

# Evaluation of an Online Information System for Shoulder Pain Patients

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**Abstract—** In recent years the number of users looking for information regarding health issue on the internet has increased significantly. In the search for relevant information users may, however, encounter incorrect, misleading or outdated information. Due to this scientists have developed over the past few years new forms of information provision for patients suffering pain. In the context of this study a prototype of an internet based information system for patients with specific reference to anamnesis of and information on shoulder pain was developed and extensively evaluated. Aim is to check if a guided search delivers better and more satisfying results than search engines and health portals. For the evaluation of this shoulder pain system the University of Applied Sciences Zittau/Görlitz conducted a double blind two-group study with 122 participants. It could be obtained that with the aid of the shoulder pain system significantly better laymen diagnosis were provided than without. The study confirmed that an information provision by means of medical expert systems present an efficient alternative for patients suffering pain.

**Keywords-** health information technology; health care; health information; information systems; shoulder pain

## I. INTRODUCTION

According to the BITKOM (German federation of computer science economy, telecommunication and new media) approximately 28 million Germans are seeking health related advice on the internet [1]. This equates to 60% of German internet users – five years earlier it was 50%. The group of 30 to 49-year olds are hereby those who research frequently. Diverse providers give differing health relevant information on the internet. Problematic in this context is, beside the information overload, the fact that a search may also lead to incorrect, misleading, outdated and perhaps even harmful information. The pain patient's need for information is often nonspecific and the search is not targeted and precise enough. Due to this quality management and a certification of health information on the internet becomes urgently necessary. Various scientists identified and implemented new demands for an ideal health information system over the last 10 years.

The amount of varying health information interests is offered via web presences from health organisations, hospitals

and doctors. The contents are usually diagnosis oriented or tailored to specific pains or illnesses. A search for the term 'shoulder pain' on the Google search engine, for example, results in over 6 Million hits. In this context the question is posed whether or not a structured, guided internet search that is tailored to the user's need results in better information than an intuitive and customary search via search engines and health portals. Meta search engines could resolve this problem and related to health information do exist in English and French, however, a German version is non-existent at this point. Furthermore, even those engines are unable to support the user in terms of specification of his/her need for information. It, thus, poses the question if a structured, guided internet search that is tailored to the user's need may deliver better information.

For the person searching for health information there should be, first of all, information that helps to determine if their symptoms point toward an acute illness and if this needs to be seen by a doctor immediately. For the treating physician this might mean a reduction in time with regards to anamnesis and diagnosis. Furthermore, it provides a certain preliminary diagnosis' choice for the doctor. The long-term goal for the development of this system is to create an extensive information system for internet based information for pain patients. The expert system should thereby depict a complete body with all relevant areas of pain. It is necessary in this context to test the to be developed part systems after they have been implemented successfully into the expert system with regards to their effectiveness.

In the framework of this project a prototype that combines an expert system with a meta search engine has already been developed with the aim to provide patients with tailored information. For the first time the possibility exists here to identify the users' need for information with the aid of an information system and the users' search is guided in such a way that they are led to the information looked for directly. The prototype is based on current information technology and transmitted to the end user via a website. The system was programmed with the scripting language PHP, formatted via HTML and displayed as internet site. Each user submission is assessed according to the 24 most common shoulder pain

illnesses and afterwards an internal, for the user not visible, diagnosis is determined [2]. For each diagnosis search terms are defined that aim to provide the best possible information according to the user's needs [3]. With these search terms a search is conducted via sites that are certified by the Health on the Net Foundation (HON) and the search results are presented to the user [4-5]. With the aid of the following evaluation the following goals should be obtained:

1. Via a computer-based expert system the user's information need should be determined and via a meta search custom-made, assessed and evaluated information should be provided.
2. Aim is to verify that this kind of information provision is better targeted and easier to navigate for the user in comparison to customary search engines and health portals.

## II. BACKGROUND

In order to contextualise the main research question we will consider the two fundamental aspects of the study: on the one hand, the health information on the internet, on which this investigation is based; on the other, the evaluation of these information. It is necessary here to clarify what distinguishes good health information from bad ones and how this difference can be quantified [6].

The users' perspective with regards to the evaluation and the effect of evidence based health information has been examined in the context of the MA thesis by Hirschberg, submitted at the Patient University of the Medical University Hannover. It was discovered that for the main part the test readers' reaction patterns were mainly negatively afflicted. Indeed, approximately 135 out of 160 people stated that they were dissatisfied and disappointed on first impression. Nearly 70 people stated they had doubts regarding the information given [7].

In the context of the 'Health Care Monitoring 2009' – report of the market research and advice bureau YouGov-Psychonomics Corp. on the theme of 'health information on the internet' 2.000 internet users were questioned with regards to public profile, use, as well as the perceived quality of the health information given on the internet. Again, it was discovered that approx. 50% of those questioned were unsettled or alienated by the information given. "Thus, around half of the internet users would like an independent authority to verify the information given on the internet" [8].

The online study 'PILOT – Patient Involvement – Leading to Optimized Therapy?' questioned 1.584 participants from 14 health portals and forums with reference to the benefit of health and/or illness related information. "The PILOT-study showed that the majority of the patients ask their doctors different or more questions and communicate in a different way with the health insurances. It also emerged that a lot of patients were now making their own decisions in favour of or against a specific treatment" [9].

## III. METHODS

In order to assess the additional benefit of the prototype operationalisation procedures of empirical social research are applied within the framework of study. Here the influence of the independent binary experimental variable 'manner of internet search' (via, on the one hand, the prototype or, on the other, prevalent methods such as search engines and internet portals) on the dependent variable 'quality of the results' should be achieved through an explanatory examination of a two-group-study. The study should basically be conducted as an experimental investigation via blind testing with the aid of an experimental and a control group.

Within this context the influence of the prototype with regards to diagnosis and, thereby, quality of the provision of information should be determined. The population is assumed to be the mass of all suffering adults within the respective pain areas in German speaking regions, who search for information about their illness on the internet. The control sample is determined as an adequately large group of people, who complain about the respective pain area and who, so far, have not consulted a doctor. As a means to randomise, the participants are allocated to the experimental or control group by chance. The members of the experimental group use the prototype for their research on information about their illness, whilst the people from the control group use a computer with internet access and standard browser.

### A. Questionnaire design

A general part obtains data with regards to gender, age, occupation and sports activities. The first paragraph asks about the frequency and characteristics of the pain. The second paragraph captures subsequently information about the link between possible course of movement and occurring pain. Additional questions are related to potential sensation disorders and/or adverse effect on the patient's strength. The last paragraph asks about possible illnesses in general, such as, for example, gout or chronic polyarthritis. The used questionnaire has been developed in a series of test runs and contains only the most relevant and differential diagnostic meaningful information.

### B. Questionnaire structure

In the context of the evaluation a randomised two-group-study is conducted. The participants receive an anamnesis form of a notional close relative or an acquaintance asking for support in obtaining information. Subsequently the test person searches with or without the aid of the prototype for information with reference to shoulder pain. The study is conducted in two parts, thus presents two different types of notional patients. In each study part 60 people are automatically allocated to either the experimental or the control group (120 people in total). This happens in a secure working environment where the study participants are able to either search for information via the expert system or via search engines and health portals. The participant comprises the above describe data after the execution.

C. Description of the notional patients

The close relative of study part A is a 45-year old female who complains about pain in her right shoulder. She is right handed, has a sedentary job and does hardly do any sports. She describes that the pain started suddenly and since then nearly always occurs through strain, movement and nightly lying on the shoulder. She describes the pain as acute and dull and states that even the upper arm hurts ‘very, very much.’ During everyday activities the pain occurs (combing her hair, general movement, obtaining things from the top shelves in the wardrobe) or when she tries to throw a stick for her dog. The pain is debilitating her physical strength. Potentially underlying pre-existing illnesses do not exist (notional patient A; description based on participants’ study information).

The close relative of study part B is a 75-year old, sport-active man. Despite his age he keeps house and property in good shape and ‘does everything himself’. He is right handed and complains about pains in the right shoulder and upper arm that have been getting worse over the last few weeks. In addition, he says that he suffers from pain during the night, when he is lying on his right shoulder – and when he works in the garden, putting strain on his right arm. He states that there is a ‘creaky sound’ and a ‘dull pressure pain’ and that he suffers from severe pain after a specific movement. Since then he is unable to do all the work, even when combing his hair or making a throwing movement he complains about pain, since the functioning is disturbed through particular movements. Upon further questions he reports finally that the pain is particularly bad when the upper arm is resting against the body, yet not as bad when he raises his arm, which is difficult due to the pain weakening the arm. Other pre-existing illnesses are not known (notional patient B; description based on participants’ study information).

D. Test persons

Overall 122 test persons participated in the study, which means 60 or 62 participants per notional patient respectively. In each case 30 (notional patient A) of the participants searched via random allocation in the control group with the aid of relevant search engines for a possible diagnosis according to the described complaints of the close relative. Another 31 participants respectively determined the possible diagnosis in the experimental group with the aid of shoulder pain systems of the University of Applied Sciences Zittau/Görlitz.

55 female (45.1%) and 67 male (54.9%) persons took part in the study. The age of the test persons varied between 19 and 62, with a median of 23 years. The mean was 24.8 years.

The duration of the participation varied between three and 22 minutes with a median of four minutes. This comprises the entire period of the participation, including the time for the search. Within the experimental group the duration of participation also includes the time that was needed for the expert system dialogue. After the study the participants’ perception was obtained too. 55 (45%) of the test persons felt ‘good’ during the study, 46 (38%) felt insecure, 10 participants (8%) felt overwhelmed and 11 (9%) uncomfortable.

E. Statistical analysis

A higher rate of analogy between test persons and medical diagnosis is seen as verification for a better provision of information by the information system and postulated here as non-specific alternative hypothesis (H1). A lower or comparable rate, on the other hand, is seen as null hypothesis (H0). These data and correlations are the basis for the selection of suitable significance tests. Fisher’s precise test was applied due to the independence of the control sample from experimental and control group and the normal-scaled dichotomy of the data. In order to determine the influences of the control variables a correlation analysis according to Spearman was executed. The evaluation was done with the programme IBM SPSS 19.

IV. RESULTS

Within the experimental group (30 participants) the research, on the basis of the notional patient’s information, took with the aid of the shoulder pain system of the University of Applied Sciences Zittau/Görlitz an average of three minutes. The control group, using pertinent search engines and health portals, needed on average six minutes research time till they found a diagnosis. These results correspond with the average research time of the second part of the study.

TABLE I. FEELING DURING THE STUDY IN THE STUDY GROUPS

Study group	Feeling during the study				Total
	Good	Doubtful	Overstrained	Bad	
A E	17	12	0	1	30
A C	10	13	3	4	30
B E	12	13	3	3	31
B C	16	8	4	3	31
Total	55	46	10	11	122

A. Feeling during the study

The feeling in the experimental group (search via shoulder pain system) was during the study in both study sections better than in the control group (free search). While in each case seven participants who used search engines to find a possible diagnosis stated that they felt overwhelmed or uncomfortable during the search, of the experimental group only one participant during the first and six during the second cycle stated the same. On average 37.7% of the participants of both groups felt insecure, 45% stated that they felt good. A distribution of these qualitative statements can be found in table 1.

The feedback of the study participants with regards to the expert system for shoulder pain was positive but critical. The determination (via questioning) of the feeling during the study showed that some of the test persons felt overwhelmed and uncomfortable. Nonetheless, the study generated the expected positive results with regards to the application of the information system for shoulder pain. In addition, the statements with reference to obtaining information with the aid of search engines and health portals were critical. Thus, it was

stated that a lot of seemingly dubious or unreliable sites for custom and advertisement complicated the search, making it more stressful and that the results were imprecise. Inhibition thresholds and lack of knowledge with regards to the notional patient's pathology, too, seem to point towards reservation in terms of health information on the internet and, thereby, verify the hypothesis that for a lot of people a guided search is easier and more effective. It was also stated and critically challenged that one is able to give a diagnosis based on information from the internet, while it would be better to actually go and see a doctor.

The participants perceived the guided search and its success with the aid of the expert system as positive. A list of well-directed information for the notional patient convinced some test persons about the benefit of the use of the information system for shoulder pain, even though they felt uncomfortable and overwhelmed. The search seemed so 'easy and quick' and delivered 'in a short amount of time a lot of results', which were presented already filtered through the information system. The idea of the system was seen as 'interesting' and 'exciting' and raised certain curiosity within some of the participants in terms of the subject matter. The execution and atmosphere during the study was praised and perceived as very positive.

**B. First study section**

During the first study section the test persons had the aim to diagnose a calcific tendinitis of the shoulder (tendinosis calcarea) with the aid of the search possibilities. Both the experimental as well as the control group consisted of 30 participants. Based on the close relative's information the participants were able to research with the aid of search engines and shoulder pain system respectively appropriate links, seemingly responding to the descriptions by the relative.

In the experimental as well as the control group an overall of 60 test persons determined a suspected diagnosis during the first study section. The total time of all test persons in the experimental group was 115 minutes with the shoulder pain system (on average 3.83 minutes), while the period of research within the control group was 188 minutes (on average 6.27 minutes) (table 3). With the aid of the shoulder pain system 28 out of 30 people (93.3%) gave the correct diagnosis 'calcific tendinitis of the shoulder' – in the control group eight participants (6.7%) determined the correct illness with the aid of search engines (table 2).

**C. Second study section**

During the second study section the diagnosis 'rotator cuff rupture' (respectively tear of the rotator cuff) was supposed to be found. Experimental and control group both consisted of 31 test persons respectively. The course of the second study section was analogue to the first. With the aid of random division in experimental and control group the complaints of the notional close relative were supposed to be determined via the use of search engines and shoulder pain system respectively.

The total time in this study section was in the experimental group 99 minutes, in the control group 209 minutes. The

participants using the shoulder pain system researched on average 3.16 minutes, whereas it took 6.74 minutes with the search engines. As table 2 shows, 23 out of 31 people found the correct diagnosis (74.2%) in the experimental group through the application of the pain-guide of the University of Applied Sciences Zittau/Görlitz. In the control group seven test persons were able to find the correct diagnosis (22.6%).

TABLE II. CORRECTLY DETERMINED DIAGNOSIS OF THE STUDY GROUPS

		Correct diagnoses		Total
		No	Yes	
Study group	A E	2	28	30
	A C	22	8	30
	B E	8	23	31
	B C	24	7	31
Total		56	66	122

**D. Analysis of control variables**

Participants perceived the usability of the pain-guide that was used by the experimental group as good, similar to the overall idea of searching targeted information via an information system. Furthermore, a desire was expressed to develop such a form of information provision for the whole body, and that the search by means of an information system was quick and easy.

The research via search engines was criticised with regards to the amount of information and the varying data, some of which actually contradicting each other. In addition, it was stated that one felt confused and overwhelmed, since the subject matter and the symptom description was something new and unfamiliar for a layman.

The participants evaluated the search in both groups at the end of the study. The easy use of the shoulder pain system, its simple structure and the fact that at the end of the input the amount of provided information was limited and comprised were seen as positive. In the control group the amount of variable information was criticised and the trustworthiness of the found links questioned.

TABLE III. SEARCH TIME AND DIAGNOSIS' CORRECTNESS OF THE GROUPS

Group	Time	Diagnosis	
	Average	Correct	Wrong
A E	3.83	28	2
A C	6.27	8	22
B E	3.16	23	8
B C	6.74	7	24

Table 3 shows the research time to the point of a supposed diagnosis in summary. The experimental group was able to give a correct diagnosis in an average search time of three minutes (patient A and B) in 28 out of 30 (93.3%) and 23 out of 31 (83.9%) cases respectively. In comparison to this, the

participants of the study in the control group gave a correct diagnosis in an average search time of six minutes (patient A and B) in 8 out of 30 (26.6%) and 7 out of 31 (22.5%) cases respectively. The correlation analysis according to Spearman showed a significant correlation between search time and the correctness of the diagnosis ( $r=0.455$ ). There were no further significant correlations with the control variables.

## V. DISCUSSION

The study confirmed that medical laymen are able to find an accurate diagnosis for the given shoulder pain symptoms when they are supported during their internet research by the prototypical expert system. The search time was also significantly reduced and led in a shorter period to more correct laymen diagnosis than those using search engines and health portals.

From an evidence-based medicine perspective it has to be said that turning clinical problems into search keywords is a challenge and demands long-term experience and medical knowledge changes rapidly. The determined keywords therefore have to be reassessed on a regular basis.

The study was restricted with regards to the different classifications of the type of shoulder pain and only two forms of diagnosis were the focus of the examination. It is, therefore, possible to assume that the shoulder pain system would achieve similarly positive results in the other types of shoulder pain, as for those selected and examined classification data.

## VI. CONCLUSION

An internet search that is computer supported and related to anamnesis can deliver better results for patients than the use of search engines and/or health portals. With reference to the study ‘information provision for patients with headaches’ it is possible to determine that in the area of shoulder pain, too, a guided search via an expert system leads to faster and better information. In every case the user has to be given clear instructions, and it has to be stated that an internet research can not replace the consultation of a practitioner.

## REFERENCES

The template will number citations consecutively within brackets [1]. The sentence punctuation follows the bracket [2]. Refer simply to the reference number, as in [3]—do not use “Ref. [3]” or “reference [3]” except at the beginning of a sentence: “Reference [3] was the first . . .”

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For papers published in translation journals, please give the English citation first, followed by the original foreign-language citation [6].

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