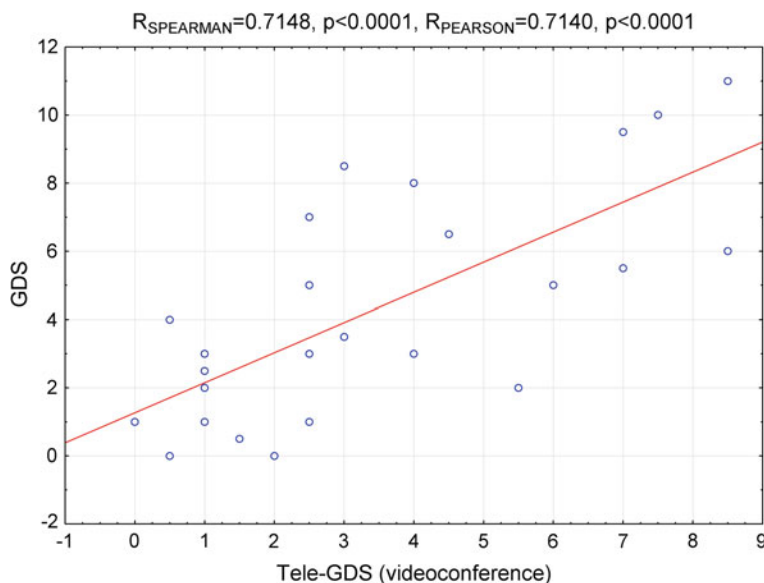


Fig. 2 Linear correlation for GDS and videoconsultation GDS

between both GDS assessments was $R = 0.7140$ ($p < 0.0001$) (Fig. 2). Spearman rank correlation between both GDS assessments has been calculated as $R_{\text{SPEARMAN}} = 0.7148$ ($p < 0.0001$). Despite the correlation, in four cases patients diagnosed with depression in face to face examination have not received the same diagnosis by videoconsultation (type II error). As shown in Fig. 2, the results obtained were lower mostly in videoconsultation. Assuming the same threshold for both tests, established for traditional GDS [34] (six or more points), sensitivity and specificity have been assessed as 56 % and 88 %, respectively.

Various factors have been considered, that may lower the results of GDS in videoconsultation, including: (1) insufficient perception of questions due to the use of telecommunication equipment (2) lack of direct contact, weakening the relationship between the examiner and the patient, (3) second examination being performed too soon after the first one, and the subject experiencing the fear of evaluation, which resulted in her/his dissimulation. However, the lower results during Tele-GDS have also been observed during sessions, in which Tele-GDS was the first test (2 of 4 cases). Further investigation is necessary to explain this phenomenon.

In the interview following the examination, several advantages of videoconsultation have been noted by psychologists: (1) it is easier to establish contact with the patient, (2) the examination is easily accessible, (3) facial expression can be observed in great detail, also in recordings, (4) patients, who may not be able to participate in face to face examination, due to physical limitations, may be examined, and (5) examinations can be repeated and results easily compared using recordings. The disadvantages pointed out include: (1) the fact that unnoticed hearing impairment

may affect the results, (2) the behavior of patients cannot be observed as well as during direct meetings; some non-verbal communication may be missing, (3) patients may be overwhelmed by technology and strongly prefer traditional examination; (4) additional consent is necessary.

3.3 Analysis of Writing

The pilot study [18] was conducted between February and May 2014. 26 patients of GH (avg. age 76 years, 20 women, 6 men) were examined. Making use of the obtained samples of writing, several features have been extracted. The presence of tremor, level of focus, number of pen detachments (exercises with written and block letters separately), etc. have been assessed for all samples. Time of writing, angle and various dynamic parameters have also been extracted for six electronically registered samples. The number of pen detachments has been chosen for correlation with MoCA and MMSE. One case was excluded from MoCA analysis, as the test was not completed during the session.

The negative correlation between the number of pen detachments in written text and MMSE was $R = -0.6146$ ($p = 0.001$), while for written text and MoCA it amounted to $R = -0.5509$ ($p = 0.004$), Fig. 3. The calculated Spearman rank correlation for the number of pen detachments in written text and MoCA was $R_{\text{SPEARMAN}} = -0.6649$, ($p < 0.001$), and in case of written text and MMSE $R_{\text{SPEARMAN}} = -0.6167$ ($p < 0.001$). No correlation has been confirmed to exist between pen detachments in block letters and gold standard.

The obtained mild correlation values between the number of pen detachments in reference text and the results of MoCA and MMSE are considered promising, but the evaluated number of samples should be increased to confirm the screening value.

3.4 Discussion

High correlation between the Polish version of TICS and MoCA/MMSE tests confirms the screening value of the local, Polish version of TICS. Mild correlation of Tele-GDS performed during videoconsultation and regular GDS also confirms the screening value, however, further investigations are needed, following the noticeably lower average results obtained during the videoconsultation test. Experimental analysis of writing samples is also promising, but further work is necessary in order to collect and analyze more data.

In our opinion, work in the field of comprehensive assessment of geriatric patients with the use of telecommunication should be continued. Implementing telemedicine solutions in mental health examination improves diagnostics and access to care in most scenarios [15], and despite age-related digital divide, the effects in geriatrics should be similar.

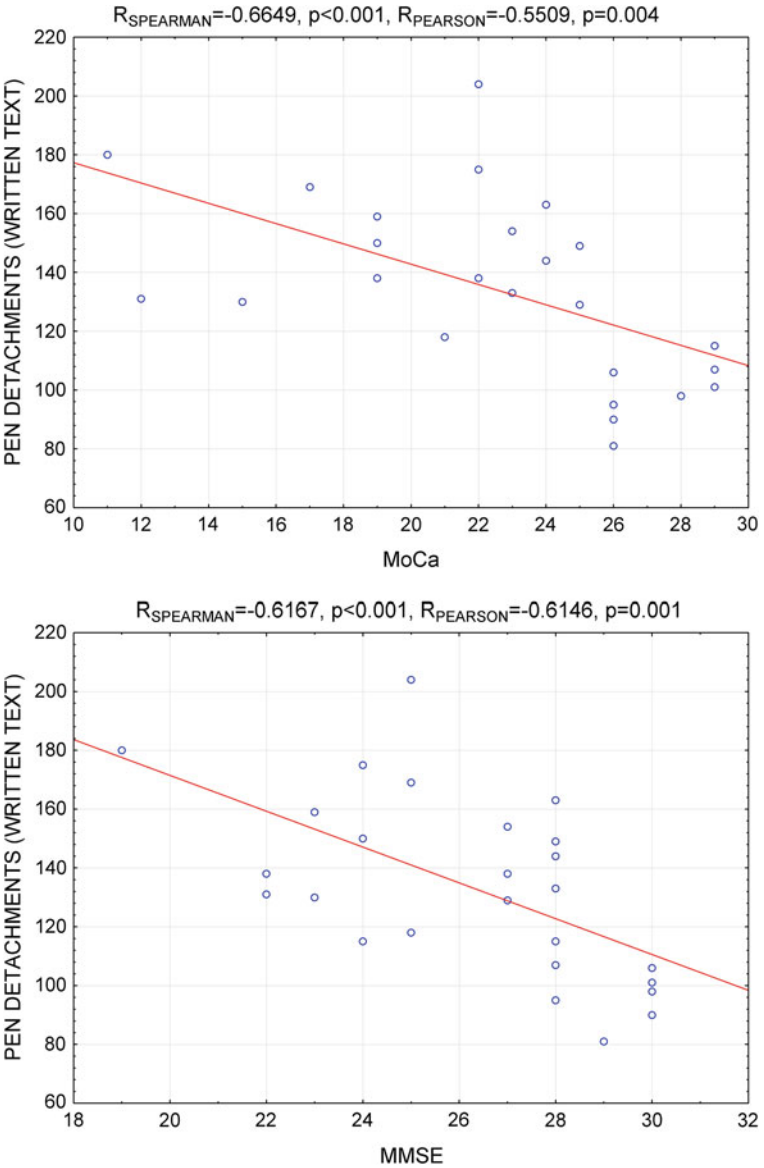


Fig. 3 Correlation between number of pen detachments in written text and MoCa (*top*) and MMSE (*bottom*)

It is crucial in Poland, where despite the aging society and growing demands, the number of geriatric specialists and hospital beds is very low. The use of telegeriatrics may be the only option available, especially in rural areas. However, remote access

to fast screening procedures should provide several benefits, even in countries with more developed elder care:

- residents of nursing homes and similar non-medical facilities can be easily examined, which increases the coverage of screening procedures,
- elder inhabitants of isolated locations and communities can be included in screening programs,
- access to geriatric care in non-geriatric medical facilities may be secured.

Once the vulnerable patient is identified using telegeriatrics, s/he can later be examined and treated using conventional means.

Consequently, further research has been planned in GH, especially in Tele-GDS and writing samples analysis.

Other popular geriatric tools that could be used in remote manner (e.g. MiniCOG) will be included.

Acknowledgments The research has been partially co-financed by the European Regional Development Fund under the Operational Programme Innovative Economy (project no. POIG.01.03.01-24-061/12) as well as National Centre for Research and Development (project no. IS-2/54/NCBR/2015).

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Information Technologies in Medicine

5th International Conference, ITIB 2016 Kamień Śląski,

Poland, June 20 - 22, 2016 Proceedings, Volume 2

Piętka, E.; Badura, P.; Kawa, J.; Wieclawek, W. (Eds.)

2016, XII, 410 p. 213 illus., 149 illus. in color., Softcover

ISBN: 978-3-319-39903-4