Training inter-physician communication using the Dynamic Patient Simulator®

R. Sijstermansa,∗, M.W.M. Jaspersb, P.M. Bloemendaalc, E.M. Schoonderwaldtd

a Department of Educational and Student Services, Academic Medical Center, University of Amsterdam, P.O. Box 22700, 1100 AZ Amsterdam, The Netherlands
b Department of Medical Informatics, Academic Medical Center, University of Amsterdam, The Netherlands
c Department of Surgery, Leiden University Medical Center, The Netherlands
d Department of Obstetrics and Gynaecology, Erasmus University Medical Center, Rotterdam, The Netherlands

ABSTRACT

Keywords:
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Patient simulations
Computer-based training

Purpose: Clear and adequate communication between physicians is essential in modern medicine. Nevertheless, the medical curricula in The Netherlands lack an identifiable part in their education concerning inter-physician communication training.

To train medical students in inter-physician communication skills using the Dynamic Patient Simulator® (DPS), the Academic Medical Center at the University of Amsterdam and the Leiden University Medical Center joined in a 2-year project sponsored by the Dutch government. DPS is an educational computer program to create and simulate virtual patients with a wide variety of medical conditions in different clinical settings and over different time frames. To evaluate whether DPS is a suitable method for training medical students in inter-physician communication, we assessed if medical students felt that they had improved their inter-collegial communication skills after the pilot with DPS. Besides, we inquired students on DPS’ usability and their satisfaction with DPS.

Methods: We first developed and implemented 20 patient simulations in DPS to be practiced upon by two students asynchronously during a week. These students were situated in different medical institutions, geographically spread over The Netherlands and had to treat the virtual patient as a team supported by DPS. The students had to report their findings and treatment plan in the electronic referral form of DPS. A total of 134 students participated in the pilot. To evaluate inter-physician communication training using DPS we conducted a survey amongst these students who were entering their internships. The evaluation focused on self-assessment of their communication skills, usability of the DPS program, and their satisfaction with DPS as educational format, using multiple questionnaires.

Discussion: The outcome of the evaluation showed significant progression in students’ feeling of improvement of their skills in different aspects concerning the referral of a patient after participating in the pilot. Besides, students evaluated the usability of DPS positive and were highly satisfied with the education in inter-physician communication training using DPS. Based on these outcomes, nowadays this form of training is incorporated in the curricula on a regular basis.

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∗ Corresponding author. Tel.: +31 20 5662628; fax: +31 20 6974351.
E-mail address: r.sijstermans@amc.uva.nl (R. Sijstermans).
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1. Introduction

1.1. Inter-physician communication

Clear and adequate inter-physician communication is of vital importance in modern health care [1]. Physicians have to inform each other on a regular basis to ensure the continuity of the care for the patient. This inter-physician communication involves registration of patient care data and transfer of patient’s medical records and treatment strategy within one medical discipline, as well as consultation of physicians across different specialties.

Since medical training includes all aspects of medical practice [2], training of inter-physician communication should be integrated in the medical curriculum. However, training of these skills is still underexposed in most medical curricula in the Netherlands.

Changes in the environments in which clinical medical education takes place, have profoundly affected the quality of medical students’ learning experiences. A shift to out-patient based care, minimization of hospitalization time, shrinking clinical revenues and growing numbers of medical students has changed the teaching hospital to a degree that we must develop innovative approaches to medical education [3], such as virtual medical learning environments.

1.2. Patient simulations

Simulations are replications of the “real world” setting to model the environment, resources needed, and people involved so as to offer a context in which professionals can train or test procedures without placing individuals at risk or injury. It is particularly valuable in situations that involve complex teamwork from different disciplines [4].

Experimental use of patient simulations in medical education has been going on for the past 25 years. The purpose of these simulations is to offer students a patient on whom they can practice medical history taking, physical examination, laboratory and functional tests ordering and assessment, inferring differential diagnoses and treatment planning. A student is provided with different kinds of feedback generated within the virtual learning simulation environment. The feedback is dependent on the performance of the student and the state of the patient (that is influenced by the actions undertaken by the student). Patient simulations can be static, dynamic or virtual and virtual learning environments can be distinguished on the kind of patient simulation they offer [5].

For the past years static patient simulations have been the most frequently used form in medical computer based training. The purpose is mainly teaching students to ask the relevant questions and to order relevant tests in the context of a patient’s medical condition. Besides that, the aim is teaching students to recognize abnormal findings and to infer a diagnosis, followed by an appropriate treatment plan. An example of a static patient simulation is the DDXTx program developed at the University of Iowa. This system solidified the concept that student “doctors” can ask the computer-based, simulated patient a question after which the student receives an answer of the “patient” [6].

In contrast to static patient simulations, dynamic patient simulations allow students to perform a vast range of medical procedures such as medical history taking, physical examination, ordering and reviewing of laboratory tests, requesting additional investigations and planning for treatments. Besides, dynamic patient simulations allow a patient’s condition to change over time. This enables pressuring students into making decisions during a simulation. An example is the Minnesota Virtual Clinic, a web-based educational tool for simulating patients representing a variety of conditions and cultural backgrounds exposing students to critical basic science and clinical concepts in the context of patient care [7]. Such a process of independent decision-making is something a student or resident hardly ever gets round to in medical practice [8].

Virtual patient simulations make use of virtual reality (VR). VR is a computer technique that simulates reality as truly as possible through the use of a VR-helmet or a data glove. This technique would allow the simulation of an actual physical examination or even surgical procedures on virtual patients. For now VR is a technique that is not yet commonly used in medical education. Yet, one of the first examples is the Virtual Interface (VHI) system: virtual patients appear in a virtual reality environment featuring full panoramic backgrounds, animated 3D objects, behaviour and AI models to create real-time patient–doctor interactions for educational purposes [9].

Because VR still is an expensive technique, nowadays dynamic patient simulations are most commonly used in medical education.

1.3. The project

In a 2 year joined project sponsored by the Dutch government, the Academic Medical Center at the University of Amsterdam and the Leiden University Medical Center made use of the Dynamic Patient Simulator® (DPS) to train medical students in inter-physician communication skills. The purpose of the pilot project was to examine whether DPS would be an appropriate method for training medical student in inter-physician communication.

The project raised the following questions:

- Do students feel that they have improved their skills in different aspects concerning the transfer of a patient referral after participating in the DPS educational environment?
- How do students evaluate the usability of the DPS program?
- Are students satisfied with education in inter-physician communication training by use of DPS?
- Do students recommend education in inter-physician communication by use of DPS to be incorporated in the medical curriculum?

These addressed issues will be described and discussed in the following sections.
2. Materials and methods

2.1. Dynamic Patient Simulator®

DPS is a computer program developed at the Leiden University Medical Center for creating and running patient simulations [8]. A screenshot of DPS is displayed in Fig. 1.

On the right part of the screen, the patient scenario is presented. The left part shows the students’ navigation buttons and allows students to perform a vast range of medical procedures such as medical history taking, physical examination, ordering of and reviewing of laboratory tests and additional investigations and the planning of treatments. The engine of DPS simulates the state of a patient over time. Due to the dynamic nature of DPS, symptoms of a patient’s disease may change over time; they may deteriorate or disappear according to the actions undertaken by the student. In running a simulation the students must be aware of the time delays of requested tests and therapies as occurring in daily practice, which should have an impact on their decision-making.

DPS can be used for most kinds of clinical simulations, varying from emergency situations (lasting less than a half hour), up to simulations of patients of whom the care process may extend over several years.

DPS makes use of a database (MS Access or MS SQLServer). The state of the patient and all actions performed by the student are continuously logged into this database. This enables DPS to comment on a student’s action and to provide a student with personal feedback and with a final score. This score, presented to a student during and at the end of a simulation, expresses a student’s competence in treating a virtual patient. DPS is equipped with a dynamic help system that can be triggered by different means; for instance at a predefined time lapse, in circumstances that the state of the patient is (becoming) critical, or on the student’s request. The assistance offered by DPS is based on the actual state of the patient at that specific moment in time and on the earlier actions performed by the student.

To enable the use of DPS by two students at different physical locations, the Academic Medical Center at the University of Amsterdam and the Leiden Academic Medical Center, we created an inter-physician communication module and integrated it in the existing DPS program [10]. In this module multiple types of communication have been made possible, such as the transfer of collected evidence on a patient, consultancy with fellow physicians, and the formulation of treatment strategies including the further collection of required evidence, patient assessments and interventions.

Simulations in this adapted version of DPS are performed by two medical students forming a team responsible for the treatment of the virtual patient. Each student has a different role in the treatment process. For example, during a case the first student acts as a cardiologist and the other student plays the role of a surgeon. They visit the virtual patient asynchronously, report their findings and treatment plan in the electronic referral form integrated into DPS. As
a team they are responsible for the treatment of the virtual patient.

The referral form in DPS represents the chronological steps undertaken by clinicians in their clinical reasoning process for interpretation of a clinical case [11,12]. During clinical problem solving, clinicians cluster patient findings that are potentially relevant to the diagnostic task, into patient problems. Then a differential diagnosis constituting one or more patient problems is inferred from these clusters on the basis of which a clinician decides on next actions. The referral form of DPS is shown in Fig. 2:

- Collecting activating patient findings; patient data which determine the episode of disease of the patient.
- Constructing a list of problems; a problem constitutes one or more activating findings.
- Constructing a differential diagnosis; a diagnosis constitutes one or more problems.
- Constructing an action plan; a treatment plan or consult question to the colleague student. The action plan is also e-mailed to the student who takes over the patient.

At the end of a simulation students have to assess their colleague on different aspects of a patient data transfer, such as completeness, validity and timing of the patient data. For each student, an overall communication score is calculated on the basis of these sub scores.

We developed and implemented 20 patient cases to train medical students in inter-physician communication. In order to allow several patient transfers between the students, the cases were especially designed to be played in real time mode. The cases lasted about 5 days, depending on the actions undertaken by the students.

2.2. Pilot study

To evaluate whether DPS would be an appropriate method for training medical students in inter-physician communication, a pilot study was conducted in which a total of 134 fifth-grade medical students participated: 70 students from the Leiden University Medical Center and 64 students from the Academic Medical Center - University of Amsterdam. None of the students was familiar with the DPS program nor had participated in any other form of inter-physician education. At the beginning of the pilot, all students received a short oral instruction of the program. Ten out of the 20 patient cases were at random included in the pilot. Table 1 shows a description of the cases used in the pilot. Each student was randomly assigned two patient cases which were linked to a fellow student in the other institution. They were instructed to treat these two patients within a week and to use the program at least once a day. The geographical distance and the fact that the students did not know each other ensured that they could only communicate through the electronic referral form of DPS.

We used questionnaires for collecting evaluation data using a five-point Likert scale. Each item was rated as follows: 1 = strongly disagree; 2 = disagree; 3 = undecided; 4 = agree; 5 = strongly agree. Before and after performing the two patient simulations each student filled out a questionnaire, self-evaluating their skills on different aspects concerning their competence of:
constructing a list of activating patient findings;
• constructing a list of patient problems;
• constructing a differential diagnosis;
• constructing an action plan;
• executing the action plan of a colleague.

After the two patient simulations the students filled out an additional questionnaire assessing the usability of the DPS program and evaluating the education in inter-physician communication training by use of DPS using a five-point Likert scale. Each item was rated as follows: 1 = strongly disagree; 2 = disagree; 3 = undecided; 4 = agree; 5 = strongly agree. Besides, students were asked to indicate whether they had any additional comments with regard to the navigation structure, user-interface and referral form in DPS using free-text questions.

### 2.3. Statistical analysis

To determine the students perceived knowledge gain in inter-physician communication before and after use of DPS, we used the Wilcoxon Signed Rank test. The data from the student’s evaluation ratings were summarized using descriptive statistics (means and standard deviations). Statistical computations were obtained using copyright©SPSS for Windows, 12.0.1, and Microsoft® Excel 2003.

### 3. Results

All of the 134 students took the pre- and posttest, and the additional questionnaire assessing the usability of the DPS program and evaluating the education in inter-physician communication training. At the beginning of the pilot the students’ self-evaluation indicated confidence in constructing a list of activating findings, a list of patient problems, a differential diagnosis and executing an action plan from a colleague. Mean ratings for each question in the pre-test ranged from 3.13 to 3.97 with an average rating of 3.56 (±0.34) for all 5 items, as shown in Table 2.

After performing the two patient simulations the students’ self-evaluation indicated confidence in constructing a list of activating findings, a list of patient problems, a differential diagnosis and executing an action plan from a colleague. Students’ self-evaluations showed less confidence in constructing an action plan.

Mean ratings for each question in the post-test ranged from 3.58 to 4.30 with an average rating of 3.91 (±0.28) for all 5 items, as shown in Table 2.

Analysis of the pre- and post-test results demonstrated statistically significant progression (P < 0.05, Wilcoxon Signed Ranks Test) in the students’ perception of their skills in:

• constructing a list of activating patient findings (P = 0.000);
• constructing a list of problems (P = 0.000);
• constructing a differential diagnosis (P = 0.000);
• constructing an action plan (P = 0.000);
• executing the action plan of a colleague (P = 0.000).

Fig. 3 shows the distribution of students’ answers in percentages over the different aspects of a patient transfer before and after performing the two patient simulations.

All of the 134 students filled out the additional questionnaire evaluating the DPS program on its usability and the students’ satisfaction of education in inter-physician communication training by the use of DPS.

As shown in Table 3, students indicated that the user navigation structure of DPS was clear.

The average rating was 4.31 (±0.31). None of the students had additional comments with regard to the user navigation structure. The screen lay-out of the DPS program was clear.

### Table 1 – Description of the cases used in the pilot, including the diagnosis and students’ roles

<table>
<thead>
<tr>
<th>Cases</th>
<th>Description</th>
<th>Diagnosis</th>
<th>Students’ roles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case 1</td>
<td>A 73-year-old man with abdominal pain and a myocardial infarction in medical history</td>
<td>Cholecystitis</td>
<td>Internist, surgeon</td>
</tr>
<tr>
<td>Case 2</td>
<td>A 34-year-old woman with chronic ulcerative colitis and bloody diarrhea</td>
<td>Toxic megacolon</td>
<td>Gastroenterologist, surgeon</td>
</tr>
<tr>
<td>Case 3</td>
<td>A 45-year-old woman with abdominal pain, diarrhea and fever</td>
<td>Diverticulitis</td>
<td>Surgeon, internist</td>
</tr>
<tr>
<td>Case 4</td>
<td>A 17-year-old girl who fell off her scooter and has a head wound</td>
<td>Epidural hematoma and a splenic rupture</td>
<td>Trauma surgeon, neurologist</td>
</tr>
<tr>
<td>Case 5</td>
<td>A 70-year-old man with palpitations</td>
<td>Atrial fibrillation</td>
<td>General practitioner, cardiologist</td>
</tr>
<tr>
<td>Case 6</td>
<td>A 31-year-old woman with chronic sinusitis, rhinorrhea and a headache</td>
<td>Chronic sinusitis; an ethmoidectomy is necessary</td>
<td>ENT specialist, neurologist</td>
</tr>
<tr>
<td>Case 7</td>
<td>A 53-year-old man who vomits blood</td>
<td>Bloody esophagus varices caused by portal hypertension and alcoholic cirrhosis</td>
<td>Internist, internist</td>
</tr>
<tr>
<td>Case 8</td>
<td>A 49-year-old woman with a thickening in the breast</td>
<td>Metastatic breast cancer</td>
<td>Surgeon, surgeon</td>
</tr>
<tr>
<td>Case 9</td>
<td>A 46-year-old man with pain in the left kidney region and colic</td>
<td>Urinary tract infection with sepsis caused by a kidney stone</td>
<td>Urologist, urologist</td>
</tr>
<tr>
<td>Case 10</td>
<td>A 65-year-old woman who fell off her chair during dinner</td>
<td>Vertebrabasilar ischemia</td>
<td>Neurologist, internist</td>
</tr>
</tbody>
</table>
### Table 2 – Mean of students’ self-evaluation of their skills in different aspects of a patient transfer before and after performing two patient simulations using a five-point Likert scale questionnaire

<table>
<thead>
<tr>
<th>Question</th>
<th>Before Mean (M)</th>
<th>Before Standard deviation (S.D.)</th>
<th>After Mean (M)</th>
<th>After Standard deviation (S.D.)</th>
<th>Before–After P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constructing a list of activating findings</td>
<td>3.97</td>
<td>0.52</td>
<td>4.30</td>
<td>0.63</td>
<td>0.000</td>
</tr>
<tr>
<td>Constructing a list of problems</td>
<td>3.78</td>
<td>0.52</td>
<td>4.07</td>
<td>0.52</td>
<td>0.000</td>
</tr>
<tr>
<td>Constructing a differential diagnosis</td>
<td>3.57</td>
<td>0.54</td>
<td>3.82</td>
<td>0.60</td>
<td>0.000</td>
</tr>
<tr>
<td>Executing an action plan of a colleague</td>
<td>3.13</td>
<td>0.63</td>
<td>3.58</td>
<td>0.72</td>
<td>0.000</td>
</tr>
<tr>
<td>Total</td>
<td>3.56</td>
<td>0.34</td>
<td>3.91</td>
<td>0.28</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Each item was rated as follows: 1 = strongly disagree; 2 = disagree; 3 = undecided; 4 = agree; 5 = strongly agree.

![Self-assessment](image)

**Fig. 3** – Percentages of students’ self-evaluation of their skills in different aspects of a patient transfer before and after performing two patient simulations.

### Table 3 – Mean of students’ evaluation of the DPS program and the education in inter-physician communication training using a five-point Likert scale questionnaire

<table>
<thead>
<tr>
<th>Questions</th>
<th>Mean (M)</th>
<th>Standard deviation (S.D.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The user navigation structure of the DPS program is clear</td>
<td>4.31</td>
<td>0.32</td>
</tr>
<tr>
<td>The screen lay-out of the DPS program is clear</td>
<td>4.18</td>
<td>0.38</td>
</tr>
<tr>
<td>The structure of the referral form in DPS is clear</td>
<td>4.07</td>
<td>0.59</td>
</tr>
<tr>
<td>I am satisfied with education in inter-physician communication using DPS</td>
<td>4.33</td>
<td>0.66</td>
</tr>
<tr>
<td>I recommend education in inter-physician communication using DPS to be incorporated in the medical curricula</td>
<td>4.16</td>
<td>0.89</td>
</tr>
</tbody>
</table>

Each item was rated as follows: 1 = strongly disagree; 2 = disagree; 3 = undecided; 4 = agree; 5 = strongly agree.

Electronic referral form in DPS was clear (4.07 ± 0.57). None of the students had any additional comments.

Students were satisfied with education in inter-physician communication using DPS (4.33 ± 0.66). Students recommended education in inter-physician communication using DPS to be incorporated the medical curricula (4.16 ± 0.89).

The students did not encounter significant difficulties in using DPS and although students were instructed to start the program at least once a day, many students logged in more often.

### 4. Discussion

In a pilot study, we evaluated whether DPS would be an appropriate method for training medical students in inter-physician communication before DPS was to be implemented in the medical curricula of the Academic Medical Center – University of Amsterdam and the Leiden University Medical Center. We feel that overall the pilot was a success, especially since it was the medical students’ first experience with inter-physician communication training and with the DPS program. DPS as
educational method was evaluated positive by the students and was considered effective and relevant for their learning to communicate with fellow “physicians.” DPS as virtual learning environment can initiate students’ skills and opportunities they would not have in the traditional classroom, as well as enhance their confidence with the computer [13].

The dynamic character of the DPS program allows the simulation of real-life patient problems. As a result, the student can immediately see the effect of a therapy on the patient and learn to make decisions, for example in acute situations which requires immediate intervention and in which there’s no time to await test results. With simulation technology, students can gain and improve their skills in a safe, non-threatening, experimental environment also providing opportunities for decision-making, critical thinking, and team building [14]. Research has shown that for an effective simulation experience: (1) the user must have a trial-and-error experience with the patient; (2) the user must have unconstrained access to query and treat the patient; (3) anatomic and physiologic values in the patient must change appropriately in response to user actions; and (4) the user must be able to control certain time related aspects of a simulation [15]. DPS contains all these aspects. A phenomenological study indicated that computer based virtual patients have substantial emotional effects on medical students [16]. They feel responsible for the treatment of their virtual patient. This finding may explain the reason for students logging in DPS more often during our pilot study.

Through the use of DPS students also learn to define the domain of a specialty. Since the student takes on a certain role during a certain patient scenario, for example the role of a surgeon, the student has to decide whether certain examinations and therapies have to be undertaken by him or has to be referred to his colleague student, e.g. the other specialist. These choices are also to be made in daily practice [17].

Medical students often complain about the lack of contact they have with their instructors [18,19]. Moreover the growing numbers of medical students in relation to a low availability of instructors and real patients willing to participate in medical students’ skills education will add to students’ feelings of being thrown on their own resources. The use of virtual learning environments such as DPS in medical education may compensate for the low availability of teachers and patients, as these learning environments are instructor independent and provide the student with feedback, provide a dynamic help function and offer extended dialogues with students in real time.

DPS supports the use of multimedia, such as pictures, movies and sounds. In addition to these multimedia aspects, DPS integrates a web browser in its interface. This enables direct links in the program to a variety of additional information resources such as tutorials, literature references and other web-based virtual learning programs which makes students even more independent of instructor time and stimulates an active learning attitude of students.

Our study has limitations too. First we only assessed whether students felt they improved their skills in different aspects concerning the transfer of a patient referral form after participating in the DPS pilot. We did not assess whether students actually improved their communication skills. Further research is needed to evaluate whether medical students actually enhance their inter-physician communication skills through the use of DPS and whether the use of DPS has a surplus value in comparison with education in writing a referral letter from a paper patient scenario.

Secondly, a comparison with “real life” patients could not be done, because inter-physician communication training was never before implemented in the medical curricula of Amsterdam and Leiden. It is therefore unclear if DPS scores better, worse or equal in comparison with “real life” patients as a method for training medical students in inter-physician communication.

Thirdly, we did not analyze the quality of the patient referral forms that students sent each other during the pilot, e.g. on completeness, validity and timing with regard to the patient findings reported to the colleague student. These kinds of data would shed light on students’ progress in collecting and interpreting evidence and decision-making. Future research could focus on the evaluation of these aspects of the students’ patient referrals in DPS by experienced medical specialists. On the other hand, student peer-assessment seems an appropriate method for evaluating the quality of patient referrals, because students have to interpret and react on incoming referral notes like specialists have to in daily practice.

Besides for education in inter-physician communication for which we used DPS in the pilot study, DPS can also be used for education in clinical reasoning. The aim of clinical reasoning is to come to a diagnosis and treatment plan, based on a patient’s symptoms [11]. Clinical reasoning is a complex, cyclic process: The gathered (activating) patient findings have to be translated into a list of patient problems. One or more of these problems constitute a differential diagnosis. The differential diagnosis has to be confirmed with laboratory tests or further examination. From this follows new activating patient data and the clinical reasoning cycle starts again until the final diagnosis remains [12]. The structured referral form in DPS corresponds to these subsequent steps in the clinical reasoning process. Clinicians yet are faced with the difficulty of filtering large quantities of patient information and incorporating evidence to infer an accurate diagnosis and therapeutic decision. This hypothesis generation and clinical reasoning differ as a function of prior medical knowledge and expertise and problem difficulty, leading to medical students applying a different approach to resolve inconsistent evidence than more expert clinicians [20,21]. These findings have implications for DPS as a tool in training medical students in clinical reasoning. Although the structured referral form in DPS offers students a step-by-step guidebook for clinical reasoning to make the appropriate decisions, the evidence presented by DPS to the students yet would have to be adapted to a students’ level of expertise and medical background knowledge. To help medical students in making appropriate decisions, this evidence could be integrated with heuristics suggesting higher level hypotheses covering a more fully range of potential problems in a patient [21]. This would require the development and integration of a tool into DPS that would generate a model of each individual student during his/her interaction with DPS, representing a student’s medical background knowledge and level of expertise on the basis of which DPS could suggest more accurate hypotheses to the student.
Our study suggests that virtual learning environments should be more widely implemented in medical settings so as to increase students’ competence, acceptance and awareness of education in inter-physician training. In reporting on our first experiences with DPS, we hope to contribute to future initiatives focusing on implementing virtual learning aids in medical environments. More specific, we hope to have provided useful information to future initiatives of medical education in inter-physician communication training, helping faculty to adapt to developments in modern medicine, as well as to the needs and demands of future medical students.

5. Conclusions

The Dynamic Patient Simulator seems an appropriate method for training medical students in inter-physician communication training. In our study, students felt they improved their skills in different aspects concerning the transfer of a patient referral form after participating in the education with DPS. Students evaluated the usability of the program, consisting of the user navigation structure, screen lay-out and referral form, positive. Besides, students were highly satisfied with the education in inter-physician communication training using DPS and recommended communication training with DPS to be a part of the medical curricula.

Although further research is needed to establish if these first results are based on real facts, both the Leiden University Medical Center and the Academic Medical Center decided to incorporate this form of training into their medical curricula on a regular basis. Every 2 weeks 20 fifth-grade medical students from Amsterdam and Leiden attend education in inter-physician communication. Each student is randomly assigned two patient cases which are linked to a fellow student in the other institution. They treat these 2 patients within a week and use the DPS program at least once a day.

REFERENCES