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MOBILIZING MEDICAL INFORMATION AND KNOWLEDGE: SOME INSIGHTS FROM A SURVEY

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Abstract

The mobile medical information system investigated in the study is developed for mobilizing medical information and knowledge and for matching physicians' multiple needs, including mobility, reliability and time efficiency. This paper is set to investigate physicians' perceptions, intentions and actual use regarding the system in a pilot trial conducted in the Finnish health care sector started from April to September 2003. The results from this empirical survey (N=500, returned N=379) indicate that physicians have rather positive perceptions of the system and future intentions to use it in their work practice. Mobile evidence-based medical guidelines-EBMG and mobile textbooks were the most favourite information sources that physicians might use through a mobile device. Mostly, they would search information about certain treatments, drugs and diseases. Mobile EBMG, Pharmaca Fennica and ICD-10 were their most wanted mobile information contents in the system. The physicians were highly motivated to use mobile Internet in order to access the Internet-based EBMG as well as the Finnish Internet medical portal— Terveysportti. Mobile prescription also gained a high probability for being adopted. Individual differences do matter physicians' perceptional assessments and future intentions to use the system. These findings indicate some potential to mobilize "personalized" medical information and knowledge in order to create knowledge freedom to physicians by taking full advantage of mobile technologies. Mobile prescription might be a step further towards mobilizing medical information but with political difficulty. Implications for future system improvement are discussed briefly.

Keywords: health care, mobile medical information system, knowledge mobilization, perceptions, future intention

1 INTRODUCTION

The emergence of mobile electronic communications has created a multitude of services that were impossible just a few years ago. Even though the breakthrough of the mobile Internet has not been as fast and powerful as envisioned by enthusiasts in the late 1990's, the case for mobile services is clear. Much of the need for information arises in situations where the handiest medium for information delivery is a mobile information system. The health-care sector is no exception. Patient care in most environments is by its very nature a mobile experience, and a physician who can access information at the point of care and the point of need has a clear advantage over a colleague who is tied to a traditional desktop terminal. The use of mobile systems might substantially save time and effort as well as reduce errors that might be not only costly and inconvenient but even fatal.

It is generally agreed that mobile e-health applications for physicians must be designed to match their multiple needs, e.g. mobility, reliability, time saving and ease of use. The mobile medical information system that we studied is a set of databases where physicians can search and retrieve medical information and knowledge, e.g. medical guidelines, drug lists and diagnosis codes etc. at any time and in any place.

Research into how willing individuals are to adopt new technology show that individual characteristics, such as personality and demographic variables, together with situational variables accounting for differences attributable to circumstances such as experience and training (Agarwal and Prasad, 1999), are germane to the users' perception and intentions with regard to technology (e.g. Venkatesh and Davis, 1996 & 2000; Venkatesh and Morris, 2000).

Drawing on survey data reflecting Finnish physicians' interest in using the medical information system (interchangeably referred to *the mobile medical system* or *the mobile system* or *the system*), we address the following research questions:

(i): *What are the general perceptions, intentions and actual use regarding the mobile system by Finnish physicians?* Here we focus on physicians' preferred source of information using mobile devices, the content of the mobile information they most need, their future intention to use mobile Internet to access evidence-based medical guidelines - EBMG and the Finnish medical information Internet portal, Terveysportti - as well as their future intention to adopt mobile prescription.

(ii): *Do the individual characteristics/differences, i.e. working places, positions in hospitals, age, gender, education and current usage of Terveysportti affect physicians' perceptions and intentions towards the mobile system? If so, what causes the differences?*

2 LITERATURE REVIEW

2.1 Physicians' information needs and use of supportive medical IT tools

Medical knowledge is changing constantly. It is not easy for physicians to keep their knowledge and information up to date to help in their patient care and patient management efficiently on the one hand and to maintain the level of their professional competence on the other (Jousimaa, 2001).

Chamliss and Conley (1996) argued that physicians often had unanswered critical questions during patient care. The available medical literature can provide answers to most of the questions, but to search for and find these answers is time-consuming and expensive. Therefore, it was important to provide more efficient ways to help physicians seek and retrieve medical information or knowledge. Through a systematic review of physicians' information needs (Smith 1996) and their information-seeking behaviour (Dawes and Sampson 2003), it was found that physicians' desk references were the most common sources of printed information, but electronic information resources supported by computer systems had to be developed to meet the physicians' information needs and help them reduce the burden of information overload. They also argued that the best information sources for

physicians should provide relevant, valid material that can be accessed quickly and with minimum effort. Likewise, the sources enabled physicians to keep up to date and improve knowledge transfer. Finally, they pointed out the most important features that need to be taken into consideration when a new information tool is designed. These are that it should be electronic, portable, fast, easy to use, connected to a large valid database of medical knowledge and patient records and serve both patients and physicians. Verhoeven et al (2000) also emphasized these features in their empirical study where they examined which literature retrieval method was most effective for general practitioners (GP's) from the year of 1994 to 1997. They concluded that using printed sources might be the most effective medical literature retrieval method, but electronic sources seemed to be the most efficient. It is clear that physicians need to be encouraged to use electronic sources.

In spite of the advantages of supportive medical IT systems, they should be tailored to fit physicians' pragmatic working styles and the context of their work. Berg (1999) claimed that using IT tools in health care "*is dependent on the meticulous interrelation of the system's functioning with the skilled and pragmatically oriented work of health care professionals"*. As Jayasuriya (1998) indicated, health professionals were willing to use technology in their jobs when they perceived it to be useful for their performance. Ridderikhoff and van Herk (1999) studied physicians' attitudes towards a system supporting medical diagnosis. Their results showed that physicians were reluctant to use the system because the criticizing function did not match the physicians' information-seeking behaviour. The authors suggested that system designers should beware of not producing something that appears ultimately superfluous. Physicians, on the other hand, might change their behaviour to welcome criticism, thus creating a kind of match. Yong et al. (2001) reported that the usefulness of different types of technology for nurses' data entry was determined by the match between the utility and efficiency of data input technology (keyboard or pen-based) and clinical tasks (structured or textual data). Rousseau et al. (2003) also found a computerized decision support system for chronic disease to be useless in general practice since it did not fit well into general practice consultation. Another important issue is that an IT tool could help users to search for and retrieve information effectively from its right location and it should store knowledge which is dynamic and updated rather than static (Alavi and Leidner, 2001).

2.2 Mobilizing medical knowledge

A number of companies are extending their Internet services for physicians to make them compatible for use with PDA's or other mobile terminals. For example, the use of Personal Digital Assistants (PDA's) among doctors is rising; it had reached 27 % by 2001 in the U.S. (Harris Interactive, 2001). In Europe the leaders, in terms of the percentages of general practitioners who use PDA's in their practices are: the Netherlands (31%); the United Kingdom (18%); Spain (17%); France (11%); and Germany (10%) (Harris Interactive, 2002).

Mobile e-health services range from simple medical dictionaries to sophisticated patient data systems capable of handling digital images and lab test results. Another set of applications is being financed by the pharmaceutical companies and focuses naturally on the creating and handling of drug prescriptions.

All existing operating systems for mobile devices are supported; the following services for health-care professionals are listed in the Yahoo! Mobile portal: (http://mobile.yahoo.com) 331 for Pocket PC; 89 for Windows CE; 12 for Symbian; 781 for Palm OS in year 2003. Palm OS has become something of a standard due to its large market share among medical practitioners. The number of services available is of course far greater than those listed by this one portal, but the relative market shares of the operating systems are clearly visible.

In Finland, the first computerized medical information database was launched in 1989 and disseminated on diskettes. It mainly contained 20 Finnish guidelines dealing with common and important primary health-care problems. In 1991, a CD-ROM was published with the database as well as other addition databases, e.g. Finnish medial journals, laboratory databases, pictures. Throughout

the 1990's, Duodecim Publishers Ltd. owned by Duodecim—Finnish Medical Society, put more effort into improving evidence-based medical guidelines (EBMG) to make them more comprehensive and reliable. With the development of Internet technology, an Internet-based version was introduced in October 2000 (www.ebm-guidelines.com). Translation of these into English was completed in the year 2000 and into Swedish in 2001. Use of the computerized EBMG's by Finnish physicians was found to be very encouraging. They could usually find the information they were looking for, and their searches usually finished within 5 minutes (Jousimaa, 2001). EBMG has become an important source of information for Finnish physicians. Currently, EBMG as well as other databases, e.g. drug, diagnosis, etc. can be accessed by various channels, i.e. printed books (published annually), Intranet or the national Internet portal Terveysportti (www.terveysportti.fi), which also contains links to many domestic and international providers of health-care information. In 2002, a mobile version of those databases was developed and ready for a pilot trial.

The mobile medical information system is designed by Duodecim Publishers Ltd. It is a set of medical information and knowledge databases. It contains the EBMG (available both in English and Finnish) with Cochrane abstracts, the pharmacology database Pharmaca Fennica with wireless update service for a complete medicine price list, the international diagnosis code guide (ICD-10) in Finnish, the emergency care guide issued by Meilahti hospital, a medical dictionary of over 57 000 terms and a comprehensive database over health-care related addresses and contact information (pharmacies, hospitals, health centres). The content of the system is generated by an XML database. The system functions in most mobile devices operated by different systems, e.g. Symbian, Palm OS and Windows CE, etc. The device most commonly used as a platform in Finland is the Nokia 9210 Communicator. The mobile medical system is delivered on a 128 MB (later 256MB) memory card and is self-installing, containing the search engine, user interface programs and core databases. Currently, the update is delivered in the form of physical memory cards, the users returning the older ones. In the near future, it will be able to update itself partly or completely through the GPRS or UMTS wireless networks. In the autumn of 2003, the new medicine price list was successfully updated through the GSM network. Not only physicians involved in the trial, but also others are now able to get medical news in SMS form.

3 DATA COLLECTION

From spring 2003, the Publisher has, with support from Pfizer Finland Oy, started a pilot trial in which 800 physicians were given access to Nokia 9210 Communicators equipped with mobile medical databases. We adopted the convenient sample technique to collect data. The 500 physicians investigated in this survey received their devices and the questionnaire for the survey during training sessions from April to September 2003. The respondents were all medical practitioners holding different positions in health care, each of them having used or using the mobile medical system. During the six months of data collection, questionnaires have been amended twice. First, questions about access to Internet-based EBMG and Terveysportti through the GPRS mobile Internet were added, together with questions on what kind of information would be sought with the aid of mobile devices. The second time a question on physicians' current usage of Terveysportti was added. Therefore, the answers to those questions were comparatively fewer than the others. The questionnaire was intended to shed light on how the physicians perceived the mobile system and whether they intended to use it as well as other details about their work considered important by the Publisher. Our main attention here is to present findings concerning their perceptions and intentions regarding the mobile system. With 379 returned questionnaires, the valuable response rate was 75.8%. The variation in useful data of different questions is due to various missing answers.

4 RESULTS

We ran the SPSS Version 11.0 descriptive statistics frequency procedure to get a basic summary report of our data, as well as ANOVA and MANOVA procedures for identifying differences between groups.

The Bonferroni test was adopted for *post hoc* multiple comparisons. Some results discussed below are summarized in the Table 1; the results concerning the most wanted mobile contents are presented in Table 2.

4.1 Individual respondents' profile

Of the 379 respondents, 152 were from the Greater Helsinki area, which includes the cities of Helsinki, Espoo and Vantaa. Fifty-one were from the city of Oulu, 15 from Turku and 47 from Tampere, the rest from other small towns.

Of the 378 responses, 153 were from physicians working full time in health centres, 176 in hospitals, 26 were private doctors and 4 were researchers doing academic work only. Nineteen responses were from other service locations, e.g. from occupational health care. Of the 379 responses 226 physicians also had positions in hospitals. Among them, 1 was still a student, 47 were specializing physicians who are doing practical work to get specialist qualifications. One hundred and twelve were specialists and 66 were general practitioners. With five missing answers, 105 of 374, 28.1% were practically educated as general practitioners— GP and 269 (71.9%) were specialists.

The academic levels of the respondents were as follows: 60.3% (N=225) of the 373 response had a Licentiate degree in medicine (required to practise medicine), 11.8% (N=44) were studying further towards a doctoral degree, 18.5% already had a doctorate in medicine and 32 were Docents[1].

The gender distribution was 59.4% male and 40.6% female (N=374). The sample included a wide range of age groups. The youngest respondent was 23 years old, the oldest 67. The age variables were grouped in six categories. Most respondents belonged to groups 40-44 and 45-49, 21.6% and 25.1% of the 375 responses respectively. The mean age was 45 years. Due to the late inclusion of the question about current use of the Terveysportti, we only got 96 answers. With the exception of one 'never use' answer; the rest was divided into three user groups: daily, weekly and 1-2 times per month. Some of these results are presented in Table 1.

We further refined the 6 grouping variables for ANOVA/MANOVA analysis. We used 2 groups for work locations: public health-care centre and hospital. The answers for the 4 respondents doing research, 26 private doctors and 19 working at other locations were omitted because of the risks involved in making conclusions based on small sub-samples. We also used three groups of positions in hospitals, excluding the student group, which included only one received answer. The three groups were specializing, specialist and general practitioner. The educational variable chosen for further analysis was not the academic degree since all physicians in Finland have to hold at least a Licentiate degree in Medicine (LM) before they can do practical medical work. The presence of a higher academic degree might not necessarily affect their perceptions and intentions regard the mobile system. The practical education leading to specialist or GP status may have a direct effect on physicians' behaviour. Thus, the effect of this variable was studied further. The effect of current use of Terveysportti was examined as well.

4.2 Favourite information resources for searches with mobile devices

We listed five different possible information resources for which physicians would like to use a mobile device when acquiring information. The five information sources were: colleagues asking by sending a mobile e-mail or SMS; mobile textbooks; mobile EBMG; mobile medical journals or through mobile Internet online search engines, such as Medline. Physicians gave their agreements ranging from (1) completely agree to (5) completely disagree.

1 http://www.valt.helsinki.fi/sosio/english/staff/instructions/docent.htm

	Frequency		Favourites sources via mobile devices[1]						EBMG via mobile Internet[2]		Terveysportti via mobile Internet[2]		Mobile Prescription[2]	
				colleague	textbook	EBMG	Journal	Mobile Internet						
	N.	%	N.	Sig.	Sig.	Sig.	Sig.	Sig.	N.	Sig.	N.	Sig.	N.	Sig.
Work full time in	378		290						92		91		318	
Health-care centre	153	40.5	137	.180	.184	**.000**	**.000**	**.000**	74	**.016**	73	.399	147	.060
Hospital	176	46.6	153						18		18		171	
Positions in hospital	226		196						41		40		217	
Specializing	47	20.8	44						15		14		47	
Specialist	112	49.6	93	.076	.132	**.023**	.657	.277	18	.566[a]	18	.606[a]	108	.104
GP	66	29.2	59						8		8		62	
Age	375		332						118		117		362	
20-34	35	9.3	29						15		15		33	
35-39	55	14.7	52						20		19		54	
40-44	81	21.6	73	**.035**	**.029**	**.044**	.806	.365	27	.101	27	.248	79	.194
45-49	94	25.1	83						31		31		94	
50-54	61	16.3	56						15		15		55	
55-70	49	13.1	39						10		10		47	
Practical education	374		332						116		115		363	
GP	105	28.1	98	.394	.096	**.000**	**.008**	**.000**	59	.940	58	.703	103	**.012**
Specialist	269	71.9	234						57		57		260	
Terveysportti usage	96		89						92		90		93	
Daily	25	26.0	24						23		22		24	
Weekly	44	45.8	40	.122	.200	.236	.117	.378	43	**.007**	42	**.005**	43	.310
1-2 times/month	26	27.1	25						26		26		26	
Gender	374		331						118		117		361	
Male	222	59.4	202	.725	.638	.344	.558	.380	58	.240	57	.077	216	**.009**
Female	152	40.6	129						60		60		145	

Note: [1]values from MANOVA; [2]values from ANOVA; [a]due to the small number of the sub samples size, the values are from Kruskal-Wallis Test. GP—General Practitioner. The null hypothesis that the means between/among groups are equal would be rejected if Sig. <0.05. **Bold** value: Difference of means is significant.

Table 1 Physicians' perceptions and intentions with regard to a mobile medical information system (1)

The frequency analysis showed that of 353 answers, 44.3% completely agreed and 43.7% agreed to choose mobile EBMG; 31.8% completely agreed and 47.2% agreed to search mobile textbooks; 26.9% completely agreed and 40.8% agreed to search mobile medical journals; 37% completely agreed and 37% agreed to search Medline via mobile Internet, and only 13.0% completely agreed and 37.7% agreed to search information from colleagues. From this we might draw the conclusion that mobile EBMG and mobile textbooks were the two main sources that physicians would like to search with the aid of mobile devices.

The results presented in Table 1 seem to indicate that gender and current Terveysportti use have no effect on the physicians' preference for various information sources with mobile devices. Physicians working in health-care centres are more in favour of searching EBMG via a mobile device; those in hospital are more likely to search medical journals and Internet-based databases. The differences between specializing, specialist and general practitioners in hospitals were statistically significant at the .023 level when it came to selecting EBMG to search resources. Specializing physicians agreed on it more completely than specialists and general practitioners. This may be because they might need EBMG more than others to acquire medical knowledge during the process of becoming specialists. The effect of age on physicians' decisions to consult a colleague, textbook and EBMG via mobile devices is statistically significant; younger physicians are more enthusiastic than older ones to use the three sources. The *post hoc* test showed only that the age group of 55-70 differed significantly at the .042 level from the 35-39 group regarding using EBMG via mobile devices. Differences in experience also explained physicians' differing intentions to use EBMG, medical journal and Internet-based databases via a mobile channel. General practitioners greatly favour EBMG for finding sources but not medical journals and Internet-based databases in comparison with those practically educated as specialists.

4.3 Most wanted information contents of the mobile medical information system

We used three different perspectives to detect what are the most wanted mobile medical information contents by physicians. At first, we asked them whether they would look for information about certain treatments, drugs, certain diseases, health-care news and professional training via mobile devices. Frequency answers showed that of 119 respondents, 116 would search for certain treatments. Of 118 answers, 112 and 111 would look for drugs and certain diseases respectively. Half of the respondents (of N = 119) would seek health-care news and professional training information.

Secondly, we listed 8 different contents and asked them to rank them on a scale ranging from 1, the most wanted, to 8 the least wanted. The contents were EBMG, Pharmaca Fennica, ICD-10, medical journal abstracts, medical news via the Internet or by text messages SMS, health-centre address database, and emergency care guide. By computing the mean of available answers, EBMG, Pharmaca Fennica and ICD-10 were the top three most wanted contents of the mobile system. Medical journal abstracts, the emergency care guide and medical news from the Internet or text messages followed from 4 to 7. The database of healthcare centres' addresses was rated the lowest.

As the results in Table 2 show, individual differences do affect physicians' perceptions of what mobile contents in the system they most want. (1) Physicians working in different locations differed significantly in regarding EBMG, medical journal abstracts, medical news via mobile Internet and address database as the contents in the mobile system they most wanted. Physicians who work in health-care centres are more favour of EBMG and the health-care address database than those working in hospitals. The reason might be that these two contents are more relevant to them while journal abstracts and medical news through mobile Internet are favoured by those in hospitals. (2) Physicians holding positions in hospitals also differed in their perceptions of EBMG and medical news via mobile Internet as important contents. The *post hoc* test showed that those who are specializing consider EBMG more important than those who are already qualified specialists or GP's, while medical news was considered very valuable by specialists. (3)The youngest age group preferred the emergency care guide much more than other age groups, the difference being statistically significant at the .003 level.

The *post hoc* test showed the significant differences are between the age groups 20-34 vs. 50-54 (Sig. =.007), 35-39 vs. 50-54 (Sig. =.043) and 40-44 vs. 50-54 (Sig. =.013). It is obvious that younger physicians have practised medicine for a relatively short time and therefore need a basic guide to do their job. (4) Practical education also influenced physicians' perceptions of EBMG, medical journals, medical news through mobile Internet, or by SMS and the emergency care guide as important mobile contents. Generally, GP's like EBMG and the emergency guide more than specialists but not for medical journals, medical news by mobile Internet or SMS. (5) Daily users of Terveysportti considered EBMG as a more important mobile content compared with the other two groups of users. (6) Gender did affect physicians' preferences concerning EBMG and medical journals as important contents. Female physicians like EBMG more, while male ones prefer medical journals.

	The most wanted mobile contents[1]										
	N.	EBMG	Pharmaca Fennica	ICD-10	Journal abstracts	News via mobile Internet	News by SMS	Address database	Acute care guide	Terveysportti news via mobile Internet[2]	
		Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	N.	Sig.
Work full time in	205									321	
Health-care centre	94	**.000**	.709	.348	**.000**	**.001**	.246	**.027**	.673	147	.924
Hospital	111									174	
Positions in hospital	142									219	
Specializing	34	**.007**	.307	.286	.570	**.001**	.062	.894	.241	46	.229
Specialist	72									110	
GP	36									63	
Age	234									366	
20-34	24									34	
35-39	42									55	
40-44	51	.091	.849	.136	.160	.305	.202	.667	**.003**	79	.868
45-49	59									92	
50-54	33									59	
55-70	25									47	
Practical education	233									365	
GP	69	**.000**	.882	.581	**.002**	**.000**	**.007**	.901	**.036**	102	.456
Specialist	164									263	
Terveysportti usage	60									91	
Daily	13	**.046**	.983	.463	.583	.326	.458	.601	.193	23	**.008**
Weekly	30									42	
1-2 times/month	17									26	
Gender	234									365	
Male	142	**.001**	.381	.410	**.012**	.138	.895	836	.749	148	.068
Female	92									217	

Note: [1]values from MANOVA; [2]values from ANOVA. The null hypothesis that the means between/among groups are equal would be rejected if Sig. <0.05. **Bold** value: Difference of means is significant.

Table 2 *Physicians' perceptions and intentions with regard to a mobile medical information system (2)*

The third approach to identify what contents were needed by physicians was if they like to receive the Terveysportti news to a mobile device (Table 2). We used the physicians' future usage frequency to

determine whether such mobile news service would be potentially accepted. The frequency table showed that the physicians had a positive attitude to this service. Of 370 answers, 60.8% (i.e. N = 225) would use it weekly, 16.2% daily and 23.0% 1-2 times per month. The MANOVA results indicated that only current Terveysportti usage frequency had effects on the physicians' attitude to the service, other factors did not. Daily users would use it more frequently than the other 2 groups, significant at the .008 level. The difference was mainly between daily users and those using it 1-2 times/month (Sig. =.006) from the *post hoc* test. The obvious reason is that daily users have gained considerable benefit from such services from a wired Internet source thus possible delivery by wireless networks is more than welcomed. A positive relationship was also found between these two variables. The Pearson correlation coefficient was .323, significant at the .01 level (2-tailed).

4.4 Future intentions with regard to the Internet EBMG and Terveysportti through a mobile Internet connection

We used 5 degrees: daily, 2-4 times a week, once a week, less than a week and no use to measure the physicians' future intentions to use the Internet-based EBMG and Terveysportti through mobile Internet, when a constantly open and fast mobile Internet connection (GPRS or UMTS) is available at their place of work.

Of 118 answers, 40.7% would use the Internet-based EBMG daily via wireless networks, 34.7% would use it 2-4 times a week. Of 117 answers, 43.6% would use Terveysportti daily through a mobile Internet connection, 37.6% 2-4 times a week. Physicians generally had high intentions to use the two services. The further ANOVA results (Table 1) illustrated that the differences in the current usage frequency of Terveysportti through the wired Internet did make a big difference on the physicians' future intentions, significant at the .007 and .005 levels for EBMG and Terveysportti respectively. The *post hoc* test showed current daily users of the portal differed significantly from weekly users at the .006 level to use a mobile EBMG service via a wireless network. They also differed significantly from the other 2 groups at the .035 and .004 levels respectively regarding future use of Terveysportti via a mobile Internet connection. Current use of the portal was also found to have a positive relationship with these two variables; the Pearson correlation coefficients were .212 (significant at .05 level, 2-tailed) and .326 (significant at .01 level, 2-tailed). In general, daily users were more likely to use them (EBMG and Terveysportti) through a mobile Internet connection more frequently than the users in the other 2 groups. Physicians working at different locations were found as well concerning the future use of mobile EBMG service unequally, significant at .016. Physicians in health-care centres are likely to use it more frequently.

4.5 Future intentions with regard to mobile prescription

The mobile prescription program enables physicians to write a prescription with a mobile device. We used the alternatives of probably daily, 1-2 time a week, 1-2 times a month and never to measure the physicians' intentions to issue prescriptions via a mobile device in the future. The result was very positive (Table 1). With the exception of 20 never answers, of 366 responses, 26.8% indicated that they would use such a service daily, 33.3% 1-2 time a week and 34.4% 1-2 times a month. Physicians who have different practical experience differed greatly in their intentions to use such a service (statistically significant at the .012 level). Specialists were comparatively reluctant to use it. Gender also affects physicians' intentions (statistically significant at the .009). Men are more likely to use it than female physicians.

5 DISCUSSION AND CONCLUSIONS

This paper is designed to investigate physicians' perceptions and usage intentions with regard to a mobile medical information system in a pilot trial in the Finnish health-care sector that started in spring 2003. Findings from the survey showed that physicians had rather positive perceptions and future intentions to use the system in their work. The mobile EBMG and the mobile textbook were the

two most favoured sources of information physicians might consult via a mobile device. Mostly, they would search for information about certain treatments, drugs and diseases. They thought that the mobile EBMG, Pharmaca Fennica and ICD-10 were the most desirable mobile contents in the system. When a constant and fast mobile Internet (GPRS or UMTS) is available at their workplaces, they were highly motivated to adopt it in order to access the Internet-based EBMG and Terveysportti. Mobile prescription, a new way for issuing prescriptions, also seemed highly likely to be adopted.

5.1 Mobilizing medical information and knowledge

The nature of the physicians work is pragmatic and fluid. It is characterized by the constant emergence of contingencies that need a pragmatic reaction (Berg, 1999). Their information needs in any of these situations might be difficult to satisfy without mobile technology. From the technology-task fit perspective (Goodhue 1995 &1998), mobile technology might be better fitted to meeting physicians' needs in their task of treating patients in comparison with other technology, e.g. wired Internet and/or clinical workstations, which are not always accessible. The fit leads to their positive perceptions of the usefulness of and their attitudes to a mobile system, which in turn determine their intentions to use such a system at work (Davis 1989, Davis et al., 1989, Venkatesh et al 2003).

The physicians in this study have strong future intentions to adopt mobile contents. It is a solid basis for mobilizing medical information and knowledge since physicians, the potential users, are ready to explore mobile technology. It might be a good strategy to take full advantage of mobile technology when introducing mobile medical information and knowledge services to support physicians work, and particularly their work at the point of care and at the point of need. The mobile system studied here is a good way to integrate medical knowledge, i.e. EBMG, drug lists and diagnosis codes etc. into mobile devices. To some extent, it is a crucial starting point for mobilizing medical information and knowledge. The possible contents update through wireless networks in the near future will enable physicians to work in real time and feed them up-to-date medical information and knowledge.

5.2 Individual differences do matter

Individual differences do matter when it comes to the physicians' perceptions and usage intentions with regard to the mobile medical information system (Tables 1 & 2). For example, physicians working in hospitals were more interested in getting access to abstracts from medical journals and to Internet-based medical databases through the mobile Internet than those working in health-care centres, but not in EBMG, which those working in a health-care centre favour. Physicians who were in the process of specializing in hospitals were more willing to search for medical information from EBMG via a mobile device than specialists and general practitioners. Most of the grouping variables, except age affect physicians' perceptions of EBMG as one of the most desirable mobile services. Generally, female GPs who work in health-care centres rate it much more important than male specialists working in hospitals. Younger physicians believed the mobile emergency guide was by reason of its content much more important for them compared with other age groups. Gender and practical education affected the physicians' intentions to use mobile prescriptions. Basically, daily users of Terveysportti had more positive attitudes and strong future intentions when it came to receiving Terveysportti medical news, future access to Terveysportti and EBMG through a mobile Internet service. These results indicated the decisive role that experience obtained from using a similar system, exerted in influencing individual readiness to adopt the mobile system (Thompson et al 1994; Taylor and Todd 1995).

Highlighting the importance of understanding physicians' individual characteristics/differences helps to create "user profiles" to mobilize medical information and knowledge. Knowledge freedom is one of main values that could be created by mobile technology (Keen and Mackintosh 2001). It is about adding value to the organization and its workers through knowledge mobilization which brings information, communication and collaboration to them rather than them going to the sources.

The mobile medical information system studied here provides a traditional "push" mechanism for searching for and retrieving information. It is only one step further to make wired information contents available wirelessly. It does not exploit to the full advantages of the personalized and "pool" methods generated by mobile technology to match physicians' individual needs. Thus, to a great extent, it reduces its power to create "knowledge freedom" for physicians.

The findings from our survey could be used to clarify the necessity for improving or personalizing the mobile system. The personalized services for the physicians' medical information and knowledge needs will enhance their work performance by providing access to information they desire immediately at the point of care and at the point of need. Lack of time was identified as a paramount issue and a major factor that hindered physicians in their search for information (Dawes and Sampson 2003). Therefore, a personalized medical knowledge database might be a better mobile information service for physicians. By "knowledge freedom", physicians might even be motivated to use the mobile system in their leisure time to expand their knowledge capital. It may increase their personal well-being through greater satisfaction or enhanced expertise from using such a mobile system and by being recognized as a mobile computer expert (Vimarlund et al. 1999). Encouraging physicians' usage of the mobile system will be a win-win strategy for both individuals and health-care organizations.

5.3 Mobile prescription - a step further?

In the survey, we investigated the physicians' future intention to adopt mobile prescriptions. The positive answers we received showed that the physicians are ready to use it in their work practice. However, mobile prescriptions will not be a reality in the coming 1-2 years because the social welfare authorities in Finland do not accept mobile prescriptions at the moment. Social and legal issues have to be considered when implementing an information system that might transform the shape of the whole health-care industry (Harkke et al. 2002). Obviously, inserting new mobile technologies, such as mobile prescriptions, into established health-care practices, is a politically textured process of change. The relative advantages of mobile prescriptions in improving the patient care process are obvious and they might constitute a further advance in mobile medical information but they face a certain political difficulty.

Generally, the physicians have rather positive attitudes towards and future intentions to use the mobile medical information system. They frequently use it in their work, thus giving the potential to mobilizing medical information and knowledge supporting the physicians' work, particularly at the point of care and at the point of need. This study has proved the effects of individual differences among physicians in their perceptions and usage intentions regarding the mobile medical system under investigation. Therefore, future improvements to the system need to take personalized information services into consideration to ensure knowledge freedom in conditions of overcoming information overload and pooling information to the user.

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