Usability of a store and forward telehealth platform for diagnosis and management of oral mucosal lesions: a cross-sectional study

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Abstract

**Background:** Telediagnosis is a promising tool in situations of limited access to specialty care. Considering that, an oral health telediagnosis platform (EstomatoNet) was created in the state of Rio Grande do Sul, Brazil. EstomatoNet provides specialist support over a web-based platform to primary care dentists for diagnosis of oral lesions.

**Objective:** To evaluate the usability of EstomatoNet and to identify user perceptions regarding their expectations and difficulties with the system.

**Methods:** Sixteen dentists were selected for the study: 8 were frequent users of EstomatoNet and 8 were residents who had never used the Platform. To assess usability, participants were required to request telediagnosis support for a fictional case provided by the research team. During the process of uploading the information and sending the request, users were asked to “think out loud,” expressing their perceptions. The session was observed by an examiner with remote access to the user’s screen (via Skype). After the simulation, users completed the System Usability Scale (SyUS).

**Results:** The mean SyUS score assigned by frequent users was 84.7±6.6, vs. 82.2±9.3 for residents (satisfactory usability: score above 68). The difference between the groups was not statistically significant (Student t test, *P* = .55). The inexperienced group took longer (347.1s±101.1) to complete the task than frequent users (252.8s±80.3), however the difference between the groups was not statistically significant (Student t test, *P* = .06). In their subjective evaluation, users suggested the inclusion of a field to add further information on outcomes and resolution of the case and changes in the position of the “Send” button to improve workflow.

**Conclusions:** The present results indicate good usability of EstomatoNet. The Platform seems to meet the needs of users regardless of how experienced they are; nevertheless, a few minor changes in some steps would improve the tool.

**Keywords:** Telehealth; Primary Health Care; Oral medicine; Diagnosis, Computer-Assisted.
Introduction
A fundamental principle of the Brazilian Unified Health System (SUS) is the constitutional guarantee of access to comprehensive, continuous health care, coordinated through networks, for all citizens. In the SUS, the primary care level is the entry point to the health care system [1-5] and should be capable of resolving most health conditions. Considering that assumption, oral health was introduced as an integral and inseparable component of the SUS in 2004, when the National Oral Health Policy was launched. The SUS oral health care network encompasses specialized dental care, with referrals coordinated by primary health care (PHC) services [6,7].

Telediagnosis as a tool to enhance access to specialized care
Even though face-to-face encounters between health professionals and patients remain the gold standard for patient evaluation in all medical fields, telediagnosis is a useful alternative when the availability of specialized care is limited [8]. Taking this into account, TelessaúdeRS-UFRGS, a major university-based telehealth program in Brazil [9], has created EstomatoNet, a teledentistry service available free of charge to PHC physicians and dentists in the state of Rio Grande do Sul to enhance care, prevent unnecessary referrals to specialists, and decrease the time between referral and specialty consultations [10]. Established in 2015, EstomatoNet is a web-based platform developed by TelessaúdeRS-UFRGS, and currently handles 3.7 thousand monthly requests for teleconsultations and telediagnosis support.

However, despite the advances and contributions of telemedicine, many health professionals still resist this technology. This might be explained, at least in part, by the difficulties involved in learning how to use these systems [11].

Usability in telehealth
Usability is the term used to describe the ability to use a product for its intended purpose [12]. Assessment of usability allows difficulties to be identified and resolved, making sure that telehealth systems do in fact translate into benefits. Usability assessment encompasses features such as ease of learning, ease of retaining the know-how to repeat a task after some time, how fast tasks can be performed, low error rate, and subjective user satisfaction [13]. Thus, the aim of the present study was to evaluate the usability of the EstomatoNet Platform.

Methods
Study design and recruitment of participants
This is a cross-sectional, observational study using a convenience sample. Registered users of EstomatoNet (PHC dentists from various cities in the state who used EstomatoNet regularly) were invited to participate via e-mail. Those who agreed to participate signed an informed consent form and were included as part of the experienced user group (Dent). A control group (Res) was selected among residents from the Integrated Residency program in Oral Health at the School of Odontology at
UFRGS. Members of the Res group were not familiar with the EstomatoNet Platform. The study protocol was approved by the institutional review board (GPPG 16-0440).

**Study procedures**
Initially, individual Skype videoconferences were scheduled with each participant. During the videoconference, the participant was asked by an examiner to activate the “screen sharing” tool to allow observation and analysis of the interaction with the Platform.

After screen sharing was activated, the participant was guided to access and read the tutorial on how to request telediagnosis support through a link to EstomatoNet made available at the TelessaúdeRS-UFRGS portal [10]. This procedure lasted approximately 10 minutes. After that, the examiner (a professional familiar with the EstomatoNet work flow) shared a fictional case via Skype, including clinical data and photographs, for the Platform test. During this simulation, the participants were guided to “think out loud,” that is, to express their feelings and difficulties while performing the task. In usability research, this approach has been useful to identify problems in information systems [14,15].

All simulations were recorded on a digital camera (Canon EOS Rebel T3, 12 megapixels, 18-55mm lens). The recordings were analyzed twice by the examiner.

**Outcomes**
Study outcomes included the duration of the interaction, the perceptions expressed by participants regarding the Platform, and usability of the system according to the System Usability Scale (SyUS) [16]. This validated questionnaire is highly reliable [17-19] to evaluate usability in different systems [16,20,21]. The total SyUS score ranges from 0 to 100, with scores higher than 68 considered to be satisfactory [19].

**Sample size calculation**
Sample size was estimated based on previous studies showing that 5 participants are sufficient to detect 80% of usability problems [13,22,23]. Considering a response rate of 33% [24], the sample size was defined as 8 participants per group – a highly experienced group and an inexperienced group.

**Statistical Analysis**
Quantitative variables were expressed as means and standard deviation. The groups were compared regarding the time required to complete the request, age, time since graduation, and overall SyUS score using Student’s t test, considering the normal distribution of data (Shapiro-Wilk test > 0.05). The correlation between time required to complete the request and SyUS score was evaluated using Pearson’s correlation test. A 5% significance level was adopted. Analyses were performed using PASW v. 18.
Results

Characteristics of the Sample

Eight participants were enrolled in each group. The age of participants ranged from 22 to 46 years. Most participants (12 of 16) were female (Table 1). Regarding previous use of the Platform, heterogeneous results were obtained for Dent, with the number of previous interactions (i.e., previous requests placed) ranging from 3 to 35 (14.1±10 > 2) (Table 2). As expected, none of the Res participants had had any previous contact with the Platform.

Table 1. Demographic characteristics of study participants.

<table>
<thead>
<tr>
<th></th>
<th>Dentists</th>
<th>Residents</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age (years)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>35.3</td>
<td>25.5</td>
</tr>
<tr>
<td>SD</td>
<td>6.3</td>
<td>2.8</td>
</tr>
<tr>
<td>Min-Max</td>
<td>28-46</td>
<td>22-31</td>
</tr>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Female</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td><strong>Time since graduation (years)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>9.0</td>
<td>2.3</td>
</tr>
<tr>
<td>SD</td>
<td>5.7</td>
<td>1.1</td>
</tr>
<tr>
<td>Min-Max</td>
<td>2-17</td>
<td>1-4</td>
</tr>
<tr>
<td><strong>Additional education</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specialist in Patients with special needs</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Community dentistry</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Health education</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Radiology</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Residency</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Community dentistry</td>
<td>0</td>
<td>1</td>
</tr>
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</table>

\( ^a P < .01. \)

\( ^b P = .01 \) (Student’s t test).

Table 2. Number of requests placed previously, SyUS score, and time required to complete a request.

<table>
<thead>
<tr>
<th></th>
<th>Previous use (No. of times)</th>
<th>SyUS</th>
<th>Time (s)</th>
</tr>
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<tbody>
<tr>
<td><strong>Dentists</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dent1</td>
<td>10</td>
<td>85.0</td>
<td>210</td>
</tr>
<tr>
<td>Dent2</td>
<td>15</td>
<td>90.0</td>
<td>353</td>
</tr>
<tr>
<td>Dent3</td>
<td>3</td>
<td>72.5</td>
<td>322</td>
</tr>
<tr>
<td>Dent4</td>
<td>35</td>
<td>92.5</td>
<td>243</td>
</tr>
<tr>
<td>Dent5</td>
<td>6</td>
<td>87.5</td>
<td>186</td>
</tr>
<tr>
<td>Dent6</td>
<td>20</td>
<td>77.5</td>
<td>328</td>
</tr>
<tr>
<td>Dent7</td>
<td>17</td>
<td>85.0</td>
<td>262</td>
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</table>
Residents

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</thead>
<tbody>
<tr>
<td>Dent8</td>
<td>7</td>
<td>87.5</td>
<td>118</td>
</tr>
<tr>
<td>Res1</td>
<td>-</td>
<td>72.5</td>
<td>510</td>
</tr>
<tr>
<td>Res2</td>
<td>-</td>
<td>87.5</td>
<td>375</td>
</tr>
<tr>
<td>Res3</td>
<td>-</td>
<td>72.5</td>
<td>413</td>
</tr>
<tr>
<td>Res4</td>
<td>-</td>
<td>77.5</td>
<td>247</td>
</tr>
<tr>
<td>Res5</td>
<td>-</td>
<td>100.0</td>
<td>222</td>
</tr>
<tr>
<td>Res6</td>
<td>-</td>
<td>77.5</td>
<td>310</td>
</tr>
<tr>
<td>Res7</td>
<td>-</td>
<td>87.5</td>
<td>270</td>
</tr>
<tr>
<td>Res8</td>
<td>-</td>
<td>82.5</td>
<td>430</td>
</tr>
</tbody>
</table>

SyUS = System Usability Scale.

Evaluation of Usability

Individual SyUS scores are shown in Table 2. The highest score was attributed by the most experienced participant (35 previous requests). Table 3 shows scores above 80 for both groups (Dent and Res), without statistical difference (Student t test, P = .65).

Res required more time (347.1 s) to complete a request than Dent (252.8 s), who were familiar with the Platform work flow (Table 3), but the difference was not statistically significant (Student’s t test, P = .06). Data analysis showed an inverse correlation between SyUS score and time required to place the request (R = 0.54, P = .03, Pearson’s correlation).

<p>| | | |</p>
<table>
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<tbody>
<tr>
<td>SyUS</td>
<td>Dent</td>
<td>Res</td>
</tr>
<tr>
<td>Mean</td>
<td>84.7</td>
<td>82.2</td>
</tr>
<tr>
<td>SD</td>
<td>6.6</td>
<td>9.3</td>
</tr>
<tr>
<td>Min-Max</td>
<td>72.5-92.5</td>
<td>72.5-100</td>
</tr>
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<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Time (s)</td>
<td>Dent</td>
<td>Res</td>
</tr>
<tr>
<td>Mean</td>
<td>252.8</td>
<td>347.2</td>
</tr>
<tr>
<td>SD</td>
<td>80.3</td>
<td>101.1</td>
</tr>
<tr>
<td>Min-Max</td>
<td>118-353</td>
<td>222-510</td>
</tr>
</tbody>
</table>

<sup>a</sup>Student’s t test.

Subjective Evaluation

Some participants had difficulties informing administrative information required by the Platform (Figure 1, left screen), such as the patient’s National Health Registry and Individual Taxpayer number (four Res and five Dent). Four participants (one Dent and three Res) typed the patient’s name in the first field, where actually the National Health Registry number should be informed. In addition, analysis of Screen 3 revealed two important difficulties: 1) the need to “save a draft” of the request before attaching a photograph and 2) after attaching a photograph, the need to
return to Screens 1 or 2 to find the “send” button. Other positive and negative perceptions were reported during the simulated requests (Textbox 1, Textbox 2).

Figure 1. Screens showing the steps required to request telehealth support.

Textbox 1. Positive perceptions of Residents or Dentists regarding EstomatoNet.
- “I would have done it faster if I had actually seen the patient.” (Dent2)
- “The Platform has helped me in many cases.” (Dent2, Dent6, Dent8)
- “I think the Platform is easy to use.” (Dent8)

Textbox 2. Negative perceptions of Residents or Dentists regarding EstomatoNet.
- “I would like to have the possibility to place the request by means of a phone call.” (Dent3)
- “The Platform should allow data (identification numbers) to be copied from different software and pasted into the Platform.” (Dent6)
- “I miss an option to continue discussing the case.” (Dent3, Dent4)
- “The link to send the request should be available in all screens.” (Dent3)

Discussion

Principal Results
The creation of a platform to support PHC in Brazil was a significant effort to qualify health care services in a large country with uneven professional training standards and different degrees of technological familiarity. In this scenario, assessing usability is crucial for improvement. The results show that EstomatoNet has satisfactory
usability. Even though focal problems were detected, even professionals who had never used the tool did not face major difficulties in using it.

It is known that 85% of dentists find it difficult to detect, diagnose, and treat oral lesions [25]. The establishment of a teledentistry platform is a way of addressing this need. The high usability score obtained by EstomatoNet shows that the Platform has the potential to bridge this gap in an efficient manner [26].

Even though it was statistically significant, the difference in age between the two groups in this study was small and may be considered irrelevant. We presume that this age difference did not influence the results; however, a difference in performance could be expected in the presence of a greater age difference. This hypothesis is supported by a previous study reporting that for the age range between 25 and 60 years, the time required for completion of tasks in web systems increases by 0.8% per year [27]. According to that study, this relationship may be attributed to the natural process of aging, which gradually compromises the ability to learn.

Usability assessed using the SyUS was fully satisfactory according to Dent (usability grade A +) and satisfactory according to Res (usability grade A). The fact that the difference between the groups was not significant indicates that the Platform is user-friendly, easy to learn and to manipulate, even for inexperienced users. Conversely, the worst evaluation in the Dent group was by the professional who had used the Platform the least, suggesting that frequency of interaction with the Platform improves usability. The fact the professional who had used the Platform most often assigned the highest score supports this perception. “The Platform has helped me in many cases” or “I find the Platform easy to use” are statements made by Dent participants that confirm that the Platform is well accepted. Finally, the statements regarding the interest and self-confidence to use the system again support this finding/interpretation.
Comparison with Prior Work

The high usability score obtained by the Platform becomes even more relevant if compared to the SyUS scores obtained by other tools. In a study by Ahn et al. [28], for example, in which five cardiopulmonary resuscitation training apps were assessed, only one app had a mean usability score above 80 (81.17±19.01). Lacerda et al. [29], who compared two cardiology telediagnosis interfaces, found a score below 80 for both (77.5 and 58.8). The differences among studies may be related to the tools usability or to users’ familiarity with them.

Regarding the time required to complete the task (place a request), Res took longer than Dent. This suggests that the more one uses the system, the shorter the time to complete the task. A mean time below 6 minutes to perform the task (347.2s) seems acceptable to obtain the benefit associated with having support provided by a specialist who will help clarify the diagnosis and guide clinical decision-making. In addition, in many cases, specialist support may prevent referrals, reducing costs for the government and favoring professionals and patients.

The correlation test showed that the lower the time required to place the request, the higher the SyUS score. The fact that two grade C+ evaluations were made by the participants who took the longest to finalize the task further support this finding. Another factor influencing the SyUS score was experience with the Platform, since the professional with the highest number of previous requests (Dent4) was the one who assigned the highest SyUS score.

The fact that some participants typed the name of the patient in the field meant for the National Health Registry number is justified by the name being, in general, the first information requested in web forms. The ability to copy/paste to the field and to view/access another window in the system could be considered improvements to the Platform.

In Screen 3, the steps of attaching a photograph and sending the request broke the work flow. Some simple adjustments would be sufficient to solve this problem. “Save draft” could also be available after the photograph is attached. The “Send” link could be transferred from screens 1 and 2 to screen 3. To avoid compromising task completion, this command could become automatically available as soon as the mandatory fields regarding the case were filled and the photographs attached.
The suggestion to add a field for further discussion of the case is also interesting. First, cases would be closed with information about outcomes, which would be useful for future reference; second, this adjustment would translate into an opportunity for continuity of care [30]. In other words, the specialist consultant could help the PHC dentist to evaluate the results of treatment in patients treated at the PHC level with more effective follow-up along time.

Limitations
The present study has limitations that need to be addressed. First of all, the small number of participants from one specific state precludes the extrapolation of the present findings to the entire country. Also, the number of interactions required to reach optimal usability was not assessed. Finally, the interactions assessed were simulations, and additional difficulties could perhaps arise during the placement of a request referring to a real case. All these issues could be the focus of future studies.

Conclusions
The EstomatoNet Platform has satisfactory usability and meets the needs of users. Some focal problems associated with information fields should be resolved to improve the tool.

Acknowledgements
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Conflicts of Interest
None declared.

Abbreviations
PHC: primary health care
SyUS: System Usability Scale
References

   http://www.webcitation.org/6y7CzC02M


   http://www.who.int/publications/almaata_declaration_en.pdf. Archived at: 
   http://www.webcitation.org/6y8ghLGGx


   http://bvsms.saude.gov.br/bvs/publicacoes/politica_nacional_brasil_sorridente.pdf. Archived at: 
   http://www.webcitation.org/6y7DXMaio


    http://www.webcitation.org/6y8h5fhoQ


