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Dual vs. Single Monitor in a Canadian Hospital Archiving Department: A study of Efficiency and Satisfaction

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ABSTRACT

This was a prospective study that compared, for each archivist, the time required to process records depending on whether a single or a dual monitor was used. We collected data for each archivist during her use of the single monitor for 40 hours and during her use of the dual monitor for 20 hours. During the experimental periods, archivists did not perform other related duties, so we were able to measure the real-time processing of records. To control for the type of records and their impact on the process time required, we categorized the major and minor cases based on whether acute care or day surgery was involved.

Overall results show that 1,234 records were processed using a single monitor and 647 records using a dual monitor. The time required to process a record was significantly higher (p-value = 0.071) with a single monitor compared to a dual monitor (19.83 vs. 18.73 minutes). However, the percentage of major cases was significantly higher (p-value = 0.000) in the single monitor group compared to the dual monitor group (78 vs. 69 percent). As a consequence, we needed to adjust our results, which reduced the difference in time required to process a record between the two systems from 1.1 to 0.61 minutes. Thus, the net real-time difference was only 37 seconds in favor of the dual monitor system. This represented a time savings of 3.1% and generated a net cost savings of 7896 Canadian dollars for each workstation that devoted 35 hours per week to the processing of records, over an amortization period of five years. Finally, satisfaction questionnaires responses indicated a high level of satisfaction and support for the dual-monitor system.

Keywords: Dual monitor, archiving department, efficiency.

1. INTRODUCTION

The productivity of the archiving department of the CHU of Sherbrooke (CHUS) has been affected by many factors. These include the shortage of staff, changing archiving practices, and the passage of the codification of the international classification of diseases (ICD) number 9 to ICD-10. These various changes have caused a 22% decline in productivity between 2007 and 2008, resulting in a cumulative delay of seven months in the processing of records.

To perform the analysis and codification of records, archivists must simultaneously consult multiple digital documents, including the electronic patient record ARIANE, the database MEDECHO, data from Microsoft Excel, the Canadian Classification of Interventions (CCI), and the new electronic classification ICD-10, which was previously issued as a book. In addition, some paper documents must be consulted. Therefore, archivists must switch between several windows of different software as well as paper documentation to obtain all the information required to process records.

One solution that has been proposed to reduce the backlog is to use dual monitors to maximize the simultaneous display of documents.

Primarily, this study focused on ergonomics, efficiency in terms of production time, the potential monetary gains from the purchase of dual-monitor stations and the satisfaction of archivists.

2. HYPOTHESES TESTED

Considering that archivists must check data from multiple applications to process a record, the use of dual monitors can reduce the loss of time associated with switching between windows. Doubling the surface display of information could, all other things held equal, increase the number of records processed by the archiving department.

3. OBJECTIVES

In regard to the hypotheses tested, the objective of this assessment was to study the potential benefits related to the introduction of computer stations equipped with dual monitors. Specifically, we looked at the following elements:

Efficiency
We compared the time required to process records according to the type of computer used: computer with a single monitor or computer with a dual monitor. Two types of cases were considered in this study: cases of acute care (major cases) and cases of day surgery (minor cases). Definitions for these cases are provided by the Canadian Institute for Health Information [1]. Acute care consists of medical, surgical or obstetric services for in-patient treatment and/or care. Day surgery corresponds to interventions or procedures to patients who are admitted and discharged from hospital usually on the same calendar day.

Cost savings
We evaluated the potential monetary gains as a result of using a dual monitor instead of a single monitor for processing records.

Archivists' satisfaction
Finally, we evaluated the satisfaction of archivists working with a dual monitor as compared to a single monitor.

4. PRELIMINARY STEPS

Ergonomics at work
The first step prior to assessing the effectiveness of using a dual monitor was to verify the ergonomics of the workplace. We consulted with an occupational therapist to verify the ergonomics in the workplace before and after the introduction of the dual-monitor stations. To avoid disturbing the ergonomics of the work environment, the occupational therapist suggested that each archivist should "have two identical monitors with a profiled contour as thin as possible. Both monitors should be placed on a unique stand to be adjustable in height and angle. The keyboard and mouse should be centered at the junction of the two monitors." Therefore, we followed these recommendations in our assessment.

Standardization of computer equipments
We listed the technical characteristics of the computer equipment used by the archivists that were likely to influence the performance of data processing. In fact, we collected the capacity of memory in megabytes, the power of video cards, the speed of central processing in megahertz, the disk space available, the spatial resolution of the display and the version of the operating system. Subsequently, using the results provided by the software EVEREST Ultimate Edition, we upgraded and standardized the overall performance of the computer stations by changing their components.

5. METHODOLOGY

Efficiency
Ten out of twenty archivists in the department participated in this study on a voluntary and anonymous basis. For the study, all study participants processed records on a single-monitor station and a dual-monitor station. According to statistics collected periodically by the archiving department, we estimated that an archivist could process about 2.5 records per hour. For each type of monitor, we calculated that a minimum of 20 hours would be required to obtain data on a minimum of 50 records processed by each archivist.

Each archivist in the study processed records over a period of 40 hours using a workstation with a single monitor and over a period of 20 hours using a workstation with a dual monitor. The discrepancy in time was due to the fact that only one dual-monitor computer station was available for the entire assessment. The assessment periods consisted of four consecutive hours per day in each case. During these four hours, archivists did not perform other related duties, so we were able to measure the real-time processing of records.

To achieve an acceptable level of proficiency using the dual monitor, each participant trained for a week on a workstation with a dual monitor for four hours per day for a total of 20 hours. For the assessment, we did not include data from this first week of adaptation.

A grid survey was distributed to the archivists to record the real-time processing for each medical record and the area of medical specialty as well as the type of record considered (major vs. minor). The processing time for each record was measured by the computer clock.

Cost savings
We examined whether there was interest from CHUS to finance the enhancement of the archiving department's computers by adding the components needed to install dual monitors.

Therefore, we evaluated the costs of changing a conventional workstation with a single monitor to a workstation with a dual monitor. This change corresponded with the purchase of two identical monitors (recommended by the occupational therapist), a graphics card with the capacity to manage two monitors, and an adjustable monitor stand so as to orient the two monitors as recommended by the occupational therapist.

We calculated the cost savings in terms of time savings afforded by using a dual monitor instead of using a single monitor. In this study, the annual salary for an archivist was 58,360 CAD (with fringe benefits, social benefits, and payroll taxes).

Archivists' satisfaction
We evaluated the satisfaction of the archivists on using a workstation with a dual monitor. To do this, we distributed three questionnaires that focused on ergonomics, efficiency, and general satisfaction. These questionnaires were completed by the archivists at the end of the study.

6. RESULTS

Five archivists participated in the study in June 2008, and five more participated in September 2008. All archivists were women, with an average age of 32 years, and their average experience on the job was 119 months (9 years and 11 months).

A total of 1881 records in 56 medical specialties were processed. In this study, pediatrics, orthopedics, plastic surgery, general medicine, external medicine, cardiology, obstetrics and general surgery accounted for 50% of the specialties in the records.

Of the 1881 records, 1234 records were processed with a single monitor and 647 records were processed with a dual monitor. The chart below shows the breakdown of records processed and the time required for processing based on the type of monitor used as well as the type of case (acute care or day surgery).
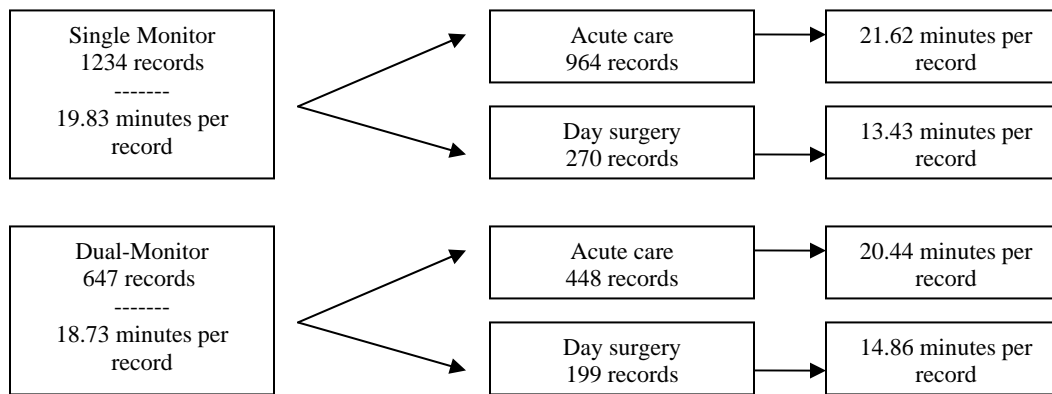
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┌─────────────────┐                    ┌─────────────────┐      ┌─────────────────┐
│  Single Monitor │           ┌───────▶│    Acute care   │─────▶│ 21.62 minutes per│
│   1234 records  │          ╱         │    964 records  │      │     record       │
│   -------       │─────────╱          └─────────────────┘      └─────────────────┘
│ 19.83 minutes per│         ╲          ┌─────────────────┐      ┌─────────────────┐
│     record      │          ╲───────▶ │   Day surgery   │─────▶│ 13.43 minutes per│
└─────────────────┘                    │   270 records   │      │     record       │
                                        └─────────────────┘      └─────────────────┘

┌─────────────────┐                    ┌─────────────────┐      ┌─────────────────┐
│  Dual-Monitor   │           ┌───────▶│    Acute care   │─────▶│ 20.44 minutes per│
│   647 records   │          ╱         │    448 records  │      │     record       │
│   -------       │─────────╱          └─────────────────┘      └─────────────────┘
│ 18.73 minutes per│         ╲          ┌─────────────────┐      ┌─────────────────┐
│     record      │          ╲───────▶ │   Day surgery   │─────▶│ 14.86 minutes per│
└─────────────────┘                    │   199 records   │      │     record       │
                                        └─────────────────┘      └─────────────────┘
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Chart 1: Breakdown of records processed and the time required for processing based on the type of monitor used and the type of case.

For using the single monitor system, we found that for cases of acute care, which are cases that are longer to process because of their complexity, compared to cases of day surgery, which are easier cases to process, there was a difference in processing time of 8.19 minutes per record. For using the dual monitor, this difference was 5.58 minutes per record.

Efficiency

The average time spent on processing a record using a single monitor was 19.83 minutes, while the average time with a dual monitor was 18.73 minutes. The difference was 1.1 minutes (1 minute and 6 seconds). Archivists would, therefore, be more efficient with a dual monitor.

A simple student t-test to compare the difference in means indicated that the difference of 1.1 minutes is statistically significant (p-value = 0.0713).

Table 1: Student t-test for the difference in record processing time (in minutes) between single and dual monitors

Group	No. Obs.	Mean	S-D	[CI 95%]		P-Value
Single M	1234	19.83	16.48	18.91	20.75	
Dual M	647	18.73	13.32	17.70	19.76	
Overall	1881	19.45	15.47	18.75	20.15	
Difference		-1.10		-2.57	0.37	0.0713

A more detailed analysis shows, however, that the statistical significance of the difference in processing time between the two types of monitor use is mainly due to the difference in the distribution of major and minor cases assigned for processing. A total of 78.1% of the records processed using a single monitor were major cases, compared to 69.2% using the dual-monitor group; this difference of 8.9% was statistically significant (Table 2). The average time spent processing a major case record was significantly longer than that spent processing a minor case record (Tables 3 and 4); therefore, the average time spent processing a record using the single monitor was mechanically longer than that spent using the dual monitor.

Table 2: Student t-test for the difference in major case records between single and dual monitors

Group	No. Obs.	Mean	S-D	[CI 95%]		P-Value
Single M	1234	0.78	0.41	0.76	0.80	
Dual M	647	0.69	0.46	0.66	0.73	
Overall	1881	0.75	0.43	0.73	0.77	
Difference		-0.09		-0.13	-0.05	0.0000

Table 3: Student t-test for the difference in record processing time using a single monitor (in minutes) between major and minor cases

Group	No. Obs.	Mean	S-D	[CI 95%]		P-Value
Acute care	964	21.62	17.51	20.52	22.73	
Day surgery	270	13.43	9.69	12.27	14.59	
Overall	1234	19.83	16.48	18.91	20.75	
Difference		-8.20		-10.38	-6.02	0.0000

Table 4: Student t-test for the difference in record processing time using a dual monitor (in minutes) between major and minor cases

Group	No. Obs.	Mean	S-D	[CI 95%]		P-Value
Acute care	448	20.44	14.03	19.14	21.75	
Day surgery	199	14.86	10.63	13.38	16.35	
Overall	647	18.73	13.32	17.70	19.76	
Difference		-5.58		-7.77	-3.39	0.0000

This simple observation was confirmed by an ordinary least squares (OLS) regression, indicating a non-significant effect of the type of monitor (single monitor = 1; dual monitor = 0) on record processing time when a binary indicating the type of record processed was introduced (acute care = 1; day surgery = 0).

Table 5: OLS regression on record processing time

Variable	Coefficient	P-Value	[CI 95%]	
Single monitor	0.465	0.529	-0.985	1.915
Acute care	7.163	0.000	5.570	8.755
Constant	13.768	0.000	12.162	15.375
No. Obs.	1881			
R^2	0.04			

Therefore, to determine whether there was interest for the CHUS to adopt the dual-monitor system, we needed to calculate the real difference in record processing time according to the type of monitor and adjust for the percentage of major cases in each type of monitor usage.

This calculation was performed as follows: we artificially increased the number of observations in the dual-monitor group so that the percentage of major cases in this group was the same as in the single monitor group (78.1% instead of 69.2%).

Thus, as a result of increasing the size of the dual-monitor group with 261.7 records of acute care, the average time to process a record in this group became 19.22 minutes.

Therefore, with 78.1% of major case records in both groups, we found a difference of 0.61 minutes (19.83 – 19.22) in favor of the dual-monitor group; this represented a difference of 37 seconds for each record processed.

This difference of 37 seconds corresponds with a time savings of about 3.1% that can be applied using the dual-monitor system compared to using the single monitor system currently in the archiving department of the CHUS.

Cost savings
For the year 2008-2009, 16,451.24 hours were spent analyzing and coding 44,713 records; we calculated that each record was processed, on average, in 22.08 minutes and that each archivist spent, on average, 822.56 hours per year analyzing and coding 2,235.65 records. Considering that each archivist works a total of 1594 hours each year (after deducting holidays), it is possible to deduce that each archivist spends 51.6% of her time analyzing and coding records.

Therefore, it is possible to calculate the cost savings for a salary with fringe benefits (2.51 CAD), social benefits (13%) and payroll taxes (11.5%). These cost savings would be 934 CAD (0.031*0.516*58360) per year, per workstation. However, if workstations with dual monitors were used only for the analysis and coding of medical records (that is, 35 hours per week rather than 18.06 hours per week), then the cost savings for each workstation using a dual monitor would be 1809.2 CAD.

Amortized over a period of 5 years, with the cost of installing a dual monitor being about 1150 CAD for each workstation, the extra annual cost for a dual monitor would be 230 CAD over the cost of a single-monitor system.

Therefore, a net gain of 704 CAD per year and per workstation over a period of 5 years by the installation of dual monitors is theoretically feasible.
Without discounting the calculation, the annual net gain for 20 workstations would be 14,080 CAD or 70,400 CAD over 5 years. However, considering an annual 4% increase in archivists' salaries, at a discount rate of 5%, and the cash cost of installing dual monitors in the first year, the discounted net gain over 5 years would be reduced to 68,637 CAD.

Table 5: Costs of components required to change each workstation (prices estimated as of 1 January 2009)

Component	Unit cost ($)	Total ($)
Monitor	350,00	700,00
Dual-monitor graphics card	150,00	150,00
Monitor stand	300,00	300,00
TOTAL		1150,00

Archivists' satisfaction

The results of our satisfaction survey indicate that the vast majority of archivists (4 out of 5) found the dual-monitor system to be easy to use, more effective for the processing of records, and allowed for easier coding and transcription. In addition, the learning time (between 1 and 5 days) required to work with the dual monitor was considered sufficient.

In terms of ergonomics, we noted that the installation of the dual monitor on the desktop met the requirements for the codification work. The distance and height of the monitors, the size of the characters on the screen, the ease of navigating from one screen to another, the ease of navigating from one software application to another, the workspace, and the reflection of the display were all judged to be more than 85% adequate.

7. CONCLUSION

From this assessment, it is possible to detect a 3.1% difference in record processing time between using the dual-monitor system and the single-monitor system. Similarly, we find that the archivists had greater satisfaction and greater ease for the analysis and coding work using the dual-monitor system.

Indeed, archivists switched less often between applications and were more efficient, especially in regard to cases of acute care, for which the records are complex and time-consuming. Therefore, although the difference in record processing time between the two systems was minimal, the archivists considered the dual-monitor system to be easy and user-friendly.

Given the productivity gain of 3.1% and the current use of workstations to perform the analysis and codification of records (a task requiring 51.6% of an archivist's work time), the potential cost savings per workstation would be 704 CAD per year over 5 years. However, if the workstations using dual-monitor systems were used full time (35 hours per week) to process the analysis and coding of records, then the potential cost savings per workstation would be 1579.2 CAD per year over 5 years. Given the number of records to process, this would generate even more savings due to an overall smaller number of workstations that need to be equipped with the dual-monitor system.

8. REFERENCE

[1] Canadian Institute for Health Information, **CIHI Portal Analyst Training Pre-Reading**, Ottawa: Canadian Institute for Health Information, 2006.