# What Explains Doctors' Usage of Mobile Information and Communication Technologies? A Comparison of US and Portuguese Hospitals

**Henrique MG Martins[a], Matthew R Jones[a]**
**[a]- Judge institute of Management, University of Cambridge, UK**

*Abstract*

*Doctors, either as a result of individual initiative or departmental policy, may use a number of different mobile computers. The relationship between device ownership/provision and usage is, however, rarely discussed. This paper therefore presents survey data (N=267) on mobile computer ownership and use by doctors in two Portuguese and two US hospitals, considering both devices owned by individuals and those supplied by the hospital. The results show that ownership is not clearly related to either usage pattern or frequency of use. Providing handheld computers also did not lead to higher number of users, higher frequency of use or significant differences in tasks carried out. Nevertheless, doctors owning handhelds alone or in combination with laptops used them more frequently than those using laptops alone. Differences in usage pattern proportions rather than demographics were a better indication of differences in usage frequencies and the tasks for which MICT devices were being used.*

**Introduction**

Mobile Information and Communication Technology (MICT) devices are increasingly available at prices affordable by most doctors and their use has been proposed as improving patient care, for example by decreasing adverse drug events or facilitating evidence-based medicine[1]. While some commercial data exists on levels of ownership of mobile computers by doctors it is often predominantly about handheld computers and mostly US data. Less is known about use of other types of MICT device in other countries, or the relationship between ownership, or provision, of a device and its use.

Most medical informatics literature on MICT devices refers to department-lead initiatives to provide doctors with PDAs [2] or laptops [3], but these are often unbalanced and self-reported accounts. Although some survey data on PDA usage by doctors, on their own initiative, is available it is department specific [4]. Cross-departmental surveys tend to focus on residents only [5] and data presented rarely allows international comparison or lacks in-depth analysis [6]. There is also little research on adoption and usage of MICT devices, that focuses on ownership and usage as a result of an individual's own initiative. This paper presents evidence on ownership and usage of several MICT devices by doctors across several departments of two Portuguese hospitals contrasted with illustrative data from two departments of two different US hospitals, one of which provided its doctors with handheld devices. It addresses the individual usage of personally-owned devices by doctors, provides a comparison between users and non-users, different types of mobile computers as well as between doctors' usage of devices they had bought themselves and a sub-set of doctors to whom these were supplied.

**Methodology**

The particular findings discussed in this paper derive from surveys carried out between December 2003 and August 2004 regarding doctors' attitudes and usage of MICT devices in four hospitals/departments (A- Hospital Fernando Fonseca, Lisbon, B – Hospital Geral de Santo Antonio, Porto, Portugal; C- Washington Hospital Center Medicine Department, Washington, DC, and D- Albany Medical Center Emergency Department, New York, US). This survey formed part of a 1-year multi-site study of the use of MICT devices in eight hospitals in four countries (Portugal, UK, US and Singapore). The current paper deals predominantly with questionnaire findings although data were also collected by participant observation and interviews at each site.

Sites A and B were randomly selected from several large teaching hospitals in each of the two cities and were particularly suited as all doctors had similar access to a rudimentary hospital information systems and there was no initiative to provide MICT or intranet/library resources to support their use. Site C was selected as it represented a department where MICT devices were not being provided to doctors but there was organizational support for its use (eg. a library webpage for handheld users), whereas site D, represented a department where all doctors were provided with handhelds. Both sites C and D are large teaching institutions with a well-established, albeit incomplete, Electronic Medical Record available to all doctors.

Table 1- Sample characteristics. **Note:** junior is a doctor with up to 5 years of work experience. Figures in brackets are percentages.

| | Sub-samples | | | |
|---|---|---|---|---|
| | A | B | C | D |
| TOTAL | 82 | 111 | 44 | 30 |
| *Gender* Female | ***47(57)*** | 40(36) | 17(39) | 11(37) |
| *Physicians* | 45(55) | 46(41) | 44(100 | 30(100 |
| *Age* mean | 38 | 39 | 35 | 34 |
| <30y | 25(31) | 36(32) | 19(43) | 13(43) |
| 30-40 | 23(28) | 30(27) | 16(36) | 12(40) |
| >40 | 34(41) | 45(41) | 9(21) | 5(17) |
| *Seniority* Junior | 26(32) | 40(36) | 27(61) | 22(73) |

*Sub-samples and data collection*

Data were collected from the four sites using similar questionnaires to capture possible differences resulting from the effects of nationality, general IT level, and initiatives towards usage of MICTs (copies of the questionnaire are available from the authors on request). At sites A and B access was arranged by contacting all Heads of Department from a list provided by the organization. About two thirds of the departments at these sites provided access and either organized questionnaire distribution and collection (40% estimated response rate) or allowed questionnaires to be distributed, completed and collected during the course of a doctors' meeting (90%). The latter technique was used in both US sites.

A total of 296 questionnaires (93 from a site A – sub-sample A; 124 from Site B – sub-sample B; 46 from site C – sub-sample C and 33 from site D – sub-sample D) were collected. 29 responses were considered invalid due to high incompleteness or severe incongruence in answers provided. The total sample of N=267 represents about a third (site A) and a half (site B) of the total medical population in the two Portuguese hospitals, about half of the doctors in US site C and about two thirds of all doctors at US site D. Quantitative data were analysed using EpiInfo® software and appropriate statistical tests (Chi-square, Fisher exact).

**Results**

Table 1 shows the demographic characteristics of sub-samples A (82), B (111), C (44) and D (30). Specialities/departments represented in sub-sample A and B included different medical, surgical and other areas (eg. Pathology or House Officer/Resident doctors) rotating through several departments). Sub-sample C included only physicians working in a medicine department. Sub-sample D comprised Emergency Medicine physicians only. In each sub-sample, about a quarter to a third of doctors did not own any of the four MICT devices identified in the questionnaire (Handheld/PDA, Laptop PC, Smartphone, or Tablet PC), except in sub-sample D where the department had provided all doctors with handheld devices and where ownership was therefore 100%. Between 20% (sub-sample D) and 44% (sub-sample C) of doctors who owned a MICT device identified themselves as non-users. The proportion of users varied between 60 and 80% across the different sites. Four usage patterns may therefore be identified: "handheld only", "handheld+laptop", "laptop only" and "non-user", Table 2 shows respective values for ownership and usage patterns for all subsamples as well as the frequency of device use for clinical work and non-clinical work.

Table 2 – Ownership, usage pattern and frequency of use (by user groups). Values in brackets are % of total.

| | Sub-Sample A | | Sub-Sample B | | Sub-Sample C | | Sub-Sample D | |
|---|---|---|---|---|---|---|---|---|
| TOTAL *Sub-sample* | | 82 | | 111 | | 44 | | 30 |
| *Ownership* \| *Usage Pattern* | | | | | | | | |
| Handheld Only | 4(5) | 5(6) | 1(1) | 2(2) | 6(14) | 5(11) | 14(47) | 11(39) |
| Handheld and Laptop | 17(21) | 19(23) | 11(10) | 13(12) | 21(48) | 20(45) | 14(47) | 12(40) |
| Laptop Only | 34(42) | 34(42) | 60(54) | 60(54) | 6(14) | 1(2) | 2(6) | 1(3) |
| Do not own any/non-user | 24(29) | 24(29) | 35(32) | 36(32) | 10(23) | 18(42) | 0 | 6(20) |
| Own other combinations | 3(4) | -- | 4(4) | -- | 1(2) | -- | 0 | -- |
| TOTAL *of Users* | | 58(70) | | 75(68) | | 26(60) | | 24(80) |
| Frequency of use for: | | | | | | | | |
| *Clinical W* \| *Non-clinicalW* | | | | | | | | |
| Never to 1/week | 12(21) | 22(38) | 31(41) | 28(37) | 1(4) | 7(27) | 6(25) | 11(46) |
| 1/day-to-1/week | 32(55) | 29(50) | 30(40) | 34(45) | 5(19) | 6(23) | 3(12) | 6(25) |
| >1/day | 14(24) | 7(12) | 14(19) | 13(18) | 20(77) | 13(50) | 15(63) | 7(29) |

Table 3 – Tasks for which MICT devices were regularly used. **Note:** Respondents could choose more that one task. Values in brackets are % of total. Mean % - mean of the 4 sub-sample percentages for each task

| | Sub-sample breakdown | | | | Mean% | Total | Usage pattern breakdown | | |
|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | | | H | H+L | L |
| TOTAL of users | 58 | 75 | 26 | 24 | | 183 | 23 | 64 | 96 |
| Tasks: *Access* | | | | | | | | | |
| patient data | 15(26) | 20(27) | 1(4) | 0(0) | 14 | 36(20) | 2(9) | 14(22) | 20(21) |
| medical reference info | **36(62)** | **38(51)** | **19(73)** | ***18(75)*** | **65** | 111(61) | ***18(78)*** | **39(61)** | 54(56) |
| drug reference applications | 22(38) | 27(36) | ***24(92)*** | ***21(88)*** | **63** | 94(51) | ***19(82)*** | **47(73)** | 28(29) |
| medical calculation applications | 14(24) | 12(16) | ***21(81)*** | ***18(75)*** | 49 | 65(36) | **14(61)** | **41(64)** | 10(10) |
| clinical work related emails | **31(53)** | 24(32) | 3(12) | 4(15) | 28 | 62(34) | 1(4) | 17(27) | ***44(46)*** |
| search Internet for medical info | ***45(78)*** | ***64(85)*** | 4(15) | 5(21) | 50 | 118(64) | 3(13) | 30(47) | ***85(89)*** |
| hospital documents/guidelines | 2(3) | 5(7) | 1(4) | 3(12) | 6 | 11(6) | 1(4) | 4(6) | 6(6) |

In total, 183 doctors reported that they used MICT devices. The breakdown of the frequency of usage (Table 2) and tasks for which MICT devices were used (Table 3) are shown. Overall, the main tasks for which MICT devices were being used was to access medical reference information, the Internet and drug reference applications. Hospital documents/ guidelines were rarely accessed using MICT devices.

*Analysis*

The results were analysed for differences between sub-samples for all variables, and within each sub-samples the relationships between variables (Age, gender, seniority, grade, being a physician or surgeon, MICT ownership, usage pattern, frequency of use). The following were significant findings regarding the differences and relationship between variables:

Sub-samples showed no difference in proportions in particular age groups (Table 1), although the Portuguese hospitals had a significantly higher proportion of senior doctors than the US hospitals ($p>0.05$). With respect to gender, only sub-sample A was significantly different from the others with a higher proportion of female doctors. Sub-samples varied in terms of the specialities represented although sub-samples A and B had similar proportions of physicians and non-physicians and sub-samples C and D only included physicians. Whether a doctor was a physician was not found to be related with differences in any of the variables of interest. A detailed comparison between physician and non-physician groups is therefore not presented.

The US sub-samples had a higher proportion of MICT device owners than the Portuguese but all sub-samples displayed the same proportion of non-users. Ownership and usage was positively correlated for all sub-samples, but sub-sample C, and especially D, where handhelds had been provided by the hospital, displayed the highest proportion of owners that did not use their devices. Regarding ownership and usage pattern the only difference between Portuguese doctors in sub-samples A and B was that more Lisbon doctors (A) owned and used only handheld computers. In the US, the two hospitals had a similar proportion of non-users despite universal handheld ownership at hospital D. Sub-sample D displayed a higher proportion of doctors that owned a handheld only ($p<0.01$) but had the same proportion of handheld-only users. The US hospitals had the same proportion of owners and users of laptops in isolation as the Portuguese, but displayed a higher proportion of owners and users of handheld computers (only, and combined with laptops). Usage patterns were not related with age, seniority, gender or whether the doctor was a physician at any of the four sites.

Portuguese doctors in Lisbon (A) used MICT more frequently than in Porto (B) for clinical work related activities but not for non-clinical work. US doctors used their MICT devices with similar frequencies for both activities, and used them more frequently than Portuguese doctors ($p<0.05$). In all sub-samples, doctors using "handheld only" and "handheld+laptop" did so with similar frequency for clinical and non-clinical work while those using "laptop only" used them less frequently. For US doctors that used handheld devices (only, or combined with laptops) those from sub-sample D displayed a lower frequency of use for non-clinical work while similar frequencies were observed for clinical work activities.

Regarding tasks for which MICT devices were being used (Table 3), Portuguese doctors in Lisbon (A) used their MICT device(s) to access medical/drug reference information, for medical calculation

applications and to access emails more than those in Porto. Task frequencies between US sub-samples were not significantly different, but, aggregated overall, US doctors used their devices differently from those in Portugal.

**Discussion**

As other authors have found [4, 5], gender was not related with ownership or usage patterns. Previously reported differences between senior and junior doctors' usage of handhelds [4], however, were not seen in this study. Although some authors have also suggested that differences might exist between specialities[5], differences between physicians and non-physicians (eg. surgeons) were not found in this study and a larger sample would be required to study differences between individual specialities. Differences in speciality, however, are difficult to separate from differences in settings (particular department or hospital), which might influence doctors' willingness to use MICT devices.

Except for hospital D, where handhelds were provided, about three quarters (C) to two thirds (B) of doctors owned a MICT device. Of these, the vast majority of the doctors in Portugal used them, whereas in the US the number of owner doctors that did not use their device was higher, even though there was no difference between this groups and rest of the sub-samples or a particular type of device. Evidence from this study indicates that non-use of owned devices does not seem to be related with the type of device *per se*, but rather with "involuntary ownership" (ie, situations such as sub-sample D where handhelds had been provided to doctors).

Between countries the only difference in the ownership and usage of MICT was in respect to handheld computers. The number of US doctors that used laptops was the same, but in addition they also used handhelds more (either alone or in combination with laptops). Although sub-samples were different in some demographic variables these did not explain these differences, as they were not correlated with usage patterns. A possible explanation may be that although handheld computers are less expensive than laptops, they are a more recent technology that originated largely in the US and may not have diffused as widely as laptops. Lastly, as the US hospitals show, it is not clear that providing handheld devices necessarily increases the number of doctors using them, indeed it actually seems to increase the number of non-user owners. Reasons given for non-ownership and non-usage were similar and related predominantly with doctors' beliefs that they had no need for mobile computing, as the availability of desktop computers was sufficient to meet their needs. Another significant theme was a lack of interest in technology. This seems to suggest that usage numbers may be more related with individual choices about the usefulness of MICT devices for their work in a particular setting then other external factors. This is in line with data collected from other sites where MICT devices were made available to all doctors

The differences in frequencies of use between sub-samples may be explained by the different proportions of MICT devices in use. Thus, hospital A, which had a higher number of handheld (alone or combined with laptops) users than B, displayed a higher frequency of use for clinical work but not for non-clinical work. Likewise the US hospitals, with higher numbers of handheld users, seemed to display a higher frequency of use for clinical work and non-clinical work. In sum, a higher proportion of handheld users was related with higher frequencies of use, while a higher proportion of laptops users was actually related with lower frequencies of use. Thus, the type of MICT device appeared to influence the frequency of MICT device use. The number of MICT devices (2 or more), however, did not influence the frequency of use for clinical work related activities but was related with higher frequencies of use for non-clinical work (eg. preparing a presentation or lecture) in some hospitals. This interaction between the type of device in use and the number of devices used by each doctor could potentially be explained by the fact that devices might be used for different tasks (act as complementary devices) and thus having two different types would increase the flexibility and range of use, especially for less well-defined activities, such as non-clinical work Similar frequencies of MICT device use for clinical work, in the two US hospitals indicates that providing handhelds did not increase the frequency with which they were used, possibly because of the nature and characteristics of work.

It seems that when doctors bought MICT devices themselves, higher ownership levels lead to a higher frequency of use, but when devices were provided - "involuntary ownership" - this did not increase the frequency with which they were used. A doctor's decision to own a personal MICT device may thus affect how often he/she uses it, and department initiatives targeted at providing support for use only, or at providing the devices only, are not enough to increase frequency of use.

Differences in tasks for which doctors used their MICT device(s) in each hospital were observed not only between countries but also between sub-samples in each of the two countries. Differences between the type of tasks for which doctors in Portuguese and US hospitals and in the two Portuguese hospitals, used their MICT devices seemed to be explicable by the higher number of handhelds that US doctors used, in addition to similar numbers of laptops. Thus the tasks for which frequency of use was higher were also those that were preferred by all doctors who only used handhelds (and to a lesser extent those using handheld and laptop combined). US and Portuguese doctors rarely used their MICT devices to access hospital documents or guidelines which seems to contrast with the current thinking in medical informatics [2, 3, 4] that identifies MICT devices as the preferred means of accessing such organizational and online information sources to deliver support "at the point of care". One reason for this may be the high availability of desktops at the particular sites and potentially higher frequency of use. Although the evidence presented cannot substantiate this claim, it raises the question of whether mobile devices or desktops are the preferred means of access in practice and why?

This paper was limited by the convenience sampling technique used to study the US hospitals due to multi-national study constraints. The idea, however, was not to provide a representative picture of US hospital practices, since that has been attempted by others[4, 5], but to collect comparable data to that gathered from Portuguese hospitals. Further data on work practices and other variables affecting usage and adoption were gathered during the study, but were not reported due to space constraints. They are available from authors on request, however.

**Conclusions**

A significant proportion of doctors at the 4 hospitals did not have, or use, MICT devices. Although when devices were bought by doctors themselves a rise in ownership was associated with a rise in usage numbers, the relationship between ownership and usage of MICT devices was not straightforward. This was particularly the case when MICT devices like handhelds, for example, were provided by departmental initiatives. Providing handheld computers was not related with more users or higher frequency of use or significant differences in the tasks for which they were used, although larger samples would be needed to confirm this. Doctors using handhelds alone or in combination with laptops seemed do so more frequently, while those using laptops alone did so less frequently. Differences in usage pattern proportions and not demographic characteristics of the doctor population seemed better able to explain differences in usage frequencies and tasks. Handheld and Laptops were being used to support different work-related tasks. Understanding doctors' behaviour as buyers and users of various mobile devices may be relevant to the design of successful MICT-enabled infrastructures and prevent unsuccessful mobile computer supported implementations.

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