Technological Training Programs to Train Healthcare Providers' Communication Skills – A Literature Review

Sophie Muhle

University of Twente, Enschede

Dr. C.H.C. Drossaert
Dr. E. Taal

University of Twente
Enschede, Netherlands

S. Stuij, MSc
Dr. N. Labrie

Academic Medical Center
Amsterdam, Netherlands

Abstract

Patient-provider interaction is an important aspect of quality care provision. Yet, healthcare providers are not adequately equipped with the relevant skills in order to meet the patient's needs. Therefore, communication skills training is needed. This literature review focuses on available technological training programs, as technology has many advantages and is on the rise as a supportive measure of trainings in general. Studies were included when (1) they described the evaluation of a training aimed at teaching communication skills, (2) the training involved technology, and (3) the training was targeted at (prospective) healthcare providers. A small number of training programs (i.e. thirteen) was identified and examined in terms of various training characteristics and in terms of satisfaction and effectiveness (i.e. performance, confidence, knowledge, and empathy). Ten of the reviewed studies reported a process evaluation, which revealed that participants appreciated the communication skills training programs and especially the value of face-to-face components was stressed. The majority of the nine training programs with an effectiveness evaluation demonstrated increased communication performance, confidence and knowledge levels. However, the present literature review is of low quality, as it was conducted by just one researcher without a pre-established review protocol. Another limitation is that most of the reviewed studies were of low quality. It can still be concluded that blended learning approaches were highly valued by the participants and that the combined effects of different training strategies are promising. However, the reviewed training programs did not completely rely on the existing evidence. Future research that builds upon existing evidence is needed in order to examine the best practice to train healthcare providers' communication skills.

Introduction

Patient-provider interaction is an important aspect of quality care provision, as it is essential for diagnosing and treatment planning (De Haes & Bensing, 2009). Studies have demonstrated various positive effects of adequate patient-provider interaction, such as increasing treatment compliance, satisfaction with the encounter, the patients' coping capabilities, and cooperation (Bredart, Bouleuc, & Dolbeault, 2005; Gaston & Mitchell, 2005). Moreover, communication is the means of the doctor to provide individualized care and to fulfill his supportive and coaching role (Bolman, 2010).

De Haes and Bensing (2009) provide a framework that defines six goals of medical communication. (1) *Fostering the relationship(s)* aims at establishing a good relationship between the patient and the healthcare provider and is the essential basis for the quality of healthcare. (2) *Gathering information* about the patient's symptoms, experiences, and expectations is necessary in order to establish an adequate diagnosis and treatment plan. (3) *Providing information* is important in order to clarify the patient's symptoms and to reduce uncertainty. (4) *Decision making* is about involving the patient in the care process (De Haes & Bensing, 2009). (5) *Enabling disease & treatment related behavior* aims at supporting and promoting the patient during the long-lasting care process, which sometimes requires the patient to adjust his/her lifestyle (Bolman, 2010; De Haes & Bensing, 2009). (6) *Responding to emotions* is a relevant task of the healthcare provider, since the disease process may evoke emotions such as anxiety, anger, and fear (De Haes & Bensing, 2009).

Studies provide evidence that these functions have positive effects on the care process. Better provision of information can enhance the patient's coping capabilities by giving a sense of control, reducing anxiety, improving compliance, and creating realistic expectations (Gaston & Mitchell, 2005). Shared decision making is associated with better treatment adherence, satisfaction from the consultation, and health (Gaston & Mitchell, 2005). Further, empathy,

which involves responding to emotions, is highly valued by patients and important for individualized communication and care (Sari, Prabandari & Claramita, 2016).

Yet, studies also reveal that care providers do not address these functions of patient-provider interaction properly. Care professionals are reluctant to give a poor prognosis and rather are oriented towards giving information on treatment options (Gaston & Mitchell; Pardon et al., 2011), although a study by Hagerty, Butow, Ellis, Dimitry, and Tattersall (2005) revealed that early stage cancer patients prefer the prognostic information to be "presented in an open and honest manner" (Hagerty et al., 2005, p. 1050). Literature further suggests that healthcare providers often miss emotional cues presented by the patient (Levinson, Gorawara-Bhat, & Lamb, 2000).

A lack of skills might be the reason for healthcare providers not adequately addressing the goals of patient-provider interaction. Several studies have indicated that experience alone does not reliably result in the improvement of communication skills (Detering et al., 2014; Moore, Mercado, Grez Artigues & Lawrie, 2013). Therefore special training is required in order to equip doctors with the skills needed for adequate patient-provider interaction.

In order to improve care providers' communication skills, several training programs have been developed. Yet, the problem with existing training programs is that they are time-consuming, costly and on-site, without evidence for long-term effects (Moore, Wilkinson, & Rivera Mercado, 2004). Given the great time pressure physicians experience and their geographic distribution, these training programs do not reach the majority of practicing physicians. Cost-effective and flexible training programs need to be developed which can be integrated in the physician's schedule in order to maintain effective time management.

Technological training programs possess several advantages and can help overcome the problems with traditional communication skills training programs. At first, they have the potential to be time-saving and cost-effective. Secondly, their use is more attractive and more likely as it can be integrated easily in everyday life, e.g. in the form of applications for mobile

devices which have great functionality and utility (Cowan et al., 2012; Norman et al., 2007). In the third place, "learners [might] gain knowledge, skills, and attitudes faster" with technological training compared to traditional training. (Ruiz, Mintzer, & Leipzig, 2006, p. 208). Fourthly, it allows for the shift from teacher-centered to more interactive, learner-centered learning, making it more interesting (Ruiz et al., 2006). Finally, technological trainings can be designed according to certain design principles such as information tailoring aimed at personalizing the intervention (Norman et al., 2007).

Technological training can be referred to as e-learning. e-Learning broadly refers to the use of Internet technologies aimed at improving certain skills or to provide information (Ruiz et al., 2006). There also is the possibility of combining e-learning with traditional on-site learning, called blended learning. Blended learning then integrates asynchronous e-learning, which is independent of time and space, and synchronous on-site learning, which is facilitated at a fixed time by an educator (Clark & Mayer, 2016).

These training programs vary significantly in the extent to which they are interactive. Ferriman (2013) proposes three, progressive levels of interactivity in e-learning: (1) text driven, (2) interactive, and (3) simulation. Text driven e-learning includes mainly text and graphics, with the purpose to present the information and to test understanding by means of questions. Interactive e-learning is similar to text driven, only with a greater emphasis on interactive components often combined with videos. The highest interactivity is conveyed in simulation e-learning by means of "graphics, video, audio, and some level of gamification" (Ferriman, 2013).

Highly interactive simulation e-learning involving gamification is called a serious game. The purpose of serious games is not merely entertainment, but also education (Susi, Johannesson, & Backlund, 2007). It can provide an environment for real interaction allowing professionals to train social interactions in an enjoyable manner (Bartolomé, Zorrilla, & Zapirain, 2011).

Although e-learning is increasingly applied in the context of medical education, there is

a lack of research concerning its usefulness and effectiveness for specific health care domains (Graafland et al., 2014; Lewis, Cidon, Seto, Chen, & Mahan, 2014). The present literature review aims (1) at identifying which technological training programs designed to improve care provider's communication skills exist (i.e. the goal and target group, the patient-provider interaction functions (PPI-functions) addressed, the intensity, the mode of delivery, the type of training, the training strategies applied, and the provision of feedback) and (2) at reviewing their usability and effectiveness.

Method

Search terms

The aim of this literature search was to identify and compare studies which evaluated technological training programs aimed at improving healthcare providers' communication skills. Therefore, the following databases were searched: Scopus, Web of Science, PubMed, and Google Scholar. The primary word string connected by the Boolean operator OR was: "doctor patient communication" OR "patient provider interaction" OR "patient provider communication". In order to narrow this initial search, further terms were added by means of the Boolean operator AND: "e-learning" / "serious game" / virtual AND improve / virtual AND intervention. As this search generated only a limited number of articles, a second, broader word string was used: doctor OR physician OR "care provider" OR "medical student". This was in turn narrowed with the following terms: "e-learning" AND "communication skills" / "e-learning" AND "communication skills" AND train* / "blended learning" AND "communication skills" / "serious game" AND "communication skills".

Inclusion and exclusion criteria

The inclusion and exclusion criteria applied were broadly formulated due to the limited number of studies available in this context. Studies were included when (1) they described the

evaluation of a training aimed at improving communication skills or when communication skills were only part of the trained skills, and when (2) technology as means to train communication skills, e.g. virtual reality, was applied. Studies were included if they targeted healthcare providers, defined as people who help in identifying, or preventing, or treating illness or disability. As medical education is mostly part of the undergraduate and postgraduate studies, prospective healthcare providers (e.g. medical students) were also included in the target group. Studies not written in English were excluded. Due to the recent and rapid progress in the field of technology, studies published before the year 2010 were also excluded. Finally, studies were excluded when they did not provide a detailed description of the employed training (i.e. no training methods), because this rules out the possibility of replication of certain methods or of the intervention as a whole if successful.

Study selection

The initial search string was entered and according to the number of results the complementing search terms were added in order to narrow the results. This resulted in a total number of 342 records. Records were immediately excluded if not written in English or if they were book chapters. The remaining studies were screened for relevant titles, which in turn were evaluated based on the abstract. After this preliminary screening, 276 studies were excluded. The remaining 66 studies were then screened full-text. After application of the exclusion criteria, 13 studies remained.

Data extraction

Extracted data concerned the training characteristics and the study characteristics. The training characteristics included goal and target population, PPI-functions, intensity, mode of delivery, type of training, training strategies, and feedback. The goal and target population described the aim of the training and for whom it was intended. The PPI-functions of the training programs were categorized according to the six-function model of medical communication by De Haes and Bensing (2009). The intensity of the training was subdivided

into the duration and the number of sessions. The mode of delivery specified the medium used to present the training (i.e. computer and face-to-face). The feedback category provided information about how feedback was delivered.

The study characteristics included study design, number of participants (n), the conducted measurements (data and instruments based on which the training was evaluated), the obtained outcome measures and results (1) related to the effectiveness of the training and (2) related to the usability and satisfaction with the training.

Results

Training characteristics

The training characteristics are displayed in table 1 (see Appendix A). In the table, numbers (1-13) were ascribed to the training programs, which were used to refer to the training programs in the following.

Goal and target population. The 13 studies described and evaluated 13 different communication skills training programs. The general target populations of all programs were medical students (1;2;3;4;9;11), both medical students and student teachers (10), speech pathology students (7), resident physicians/doctors-in-training (5;12), general practitioners (5;6;8;13), or nurse practitioners (8).

Most of the training programs aimed directly at improving participants' general communication skills, but they differed in focus. There were two training programs that set the goal to broadly train communication skills without further specification (4;7). The training presented by Aper, Reniers, Koole, Valcke, and Derese's (2012) aimed at familiarizing students with the different parts of a consultation and at increasing their self-efficacy beliefs regarding their involvement in these parts (2). Another training paid special attention to the affective responses evoked by consultation simulation with a virtual patient with a greater emphasis on

exploring the learning experience than the skills training (3). Besides training communication skills, one training additionally focused on nonverbal behavior while providing a system able to process and report vocalics (i.e. volume, pitch, turn-taking patterns, and speaking ratio) and body movement behavior (9).

Seven training programs based their goals on specific communication strategies. Two training programs aimed at enhancing participants' competency in giving bad news, which is a relevant but stress-provoking task for healthcare providers (6;11). Schmitz, Schnabel, Stricker, Fischer, and Guttormsen (2017) further provided the six-steps SPIKES framework for effective delivery of bad news to patients (11). Another training provided the model "health-oriented negotiation" for effective patient-provider interaction in general (1). Advance care planning was also a targeted communication strategy in one training (5) and is defined as "a process of decision making that aims to help patients establish decisions about future care that take effect when they lose capacity" (Mullick, Martin & Sallnow, 2013, p.1). Decision making is addressed in another training, which generally aimed at preparing participants for leading professional shared decision making conversations (10). One training focused on pain assessment and counselling, in order to enhance "resident physicians' ability to treat pain in a responsible manner" (Langenau, Kachur, & Horber, 2014). According to Mitchell et al. (2011) motivational interviewing (MI) is the most widely studied approach in patient-centered communication and this approach therefore served as a basis for their training (13).

One training did not directly train communication skills, but aimed at "[enhancing] the quality of antibiotic prescribing and raise awareness about antibiotic resistance among general medical practitioners" (Bekkers et al., 2010, p. 1). In doing so, it also trained participants in certain core tasks which can be associated with the function information gathering from the six functions of medical communication framework by De Haes & Bensing (2009) and which also is an important communication skill for healthcare providers.

PPI-functions addressed. The training programs addressed two or three different

functions as presented by De Haes and Bensing (2009), except for one training which only focused on *gathering information*, which might have been due to the specific context of the training, since it aimed at enhancing the quality of antibiotic prescriptions (8).

Fostering the relationship(s) was addressed most frequently by nine training programs (1;3;4;6;7;9;10;12;13). The goal of the function is a "good and effective relationship", which is according to De Haes and Bensing (2009) the essential basis for adequate patient-provider interaction. Another important function that was frequently addressed was *responding to emotions*, addressed by seven training programs (1;3;4;6;7;11;13). *Gathering information* is an important skill in order to diagnose adequately and was addressed by five training programs (1;2;8;9;10). Four training programs addressed *enabling disease & treatment related behavior*, three training programs addressed *providing information* and two training programs addressed *decision making*.

Intensity and mode of delivery. The training programs varied in duration, though they were all short compared to traditional programs. For two training programs, the duration was not specified (6;8). One of them, however, was a serious game and consisted of three sessions within an overall period of eight weeks (Daetwyler, Cohen, Gracely, & Novack, 2010). It was independent of space and time and could be played as often as wished, with one game lasting seven minutes at most (1). Two training programs took less than one hour (4;9), with one of them consisting of two separate sessions (9). There were three training programs which took between one and two hours (2;3;11) and three training programs with a duration ranging from three to five hours (5;7;10). The Skype consultation training consisted of four 30-min encounters over a period of 8 weeks. (12). Another training also consisted of various sessions which were completed within a total duration of 8-10 hours (13).

Twelve of the thirteen training programs were delivered on a computer (1-6;8-13), with one of them additionally accessible on an android tablet (9). The remaining training was delivered on a HD flat screen television (7). Only one article states that the presented training

was asynchronous (1).

Four training programs additionally involved face-to-face delivery and are therefore blended learning training programs (5;7;8;10). One training involved a workshop with group discussion and role-play (5). Another training conducted the introduction and a debrief session face-to-face in small groups (7). The training presented by Bekkers et al. (2010) involved a face-to-face seminar conducted by a study trainer, who also facilitated a group discussion. Two training conditions in the study of Gartmeier et al. (2015) involved role-play and a group discussion.

Type of training. The training programs were subdivided into the three levels of interactivity as proposed by Ferriman (2013): (1) purely text driven training programs were not encountered, (2) merely interactive were four training programs (2;8;10;11), and (3) simulation was used in nine training programs (1;3;4;5;6;7;9;12;13). The simulation training presented by Kron et al. (2016) also involved an interactive e-learning component for reasons of comparison (4). When referring to this training hereafter, only the simulation e-learning training (MPathic-VR) is elaborated, as the interactive e-learning training presents the current standard. Below, the different training programs are discussed, first the interactive training programs, then the simulation training programs. A more detailed description of the training programs can be found in appendix C.

Interactive training programs. Of the four interactive training programs, one was incorporated in a blended learning setting (8) and one was comparing interactive e-learning with blended learning and traditional learning (10). The former was the STAR Educational Program which consisted of seven parts in total. Part 1 and 2 involved an online introduction, case scenarios, and latest evidence. Part 3 was an on-site, face-to-face seminar and part 4 consisted of video scenarios. In part 5 the clinicians were asked to reflect on examples from their own clinical practice. Part 6 was a web forum. Part 7 was a booster session provided approximately six month after the core program (8).

Gartmeier et al. (2015) compared four training conditions: (a) e-learning with video cases and role-play with video feedback combined, (b) only e-learning with video cases, (c) only role-play with video feedback, and (d) a wait-list control group. The e-learning component was interactive since it involved video cases of professional conversations and several exercises. Groups of learners then engaged in role-play and a group discussion (10).

Two interactive e-learning training programs focused on video-based examples as a main teaching strategy (2;11). One of them provided an interactive web environment with video fragments of simulated consultations (2). The learners answered open-ended questions about the video examples and received feedback afterwards. The other training first provided an introduction to the scenario and the theoretical background (11). Then video-based examples of either correct of erroneous consultations were displayed. The learners filled out a self-explanation prompt and received feedback.

Simulation training programs. The training programs with the highest interactivity involved the interaction with a simulated patient (an actor trained to play the role of the patient) or a virtual patient (a virtual conversational agent). The simulated conversations were either conducted through a video chat platform or in a virtual learning environment.

Three of the nine simulation training programs provided systems for leading simulated consultations through video chat with simulated patients (6;9;12). EQClinic was a tele-consultation system with a personal calendar for booking consultations and a feedback generator which gives various forms of feedback (9). Langenau et al. (2014) made use of the video chat software Skype as it is well-known and easy to use. The simulated patient assessed the learner and led a debriefing session (12). The DUCOM training combined the e-learning tool ‘doc.com’ and a WebEncounter platform (6). The e-learning module included reading material, annotated video scenarios, a behavioral checklist, and multiple choice questions. Before and after the e-learning module, the participants took part in WebEncounters, interacting with a simulated patient through video chat.

The most technologically advanced training programs were the six virtual patient simulation technologies delivered in a virtual learning environment (VLE) (1;3;4;5;7;13). These learning platforms provided the opportunity to lead a simulated conversation with a virtual or simulated patient in order to train communication skills. The virtual patient displayed different verbal and nonverbal responses depending on the learner's actions. One of the VLEs was a serious game with the learner's goal to identify as many symptoms as possible in a given time (1). Mitchell et al. (2010) made use of Second Life as a virtual world venue where the learners, from different places, could interact with each other and with a coach. The learners could also engage in a simulated conversation but the conversational partner is a simulated patient rather than a virtual patient (13).

Two of the VLEs were delivered in a blended learning setting. In the 'Next Steps' training program the e-learning component was the virtual patient simulation technology (5). The patient's responses were available in the form of video clips. After completing the e-learning component, the training continued with DVD scenarios, reading material, and a face-to-face workshop. The third training condition in the study by Quail et al. (2016) was a VLE for leading simulated consultations and it was facilitated by a clinical educator who decided which verbal and nonverbal reactions the VP should display, gave immediate feedback, and led a small group debrief session (7).

Applied training strategies. In the thirteen training programs, various training strategies were applied. These include (arranged by frequency of application) role-play, feedback, observation, information provision, assessment forms, reflection, interaction with students/teachers, group discussion, behavioral checklist, and individual coaching. Role-play was applied most frequently in ten training programs, either through video chat in a virtual environment, or through face-to-face (1;3;4;5;6;7;9;10;12;13). Except for two training programs (1;3), all training programs which involved role-play also provided feedback on the role-play activity. The training presented by Aper et al. (2012) also involved feedback but only

on the given answers. As feedback is an important means to guide the learning process and as the thirteen training programs varied in the ways feedback was provided, this training strategy is discussed below in more detail.

In seven training programs observation was used as a training strategy, either observing peers or video scenarios (2;5;6;8;10;11;13). One training did only provide a video recording of the learner's own behavior which could be observed in order to support the feedback (4). Information was provided in six of the training programs, either as reading material or by an educator (4;5;6;8;11;13).

Different kinds of assessment forms were used in several training programs (2;4;6;11;13). Three training programs used questions in the end of the training to assess the learner's understanding or performance (2;6;13). Kron et al.'s (2016) training also involved questions but as a means to assess the learner's readiness prior to the training (4). A self-explanation prompt was another kind of assessment form. Here, the learner elaborated a video example regarding its appropriateness and its consequences (11).

Reflection was used by four training programs, in which the learners actively reflected on their experiences (7;8;10;12). Three training programs provided debriefing sessions, either in a small group or with the simulated patient (7;12). In the training presented by Bekkers et al. (2010) the learners reflected on examples from their own clinical practice (8). The remaining training involved reflection with the role-play partners (10).

Feedback. Eleven of the thirteen training programs provided feedback to the learners, in various ways. Three training programs gave standardized feedback (2;11;13). In the training programs by Aper et al. (2012) and Mitchell et al. (2011) the feedback was given on the learner's answers to questions concerning video fragments and concerned the learner's knowledge (2;13). The need for individual feedback was less, as the answers could be right or wrong. Mitchell et al.'s (2011) training however additionally included individualized feedback. Also in the training presented by Schmitz et al. (2017) the learner did not actively engage in

role-play. Feedback was not given on the learner's performance, but on video examples. The video fragments were enriched with an evaluation of the displayed behavior.

The remaining training programs all involved the learner's active engagement in role-play activities. Feedback then was valuable in order to ensure a learning effect. There was one training that only provided one form of feedback (7), while the other training programs provided combinations of different forms of feedback (1;4;5;6;7;9;10;12;13). Two training programs provided the learner with his/her reached scores from the simulation technology and the annotated transcript of the conversation (1;5). Six training programs involved immediate, personalized, verbal feedback, either from the simulated patient or from peers and/or the trainer (4;6;7;10;12;13). Two training programs further provided the video recordings of the conversation for the learner to observe his/her own behavior (4;10). A behavioral skills checklist filled out by the SP with suggestions for improvement was given as feedback in two training programs (6;12).

Liu, Scott, Lim, Taylor, and Calvo (2016) incorporated a feedback generator in the training platform. The system processed and reported the nonverbal behavior of the learner. The simulated patient filled out an assessment form, gave comments and could further make use of a 'thumbs-up'/'thumbs-down' tool during the conversation.

Study characteristics and results

The study characteristics and results are presented in table 2 (see Appendix B).

Quality of the studies. Of the thirteen reviewed studies, there were only a few of high quality. A high quality study evaluating a training program should apply a randomized controlled trial design with a control group. There were four studies with a randomized controlled trial design (2;4;8;11), however only three of them conducted a control group condition (2;4;11) and only two of them conducted measurements at more than one point in

time (2;4). Measurements at two points in time are relevant for effectiveness evaluation and were either pre-/post-test designs, applied in five studies (2;5;6;7;13), or repeated measures designs, applied in two studies (4;9). The remaining studies were either multi-groups, post-only designs (10;11) or single-group, post-only designs (1;3;8;12).

A high number of participants is important in order to be able to make statements which are generalizable to the target population. Regarding the number of participants, a minimum of 35 participants per condition should be met, based on the checklist for quality assessment of interventions applied in the article by Henselmans, De Haes, and Smets (2012). This was the case in five of the reviewed studies (2;4;5;10;12).

The used questionnaires were often not described in detail, in many cases it thus remains unclear whether those were standardized instruments or not. However, in two studies it was indicated that the instruments were developed by the authors themselves (6;7). This reduced the quality of the studies.

Many studies examining training effectiveness, made use of self-reported measurements (not always exclusively) (2;5;7;9;13). These, however, gave only indication about the learner's subjective perception and no objective measurement of the learner's performance. When it comes to objective performance assessments, these were either conducted by a trained rater or by the training system itself. Schmitz et al. (2017) enhanced the quality of this measurement, by involving three trained communication experts who independently rated the learner's performance.

Taking into consideration the number of participants, the study design, the presence of a control group, and the measurements, two studies were conceived as high quality studies (2;4). These were the studies by Aper et al. (2012) and Kron et al. (2016), as they (1) involved more than 35 participants per group and a control group, (2) conducted a randomized controlled trial with either a pre-/post-test design or a repeated measures design, and (3) conducted an objective performance assessment.

Results of the studies. The studies differed in whether they evaluated the effectiveness and/or the usability and satisfaction with the training. The results are separately discussed below.

Usability and satisfaction with the training. Ten studies used questionnaires and observational data in order to evaluate the usability of and the satisfaction with the training (1;3;4;5;6;7;8;9;12;13). These were all nine simulation trainings, involving the highest level of interactivity, plus the STAR Educational Program.

In every study, the overall assessment of the training was positive. Yet, participants from four studies reported technical difficulties (1;8;12;13). In the study by Langenau et al. (2014) these difficulties were associated with the Skype software, including dropped calls or poor video and audio quality. Mitchell et al. (2011) made use of the virtual world-venue Second Life, which caused difficulties due to significant system requirements. The reported ease of use varied between the training programs, but the general indication was positive.

The educational value of the training programs was in general evaluated positively (3;4;6;8;12). Participants from these studies found the communication skills useful and expected a positive impact on their clinical practice.

The results showed that participants in the blended learning programs highly valued the face-to-face components (5;7;8). In the studies by Quail et al. (2017) and Mitchell et al. (2011) the value of the clinical educator who provided feedback was especially emphasized. The evaluation of the authenticity of the learning experience and the patient cases varied across studies. For the study by Courteille, Josephson, and Larsson (2014) this was positive, as participants perceived the patient case as trustworthy and also the virtual patient was perceived as a real patient. In the study by Ziebarth et al. (2014) however, the participants reported low emotional involvement and participants did not feel understood by the virtual patient. The participants in the virtual learning environment condition in Quail et al.'s (2016) study reported their training as least natural and realistic compared with the other conditions and reported

higher levels of anxiety. In this study, as well as in the study by Langenau et al. (2014), the participants preferred interacting with real patients.

Quail et al. (2016) compared the effects of a traditional training involving interaction with a real patient with a simulated conversation training and with a virtual patient simulation training. Although the virtual learning environment was perceived as less realistic, the three training conditions did not differ in terms of perceived usefulness of the learning activity and self-reported skill improvement. The virtual learning environment was further perceived as the most challenging learning condition, which was regarded positively in terms of professional development (Quail et al. 2016).

Effectiveness of the training. The training's effectiveness was evaluated in nine of the thirteen studies (2;4;5;6;7;9;10;11;13). Outcome measures were either an assessment of the participant's performance or self-reported performance evaluations.

The participant's performance was measured as the quality of the consultation, which was assessed by a simulated patient or by an independent rater in eight studies (2;4;5;6;9;10;11;13). Except for the study by Liu et al. (2016), all studies with a pre-/post-test design or a repeated measures design, demonstrated a significant improvement in performance between the two measurements. In the high quality study by Kron et al. (2016), the participants trained with the consultation simulation training MPathic-VR performed significantly better, than the participants trained with a standard computer-based learning module. The results presented by Gartmeier et al. (2015) indicate that the video-based learning training was more effective in increasing participant's performance scores than the training condition only involving role-play. However, these two training approaches combined yielded significantly better results than independently. In the study by Schmitz et al. (2017), comparing the effects of correct versus erroneous video examples, the erroneous video examples proved to be more effective in improving communication performance.

Self-reported measurements were conducted in five studies (2;5;7;9;13) and involved

the following outcome measures: confidence, knowledge, attitudes, communication skill, and empathy. In general, the training programs resulted in an increase in self-reported confidence, knowledge, and communication skill. However, in the high quality study by Aper et al. (2012), only participants exposed to the autonomous training demonstrated significantly increased confidence scores. Quail et al. (2016) only found increased self-reported empathy levels in the traditional training condition and not in the other two training conditions.

Discussion

Summary of the main findings

Thirteen technological training programs designed to improve care provider's communication skills were identified. The training characteristics (i.e. the goal and target group, the PPI-functions addressed, the intensity, the mode of delivery, the type of training, the applied training strategies, and the provision of feedback) and the usability, satisfaction and effectiveness of the training programs were examined.

The training programs varied across the examined characteristics, still the present study revealed a number of global trends. Most of the studies presented training programs targeted undergraduate medical students and not practicing care providers. All training programs were short in duration and mostly conducted in one session, this is in contrast to traditional training programs which are often delivered over multiple days (Mitchell et al., 2011). Except for one, all training programs were delivered on a computer and in most of the cases the systems were highly interactive involving conversation simulations.

Concerning the satisfaction, only a few recurring findings were identified, since the reviewed training programs applied different approaches in terms of realization and evaluation. The overall assessment of all training programs was found to be positive. The training programs were reported to have educational value and especially the face-to-face components were

appreciated. In some cases, the virtual patient simulation was perceived as unrealistic and was therefore valued less than traditional personal interaction.

Every study that examined the effectiveness was able to demonstrate a learning effect. This learning effect was either demonstrated by a significant improvement in the experimental group(s) as opposed to the control group, or by a significant improvement between the pre- and post-test on at least one of the measured variables. From the studies measuring the learner's performance, except for one, all training programs resulted in improved communication performance. The training programs also generally increased levels of confidence and knowledge.

These results, however, need to be interpreted in the light of the quality of the studies. Effectiveness evaluations are best conducted using a randomized controlled trial design with a pre- and post-measurement. Yet, of the reviewed studies, only two were of high quality employing a randomized controlled trial design.

General implications

Most of the reviewed training programs were developed in the context of undergraduate medical education. This finding reflects the acknowledged importance of and the need for communication skills training before starting to work in real practice. Literature suggests that medical students experience a need for intensive consultation skills training (Aper et al., 2012; Moczko, Bugaj, Herzog, & Nikendei, 2016). This need can be addressed by providing communication skills training programs which supplement the undergraduate compulsory courses. Training programs conducted online are therefore promising as they can be designed asynchronously – independent of time and space. This provides the opportunity for effective time management, as students can engage in the training whenever they find the time next to their studies.

The function most frequently addressed in the reviewed training programs was fostering the relationship(s). This corresponds with De Haes and Bensing (2009), who mention this function to be the essential basis for patient-provider interaction. The least frequently addressed functions were decision making and providing information. This was unexpected, since especially these two functions are intensively discussed in the literature. Shared decisions in the care process result in "better compliance with treatment and increased satisfaction from the encounter, in both patient and health care professional" (Gaston & Mitchell, 2005). Patients further perceive the need for accurate provision of information, since this reduces uncertainty (De Haes & Bensing, 2009; Pardon et al., 2011; Rainbird et al., 2009). It is therefore important that the existing literature and the needs of the patients are taken into account when developing communication skills training programs, in order to not miss out on important skills in medical communication.

Several studies indicate that the optimal length of a clinical communication skills training is unknown (Detering et al., 2014; Moore et al., 2013). As opposed to traditional communication skills training programs, the duration of the reviewed training programs was short, ranging from less than one hour to 8-10 hours. Mitchell et al. (2011) demonstrated that their 8-10 hour training was as effective as a 2-3-day face-to-face training and even the short training programs all demonstrated a learning effect. This finding, again, supports the applicability of e-learning modules which can be integrated in the daily routine without great time exposure, while still being effective.

Interestingly, the computer was used by twelve of the thirteen training programs as a medium for delivery. The remaining training was delivered on a HD-screen television. It was expected that recent developed training programs would make use of smartphones as a medium, due to their great functionality and utility (Cowan et al., 2012). Yet, many training programs involve virtual patient simulation and the small screen might result in a decreased conversation quality. Studies indicate that a larger screen has positive effects on variables associated with

learning, such as attention, level of immersion, emotional engagement, and reduced anxiety (Courteille et al., 2014; Reeves, Lang, Kim, & Tatar, 1999). Therefore, especially training programs involving patient simulation should ideally be conducted on a large screen, either a computer or a television.

Besides technology, four training programs involved face-to-face delivery and in all cases the face-to-face component was highly valued by the learners (Bekkers et al., 2010; Detering et al., 2014; Quail et al., 2017). This finding demonstrates that despite the technological progress, face-to-face interaction cannot be replaced and is of great value for the learning process. Yet, personal interaction generally results in synchronicity of the training. Depending on the purpose of the training, either face-to-face interaction for feedback and debriefing or asynchronicity for continuous accessibility of the training is of greater importance. This consideration is relevant in the development of a training.

The various types of trainings differed in their level of interactivity. Comparing the effects of a simply interactive training and a simulation training, it can be said that the more interactive simulation training was more effective and engaging for the learner (Kron et al. 2016). This is in line with the majority of the reviewed training programs being simulation training programs with the highest level of interactivity. Research thus currently focuses on more advanced training systems as opposed to less advanced and less effective systems.

The most frequently applied training strategy was role-play and in most cases, role-play was followed by individualized feedback. Role-play and feedback are effective and evidence-based training strategies when it comes to communication training (Berkhof, van Rijssen, Schellart, Anema, & van der Beek, 2011). Although the study by Berkhof et al. (2011) further suggests group discussion as an effective, evidence-based training strategy, this training strategy was only present in three of the reviewed training programs. This demonstrates that there are some major training strategies which are frequently applied, but that not all existing evidence is taken into account in the training development.

Most of the training programs involved conversation simulation as a role-play activity, either with a virtual patient or with a simulated patient. Many studies did not offer a detailed description of how the virtual patient system exactly worked. However, the patient's responses were elaborated in most of the cases. The patient's responses were either elicited by the system or by a clinical educator, and they were either presented in the system by means of a conversational agent or displayed in the form of pre-recorded videos of an actor. The latter was applied in the study by Courteille et al. (2014) and contributed mainly to the realism of the patient case as reported by the participants, who perceived the virtual patient as a real patient. However, in most of the reviewed studies, training with the virtual patient was perceived as not realistic and low levels of emotional involvement were reported (Quail et al., 2017; Ziebarth et al., 2014). Thus, the evaluation of the virtual patients varied across studies and in order to develop a realistic and acceptable conversation simulation technology, the learners' perceptions and needs need to be studied.

The present literature review provides indication for the irreplaceability of personal interaction in communication skills training programs. Participants generally indicated to prefer face-to-face interaction over a virtual patient encounter (Langenau et al., 2014; Quail et al., 2017). When comparing a traditional learning approach with a virtual learning environment, participants preferred the traditional program and reached higher empathy levels as compared to the virtual learning program (Quail et al., 2017). Thus, although virtual simulation technologies are assessed positively by the learners, these should not replace face-to-face learning in clinical communication skills training programs. A blended learning approach, combining the advantages of technology with traditional teaching strategies, therefore seems to be the key to success in this context. This is supported by the finding that participants from the blended learning programs especially emphasized the value of the face-to-face components (Bekkers et al., 2010; Detering et al., 2014; Quail et al., 2017). However, this does not exclude the need for an asynchronous learning system which can be used independently by the learner,

as such a system can be supplemented by face-to-face learning sessions in a blended learning setting. This way, the advantages of both approaches can be combined.

The positive impacts of a combination of different learning strategies is supported by Gartmeier et al. (2015) who demonstrated that the combined approaches are more effective in training communication skills than single-mode training programs. Multiple training sessions could facilitate the combination of different training strategies by constituting a blended learning communication training to be conducted over a longer period of time. Most of the reviewed training programs were, however, conducted in just one session, which might be due to greater convenience of evaluating one session in a study rather than various sessions. Still, it is important to research the combined effects of various training strategies and the effects of a long-term training program.

Unfortunately, most studies do not provide suggestions for improvement. The findings of the studies give indication about aspects that require improvement, yet it would be of greater value if these were elaborated in the discussion section in order to guide future research on the way to the best practice for training communication skills.

Limitations

In general, the present literature review was of low quality. There was no pre-established review protocol. Search terms were identified in advance, but then randomly combined depending on the search results. This can easily result in omission of relevant studies. Further, the identified studies were screened for eligibility by only one researcher. Therefore, inter-rater reliability is not given and bias is likely to result in neglecting possibly relevant studies. Besides that, the in- and exclusion criteria are less objective and less exclusionary, as one researcher might be uncertain about where to draw the line. In general, an unsystematic review may not

provide an accurate presentation of the existing technological training programs for healthcare providers.

Guidelines for future research

Research in this area is still in its early stages. Mostly exploratory studies are conducted to examine the usability and the applicability of communication skills training programs. The present literature review helps to synthesize the existing findings, so that future research can build upon these findings in order to facilitate progress in this field. Future research should focus on blended learning approaches, involving personal interaction, and examine the combined effects of various training strategies. It is recommended that studies provide a paragraph on suggestions for improvement, to let future research profit from their results and ideas. Further, future studies should conduct a randomized controlled trial with a control group that allows for accurate inferences about a training's effectiveness. This is necessary in order to accomplish the step from exploratory research towards research which examines (long-term) effectiveness, implications for the patients, and practical relevance.

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Appendix A

Table 1

Training characteristics of the reviewed training programs

	Authors and year	Goal and target group	PPI-functions addressed	Intensity	Mode of delivery	Type of training[a]	Training strategies	Feedback
1	Ziebarth, Kizina, Hoppe, & Dini (2014)	To train medical students in doctor-patient communication based on GOG model	(1) fostering the relationship(s), (2) gathering information, (6) responding to emotions	Duration: NS Sessions: as many as whished	Computer Web-based Asynchronous	Simulation The training was a serious game in a real-world simulation system. Learners engaged in simulated consultations with a VP and had the goal to find out as many symptoms as possible in a given time. The VP reacted to the learner with verbal and non-verbal behavior. There were various features available, such as the patient's file, a doctor's bag and a diagram indicating the atmosphere.	Role play, feedback	Reached scores, annotated transcript of the conversation
2[b]	Aper, Reniers, Koole, Valcke, & Derese (2012)	To train medical students' consultation skills regarding consultation structure and clinical content and to increase their confidence regarding their involvement in the different parts of the consultation	(2) gathering information, (5) enabling disease & treatment related behavior	Duration: 130 min Sessions: 1	Computer Web-based	Interactive The training provided an interactive virtual web environment. Video fragments of simulated consultations were displayed and the learner was asked to answer open-ended questions about the video examples. Afterwards the learner received automated standardized feedback.	Observation, assessment form, feedback	Automated immediate standardized feedback on given answers
3	Courteille, Josephson, & Larsson (2014)	To investigate the dynamics of interpersonal behaviors in clinical interviewing with a virtual patient (VP) and the affective responses evoked by such a learning experience in medical students	(1) fostering the relationship(s), (6) responding to emotions	Duration: 31-87 min Sessions: 1	Computer (in pairs)	Simulation The training applied the 'Interactive Simulation of Patients'. This is a VP simulation technology and offers a platform to engage in simulated consultations. The patient responses were delivered in the form of pre-recorded video clips of an actor simulating the patient. Further the technology provided an interactive free-text driven patient-history function and a collaborative workspace.	Role play, interaction with students and/or teachers	/

	Authors and year	Goal and target group	PPI-functions addressed	Intensity	Mode of delivery	Type of training[a]	Training strategies	Feedback
4	Kron et al. (2016)	To help medical students master the complexity of healthcare communication, and develop excellent communication skills	(1) fostering the relationship(s), (6) responding to emotions	Duration: <1 Sessions: 1	Computer	Simulation vs interactive A computer-based simulation system (MPathic-VR) was compared with a conventional multimedia CBL module. With MPathic-VR learners engaged in simulated consultations with a VP. The VP was an 'intelligent conversational agent with human appearance and the capacity to interact using a wide range of communication behaviors' (Kron et al., 2016, p. 749). The learner's verbal nonverbal behaviors were recorded and stored for further assessment and feedback. Learners engaged in two learning scenarios, each followed by a feedback procedure (see feedback section). The conventional CBL module was an open-ware program, using self-paced presentation of text, images and video.	Information provision, assessment form, role play, observation, feedback (MPathic-VR condition)	Immediate personalized feedback After-action-review (AAR): evidence, suggestions for improvement, students observed their nonverbal behaviors on video recordings, received feedback and general information
5	Detering et al. (2014)	To improve confidence in undertaking advance care planning conversations with their patients, and performance on an advance care planning patient e-simulation of general practitioners and doctors-in-training	(4) decision making, (5) enabling disease & treatment related behavior	Duration: ~ 3 h Sessions: 1	Computer, face-to-face	Simulation "Next Steps" is a multimodal training program on advance care planning. At first, DVD scenarios of successful and unsuccessful conversations were displayed. Then the learners engaged in a simulated conversation with a VP. There were several possible patient's responses available in the form of video clips, depending on the learner's questions. Afterwards the learners received feedback. After completing the e-learning component, the learners received reading material to be read before the workshop. The workshop involved group discussion, DVD scenarios, role play and further information provision. Afterwards the learners again engaged in a patient e-simulation.	Observation, role play, feedback, group discussion, information provision	Score and transcript of conversation with information as why a question/statement scores well or poorly

	Authors and year	Goal and target group	PPI-functions addressed	Intensity	Mode of delivery	Type of training[a]	Training strategies	Feedback
6	Daetwyler, Cohen, Gracely, & Novack (2010)	To train physicians in the essential communication competency of giving bad news and to enhance their knowledge, skills, and self-efficacy in this competency	(1) fostering the relationship(s), (3) providing information, (6) responding to emotions	Duration: NS Sessions: 3	Computer, Web-based	Simulation The training, called DUCOM, combined the e-learning tool "doc.com" with a WebOSCE. The e-learning tool involved informational texts, two annotated videos demonstrating effective communication skills and a behavioral checklist presenting all the essential skills. In the end, the learners received multiple choice questions to demonstrate their understanding of the module. The e-learning tool was supplemented with a WebOSCE component. The learners could interact with a SP via video chat. The SP was trained in advance and provided feedback to the learner. A behavioral checklist was used as a means of feedback delivery. Video clips further illustrated essential skills if they were missed by the leaner.	Information provision, observation, checklist, assessment form, role play, feedback	Immediate verbal feedback by SP, behavioral skills checklist filled out by SP, suggestions for improvement
7[b]	Quail, Brundage, Spitalnick, Allen, & Beilby (2016)	To train health professional students' communication skills and to increase their knowledge, confidence and empathy	(1) fostering the relationship(s), (6) responding to emotions	Duration: 4 h Sessions: 1	Television, face-to-face	Simulation The third training condition was a communication skills placement in the form of a virtual learning environment. Learners could engage in consultation simulation. The VP was projected on a flat screen television, in the setting of a doctor's office. 45 VP responses were available. The clinical educator decided which verbal and nonverbal reactions the VP should display. Immediate feedback was facilitated by the clinical educator as well as a small group debrief session.	Role play, feedback, reflection	Immediate feedback by clinical educator

	Authors and year	Goal and target group	PPI-functions addressed	Intensity	Mode of delivery	Type of training[a]	Training strategies	Feedback
8	Bekkers et al. (2010)	'To enhance the quality of antibiotic prescribing and raise awareness about antibiotic resistance among general medical practitioners	(2) gathering information	Duration: NS Sessions: 1	Computer, face-to-face	Interactive The STAR Educational Program consists of six parts in total. Part 1 and 2 involved an online introduction, case scenarios, and latest evidence. Part 3 was an on-site, face-to-face seminar and part 4 consisted of video scenarios. In part 5 the clinicians were asked to reflect on examples from their own clinical practice. Part 6 was a web forum.	Information provision, reflection, observation, group discussion, interaction with students and/or teachers	/
9	Liu, Scott, Lim, Taylor, & Calvo (2016)	To help medical students identify their nonverbal behavior and improve their communication skills	(1) fostering the relationship(s), (2) gathering information, (5) enabling disease & treatment related behavior	Duration: 2x 15min Sessions: 2	Computer/ Android tablet Web-based	Simulation EQClinic is a tele-consultation system. Learners engaged in consultations with SPs through video chat. In advance, learners received an e-mail with a training video for the system. The system consisted of three main components: (1) a personal calendar to book the tele-consultations, (2) the tele-consultation component, and (3) the feedback generator. The consultations were automatically recorded. The feedback generator allowed for various forms of feedback (see feedback section).	Role play, feedback	Nonverbal behavior is processed (vocalics and body movement behavior) and reported, assessment form and comments from SP, 'thumbs-up'/'thumbs-down' tool for SP during conversation
10	Gartmeier et al. (2015)	To prepare medical students and student teachers for leading professional shared decision making (SDM) conversations	(1) fostering the relationship(s), (2) gathering information, (4) decision making	Duration: 5 h Sessions: 1	Computer, face-to-face	Interactive There were four training conditions: (a) e-learning with video cases and role-play with video feedback combined, (b) only e-learning with video cases, (c) only role-play with video feedback, and (d) a wait-list control group. The e-learning component involved video cases of professional conversations and several exercises. The role play activity was done in groups. Learners received individualized feedback and communicative behaviors that occurred during role play were analyzed in a group discussion.	e-learning (b): reflection, observation; role play (c): role play, reflection, group discussion, feedback, observation	Role play: individualized feedback from peers and trainer, video recordings of conversation

	Authors and year	Goal and target group	PPI-functions addressed	Intensity	Mode of delivery	Type of training[a]	Training strategies	Feedback
11	Schmitz, Schnabel, Stricker, Fischer, & Guttormsen (2017)	To train undergraduate healthcare students in breaking bad news	(3) providing information, (6) responding to emotions	Duration: $\bar{x}$ = 68 min Sessions: 1	Computer	Interactive The training was conducted in a CBL environment. The learning scenario and theoretical background were introduced by means of a screencast. Video-based examples were displayed, either correct or erroneous depending on the experimental group. The control group saw a neutral video. After viewing the videos, the learners filled out a self-explanation prompt and received elaborated feedback.	Information provision, observation, assessment form, feedback	Elaborated feedback on video example: what was correct/erroneous, what were the consequences
12	Langenau, Kachur, & Horber (2014)	To enhance resident physicians' ability to treat pain in a responsible manner: pain assessment and counseling	(1) fostering the relationship(s), (3) providing information	Duration: 4x 30 min Sessions: 4	Computer Web-based	Simulation The training was a formative four-station web-based Objective Structured Clinical Examination (OSCE) using the video chat software Skype. The learners could engage in clinical encounters with SPs via Skype. Each learner participated in four encounters, engaged in a self-assessment and was assessed by the SP. This was followed by a debriefing session led by the SP.	Role play, feedback, reflection	Immediate verbal feedback, SP completed a global assessment form and key action checklist, self-assessment global rating form, 'Teaching Points' document for recommendations

	Authors and year	Goal and target group	PPI-functions addressed	Intensity	Mode of delivery	Type of training[a]	Training strategies	Feedback
13	Mitchell et al. (2011)	To train clinicians in MI counselling for colorectal cancer screening (two specific MI skills: developing empathic partnership & eliciting change talk)	(1) fostering the relationship(s), (5) enabling disease & treatment related behavior, (6) responding to emotions	Duration: 8-10 h Sessions: >1	Computer	Simulation The training took place in an immersive, 3-dimensionally virtual-world venue, called Second Life (SL). Prior to the in-world training, learners received an online tutorial on the philosophy of MI and their skills were assessed in order to determine their readiness for the training. The in-world activity commenced with further information. Then the learners saw a model MI interview conducted by the trainer with a SP. In small groups, the learners could engage simulated conversations with the SP themselves. They received immediate feedback and could observe their peers during the role-play activity. After the in-world experience, participants completed a DVD-based video assessment tool. They saw video fragments and answered questions. In the end, each learner received an individual coaching session by telephone with the MI trainer.	Information provision, role play, feedback, interaction with students and/or teachers, observation, assessment form, individual coaching	Immediate feedback from MI coach and peers, feedback from video assessment tool

Notes. GOG = Gesundheitsorientierte Gesprächsführung (eng. "health-oriented negotiation"); NS = not specified; VP = virtual patient; OSCE = objective structured clinical examination; CBL = computer-based learning; SP = simulated patient; MI = motivational interviewing.
[a]For a more detailed description of the training see appendix.
[b]Referring to the 3rd condition.

Appendix B

Table 2

Study characteristics of the reviewed studies

	Authors	Study design	n	Measurements	Outcome measures related to effectiveness	Outcome measures related to usability and satisfaction	Effectiveness	Usability and satisfaction with training
1	Ziebarth, Kizina, Hoppe, & Dini (2014)	Mixed methods: observational study and online study; single-group post-only design	Observational study: n = 7; online study: n = 21	Observational study: screen capturing, detailed observation protocol, questionnaire; Online study: questionnaire, log files	NM	Observational study: user-system interaction; questionnaire: immersion, playability, reflection support, usability	NM	Usability: interaction principles were immediately understood; problems with the application of the predefined sentence openers and the detection of topics; most participants used the patient's file, but doctor's bag was mostly missed Satisfaction: "[…] the idea and approach of the game in general were assessed positively and the participants considered it worthwhile to play the game several times." (Ziebarth et al., 2014, p. 217); the time duration was perceived as short; suitability for learning and self-descriptiveness were considered moderately; imaginative immersion and emotional involvement showed middle to low values; many participants did not feel completely understood by the patient and had problems detecting the symptoms
2	Aper, Reniers, Koole, Valcke, & Derese (2012)	Randomized trial study; three-group pre/post-test design; quantitative methods	Traditional training: n = 72; autonomous training: n = 60; online training: n = 64	Pre-/post-training questionnaire; student responses to a video case before and after the intervention	Subjective: confidence; objective: performance (responses)	NM	Confidence: traditional training (+/-), autonomous training (+), online training (+/-); performance: traditional training (+), autonomous training (+/-), online training (+)	NM

	Authors	Study design	n	Measurements	Outcome measures related to effectiveness	Outcome measures related to usability and satisfaction	Effectiveness	Usability and satisfaction with training
3	Courteille, Josephson, & Larsson (2014)	Single-group post-only design; mixed methods	N = 30	Log files, video observations, questionnaire, interviews	NM	Log files: student-VP interaction activity; video observations: student-VP interaction; questionnaire: self-reported IT proficiency, educational evaluation; interviews: students' appraisal judgments with respect to their learning experience and attitudes to the VP encounter	NM	Usability: Discrepancy in completion time; indication that students were affectively engaged; the VP's pedagogical design was beneficial for collaborative learning; the VP was perceived as a real patient with real psychological concerns, though indication for a less genuine behavior towards the virtual patient as opposed to what might be expected from a real patient encounter; the collaborative workspace of the VP system studied appeared to perform its social role; "[…] a larger screen (i.e. a larger patient face) appeared to have positive effects affecting in particular the immersion level, the emotional engagement, the completion time, and leading to reduced anxiety or nervousness" (Courteille et al., 2014, p. 9) Satisfaction: Mostly positive about the educational value of the VP learning environment; clinical context was perceived as authentic and meaningful; VP case was regarded as trustworthy and consistent
4	Kron et al. (2016)	Single-blinded, mixed methods, randomized, multisite trial; two-group repeated measures design	MPathic-VR group: N = 210; computer-based learning standard control group: n = 211	Attitudinal survey, brief reflective essay, objective structured clinical exam (OSCE)	Objective: performance (OSCE scores)	Participants' initial reactions and feedback about MPathic-VR (clarity, purpose, utility, and likelihood to recommend the learning experience to other)	Communication skills (+) MPathic-VR-trained participants > CBL-trained participants	Satisfaction with MPathic-VR: Students felt they learned useful verbal and nonverbal communications skills; students valued the immediate feedback and engagement using video recordings of their interactions with virtual humans; students recognized the value of the system to prepare and practice for emotionally-charged clinical encounters; students reflected on the clinical utility of communication and need for practice Satisfaction with CBL: Learners valued the system's presentation of facts based on featured communication strategies; there was a lack of interactivity; learners experienced information overload = "[…] students' experiences with MPathic-VR were engaging and contained valuable features not found in CBL." (Kron et al., 2016, p. 755)

	Authors	Study design	n	Measurements	Outcome measures related to effectiveness	Outcome measures related to usability and satisfaction	Effectiveness	Usability and satisfaction with training
5	Detering et al. (2014)	Single-group pre-/post-test; quantitative methods	Total n = 148 (119 completed the pre-workshop survey, 98 completed the post-workshop evaluation survey, and 69 participants completed both surveys)	Pre-/post-training questionnaire, pre-/post-workshop e-simulation scores	Subjective: Knowledge, attitude, confidence; objective: performance (e-simulation scores)	Only post-education questionnaire: experience, satisfaction, acceptability	e-simulation scores (+); confidence (+); attitude (+/-); knowledge (+/-)	Satisfaction: Most valued the workshop highly; pre-reading materials were perceived as useful; 85% (strongly) agreed that the DVD was "a valuable way of learning concepts and skills that might be difficult to learn in a real workplace"; 83% (strongly) agreed that the DVD "provided a non-threatening way of learning real-life work-related experiences"; 69% (strongly) agreed that the e-simulation is "a valuable way of learning concepts and skills that might be difficult to learn in a real workplace"; 73% (strongly) agreed that the e-simulation "provided a non-threatening way of learning real-life work-related experiences"
6	Daetwyler, Cohen, Gracely, & Novack (2010)	Three-group pre-/post-test pilot study; quantitative methods	WebOSCE only group: n = 19; doc.com only group: n= 17; WebOSCE and doc.com combined group: n = 16	Pre-phase-1 questionnaire; post-phase-3 questionnaire; behavioral checklist	Objective: performance (behavioral checklist)	Post-phase-3 questionnaire: the usefulness of the third educational intervention	All conditions: performance (+); between-group differences were not significant	Satisfaction: With doc.com: Improved self-assessed knowledge, understanding, and comfort in breaking bad news; 80% valued the overall educational value of the doc.com exercise "quite a bit/a great deal"; 61.1% valued the increase in their knowledge "quite a bit/a great deal"; only 12.7% of the participants valued the increase of their abilities to break bad news on the positive side of the scale With WebOSCE: 70–78% reported that the WebOSCE activity had improved their knowledge and abilities, and would likely change their practices in giving bad news; 50% felt that the WebOSCE-activity had increased their comfort in such matters as communicating bad news, responding to the patient's emotions concerning bad news, or consoling a patient given bad news; 91% stated that the WebOSCE-activity was a good use of their time and over 2/3 of the group would recommend this kind of learning experience to their colleagues

	Authors	Study design	n	Measurements	Outcome measures related to effectiveness	Outcome measures related to usability and satisfaction	Effectiveness	Usability and satisfaction with training
7	Quail, Brundage, Spitalnick, Allen, & Beilby (2017)	Questionnaire study; three-group, pre-/post-test design; mixed methods	Nursing home condition: n = 21; SP condition: n = 22; VLE condition: 19	Pre-/post-training online questionnaire (scales developed by authors + Jefferson Scale of Empathy)	Subjective: communication skill, knowledge, confidence, empathy	Only post-training questionnaire: placement experience	All conditions: communication skill (+); knowledge (+); confidence (+) Only traditional placement: empathy (+)	Satisfaction: SP condition evaluated most favorably and VLE condition least favorably; nursing home condition perceived as most realistic and natural and VLE condition perceived as least realistic and natural; VLE participants found the experience less consistent with real world experiences, and reported lower levels of engagement and enjoyment; nursing home condition participants reported lowest levels of anxiety; "the three groups did not differ in terms of their perceptions regarding the amount of learning they derived from the placement, the helpfulness of the placement, its usefulness for learning how to interact with real patients, their degree of skill improvement, and the value they derived from the clinical educator" (Quail et al., 2017, p. 6); the VLE condition was reported as most challenging, the reported challenges were deemed positively, and promoted reflection and professional development; the nursing home condition did not challenge the participants, low competency development; clinical educator was highly valued; both simulated learning environments were viewed by students as inferior clinical education models
8	Bekkers et al. (2010)	Randomized controlled trial, one-group, post-only design; qualitative methods	N = 31	Interviews	NM	Three main areas: (1) General information about practice location, time worked in the current practice, level of importance given to the issue of antibiotic resistance before participating, (2) effects of the program as perceived by participants after completion, (3) detailed evaluation of presentation, content, and structure of the actual learning program	NM	Usability: 20% experienced (initial) technical difficulties Satisfaction: Contents and presentation of the generally valued research evidence was criticized; the web forum was dismissed by many as irrelevant; the overall program evaluation was positive; participants appreciated the communication skills and deem them as having impact directly on future consultations; participants felt empowered by their increased insight; positive feedback about the face-to-face component

	Authors	Study design	n	Measurements	Outcome measures related to effectiveness	Outcome measures related to usability and satisfaction	Effectiveness	Usability and satisfaction with training
9	Liu, Scott, Lim, Taylor, & Calvo (2016)	Single-group repeated measures pilot design; mixed methods	N = 8 One consultation, one measurement: n = 3; two consultations, two measurements n = 5	Four questionnaires: (1) Student-Patient Observed Communication Assessment Form (filled out by SPs, students, and tutors), (2) Confidence Questionnaire, (3) Reflection Questionnaire, (4) System Usability Questionnaire	Subjective: confidence; objective: performance (assessment form)	Consultation experience, system usability	Performance (+/-); confidence (+)	Usability: Students were positive about system usability and felt comfortable using it; structure and information were clear, but clearer instructions are needed Satisfaction: Consultation and feedback helped students identify skills that needed improvement; more than half of the students mentioned that they felt rushed during the consultation; some students felt confused about organizing the structure of the consultation; the SPs' real-time comments helped the students to understand their thinking during the consultations; students were confused about where they should look during the consultation: the middle of the screen or the camera; some found it difficult to maintain eye contact
10	Gartmeier et al. (2015)	Four-group post-only design; quantitative methods	Combination condition: n = 43; e-learning with video cases condition: n = 42; role-play with video feedback condition: n = 43; wait-list control group-condition: n = 40	Video recordings of two assessments with simulated patients	Performance (rated video recordings)	NM	Treatment conditions > control condition; combination condition > the single-mode conditions only when controlled for covariates (prior knowledge, intellectual ability); e-learning with video cases condition > role-play condition	NM
11	Schmitz, Schnabel, Stricker, Fischer, & Guttormsen (2017)	Double-blind randomized controlled design; three-group post-only design; quantitative methods	Experimental group COR: n = 12; experimental group ERR: n = 12; control group: n = 12	Cognitive assessment (rating of self-explanations), behavioral assessment (videotaped SP interaction)	Objective: performance	NM	Cognitive assessment: experimental group ERR > experimental group COR (control group: NM); behavioral assessment: experimental group ERR > experimental group COR > control group	NM

	Authors	Study design	n	Measurements	Outcome measures related to effectiveness	Outcome measures related to usability and satisfaction	Effectiveness	Usability and satisfaction with training
12	Langenau, Kachur, & Horber (2014)	Single-group post-only survey design; quantitative methods	N = 59	Post-exercise survey	NM	questions regarding general format, technology, scheduling, RSP experience, believability of cases, verbal feedback, global assessment, checklist assessment, teaching points, and overall experience	NM	Usability: 98% agreed or strongly agreed with the statement "I found Skype easy to use"; 58% reported technical difficulties during the encounters (dropped calls, poor video and audio quality) Satisfaction: The majority of resident participants highly valued the remote learning exercise, authenticity, ease of use, and educational opportunity; 93% acknowledged they could communicate easily with the RSPs; 80% preferred traditional face-to-face clinical experiences; inability to visualize subtle expressions maintain comfortable communication flow, or convey empathy was reported; only 80% of residents agreed or strongly agreed to the statement "I feel more confident in my ability to communicate with my patients with regard to pain."
13	Mitchell et al. (2011)	Single-group pre-/post-test pilot study; quantitative methods	N = 13	(1) self-report questionnaire, (2) pre- and post-training questionnaire, (3) pre- and post-training scores from coded audiotaped mock interviews with SP	Subjective: confidence, knowledge; objective: performance (coded interviews)	Feasibility and acceptability of recruitment, the instructional design, and the virtual-world learning environment	Performance (+); confidence (+); knowledge (+)	Usability: Technical problems, download required and significant system requirements Satisfaction: High acceptability and feasibility for conducting training in Motivational Interviewing using the Second Life virtual-world platform; feedback and coaching is highly valued

Notes. NM = not measured; VP = virtual patient; OSCE = objective structured clinical examination; SP = simulated patient; CBL = computer-based learning; VLE = virtual learning environment; COR = correct; ERR = erroneous; RSP = remote standardized patient; A > B = A significantly better than B.

Appendix C

Description of training programs

Taining 1. Ziebarth, Kizina, Hoppe, and Dini (2014) proposed a serious game as means to train medial students in patient-provider interaction. It was mainly developed for first year medical students, therefore no deep medical knowledge is needed to be able to play the game. The game is a real-world simulation in the setting of the doctor's office. The player engages in role-play and leads a simulated consultation with a virtual patient. The goal is to identify as many symptoms as possible in a given time. The player can build sentences with a predefined sentence opener and a free text feature. Also nonverbal behaviors can be conducted. Depending on the player's actions, the level of trust and empathy increases. The virtual patient has the capacity to react in accordance to the levels and to admit certain symptoms. The patient's file and the doctor's bag are other features available in the game. It can be played on the computer and is independent of space and time. After playing the game, the learner receives feedback in the form of his/her reached scores regarding the trust and empathy level and the identified symptoms. Additionally, the learner gets an annotated transcript of the conversation with analysis results.

Training 2. The study of Aper, Reniers, Koole, Valcke, and Derese (2012) compares three different types of training programs in the context of undergraduate medical education: (1) a traditional consultation training, (2) an autonomous training, and (3) an online training. Only the online training is described here, as it is the only training that makes use of technology and thus meets the inclusion criteria.

The training provides an interactive virtual web environment with the aim of training medical students' consultation skills and to increase their self-efficacy beliefs. The virtual environment represents a consultation setting, starting in the waiting room. It encourages learning by observation. The learners get to see three consultation recordings, which are

subdivided into small fragments showing different aspects of the consultation. Open-ended questions about the video examples are to be answered by the learner in order to challenge their understanding of the various consultation dimensions. After the learner typed his answer, immediate standardized feedback is given.

Training 3. The training provided in the article by Courteille, Josephson, and Larsson (2014) utilizes 'Interactive Simulation of Patients' (ISP). This is a virtual patient simulation technology developed at Karolinska Institutet (Solna, Sweden). Learners can engage in simulated consultations with a virtual patient via a realistic interface. An interactive free-text driven patient-history function is available to the learners, who solve the case in pairs without a time limit. The questions asked cause certain patient responses, which are delivered in the form of pre-recorded video clips of an actor simulating the patient. Also affective responses such as fear or anger can be triggered if a question is inappropriate. Interaction between learners and teachers is facilitated through the collaborative workspace of the system.

Training 4. Kron et al. (2016) compared a computer simulation technology (MPathic-VR) with a conventional multimedia computer-based learning (CBL) module. MPathic-VR is a consultation simulation system for learners to engage in simulated consultations with a virtual patient. The virtual patient is an "intelligent conversational agent with human appearance and the capacity to interact using a wide range of communication behaviors" (Kron et al., 2016, p.749). Learners are challenged to use communication strategies in order to elicit the desired reactions in the virtual patient. "MPathic-VR records and stores learners' conversational choices and nonverbal behaviors" (Kron et al., 2016, p.749). These are further analyzed by the system in order to provide feedback and real-time variation of virtual human behavior during the simulation.

The learners first see a multimedia presentation introducing the system and communication principles, followed by a readiness assessment quiz. Then the learners engage in the first MPathic-VR consultation. The learning scenario concerns intercultural

communications. Afterwards, an after-action review (AAR) is conducted, which is an important feedback component of the training. The learner receives personalized feedback on his performance, as well as the evidence behind the verbal choices and suggestions for improvement. Also a video recording of the conversation is provided with feedback on certain nonverbal behaviors detected by the MPathic-VR system. After the AAR, the scenario is conducted again. This process is repeated with a second scenario concerning inter-professional communication.

The CBL module is a conventional open-ware program called “Introduction to Standardized Communication for Health Professionals”. It “represents the current standard for multimedia training using a self-paced presentation of text, images, and video” (Kron et al., 2016, p. 752).

Training 5. Detering et al. (2014) presented a multimodal training program on advance care planning called Next Steps. The program starts with introducing the topic by means of DVD scenarios of successful and unsuccessful advance care planning conversations. Then an interactive patient e-simulation is introduced and the learners engage in a simulated advance care planning conversation themselves with a virtual patient. The learners can choose from several possible responses or questions. The patient’s responses depend on the learner’s choices and are available in the form of video clips. This makes the conversation either successful or unsuccessful. Afterwards, the learner receives his/her scores and an annotated transcript of the conversation. After completing the e-learning component, the learners received reading material to be read before the workshop. The 2h-workshop involved group discussion, DVD scenarios, role-play and further information provision. Afterwards the learners again engaged in a patient e-simulation.

Training 6. Daetwyler, Cohen, Gracely, and Novack (2010) propose a training called DUCOM that incorporates the e-learning tool ‘doc.com’ in a blended learning setting. doc.com is a media-rich online module that aims at teaching the knowledge aspects of medical

communication skills. Theory is presented in textbook quality texts. Additionally, effective communication skills are demonstrated in two annotated videos. All essential skills are further presented in a behavioral checklist. In the end, the learners receive multiple choice questions to demonstrate their understanding of the module.

The e-learning tool is supplemented with a WebEnconter component – a WebOSCE (Objective Structured Clinical Examination). The learners interact with a simulated patient via video chat with the task to deliver bad news. The simulated patient was trained in advance and provides feedback to the learner. A behavioral checklist was used as a means of feedback delivery. Video clips further illustrated essential skills if they were missed by the leaner.

Training 7. Quail, Brundage, Spitalnick, Allen, and Beilby (2016) compared three different communication skills placements all involving simulated conversations: (1) a nursing home placement, (2) a simulated patient (SP) placement, and (3) a virtual learning environment (VLE) placement. In the first condition, students interacted with a nursing home resident in a nursing home facility. In the second condition, the students engaged in a simulated conversation with a trained actor. The third condition will be discussed in detail, as it involves technology and provides a VLE.

The training starts with a small group introduction by a clinical educator. The VLE is a consultation simulation technology for learners to engage in a simulated conversation with a virtual patient. The virtual patient is projected on to a flat screen television in the setting of a doctor's office. 45 virtual patient's responses were available from the categories: profile, concern, challenge, affective, agree, disagree, and function (for further explanation see Quail et al., 2016, p. 4). These differed in function and in how challenging they were for the learner. The clinical educator decided which verbal and nonverbal reactions the VP should display. After the interaction, the learner receives immediate feedback by the clinical educator. Afterwards a small group debrief session was held.

Training 8. The STAR Educational Program is a blended learning training presented by Bekkers et al. (2010) with the aim to enhance the quality of antibiotic prescribing. The training consists of seven parts in total and part 1-5 are the core parts of the program. Part 1 and 2 involve an online introduction to the topic, case scenarios for reflection, and examples of the latest evidence. Part 3 is an on-site, face-to-face seminar with a STAR study trainer who facilitates a group discussion. In part 4 video scenarios demonstrate key consultation strategies and how to use certain 'core tasks'. In part 5 the clinicians are asked to reflect on examples from their own clinical practice. Part 6 and 7 are no core parts of the training as part 6 is a web forum and part 7 is a booster session provided approximately six month after the core program.

Training 9. Liu, Scott, Lim, Taylor, and Calvo (2016) present EQClinic as a tele-consultation system for medical students. Learners receive an e-mail with a training video on how to use the system. EQClinic provides the opportunity to engage in consultation simulations with a simulated patient via video chat and an easy means of organizing appointments. The system consists of three main components: (1) a personal calendar to book the tele-consultations, (2) the tele-consultation component, and (3) the feedback generator. The consultation component makes the consultations possible, which are automatically recorded. During the consultations the simulated patient can use a 'thumbs-up' and a 'thumbs-down' tool to indicate positive and negative moments. The feedback generator further detects the learner's nonverbal behavior and provides two types of feedback reports. Afterwards, the learner's performance is assessed by the simulated patient with an Assessment Form.

Training 10. In the study of Gartmeier et al. (2015), four training conditions are compared: (a) e-learning with video cases and role-play with video feedback combined, (b) only e-learning with video cases, (c) only role-play with video feedback, and (d) a wait-list control group. The traditional approach is compared with the e-learning approach and with the combined blended learning approach.

In the e-learning component video cases are presented of suboptimal and improved versions of consultations. The task is to analyze the video cases and to do several exercises such as quizzes or sorting tasks. The purpose is to elaborate on and apply the theoretical and conceptual basics of communication.

The role-play activity is conducted in groups. Learners receive individualized immediate feedback. Additionally, the conversations were videotaped for further analysis. In the group the learners analyzed communicative behaviors and were free to highlight certain aspects.

Training 11. The training presented by Schmitz, Schnabel, Stricker, Fischer, and Guttormsen (2017) is conducted in a computer-based learning environment. The learning scenario and theoretical background are introduced by means of a screencast. Video-based examples were displayed, either correct or erroneous depending on the experimental group. The control group saw a neutral video. After each example, the learner fills out a prompt for self-explanations. The learner elaborates whether the example was correct or erroneous and the consequences for the patient. Immediate feedback was then given in the form of an edited version of the video example with spoken information about what was correct or erroneous and the consequences of the behavior.

Training 12. Langenau, Kachur, and Horber (2014) present a formative four-station web-based Objective Structured Clinical Examination (OSCE) using the video chat software Skype in order to enhance resident physicians' ability to treat pain in a responsible manner. Each learner participates in four 30-minutes clinical encounters related to pain assessment and counselling. The conversation is conducted with a simulated patient via Skype. After the conversation, the simulated patient assesses the learner's performance by means of rating forms and the learner conducts in a self-assessment. After each encounter, a 10-min debriefing session takes place, led by the simulated patient and the "Teaching Points" document is given to the learner.

Training 13. Mitchell et al. (2011) conduct a motivational interviewing training in the immersive and 3-dimensional virtual-world venue “Second Life” (SL). SL is a virtual world which can be entered by individuals as avatars. The Boston University School of Medicine owns a private, virtual island which is used for the training. As a preparation for the training, an online tutorial on the philosophy of motivational interviewing (MI) is presented and on the use of the system. Prior to the in-world training, the learner’s skills are assessed in order to determine their readiness for the training.

The in-world activity commences with further information accompanied by a local text chat. Then the learners see a model MI interview conducted by the trainer with a standardized patient. Hereafter, the learners engage in role-play themselves. They are split into small groups and teleported to a separate platform with a coach and a standardized patient. They receive immediate feedback by the MI coach and their peers. They also engage in active observation of peer participant’s conversations and give feedback. After the in-world experience, participants completed a DVD-based video assessment tool. They saw video fragments and answered questions. In the end, each learner received an individual coaching session by telephone with the MI trainer.