A pilot study of noise level in a pharmacy department in a teaching hospital

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INTRODUCTION

Noise can be defined as an unwanted, intense, annoying or unexpected sound. Sound that interferes with the perception of a desired signal can also be defined as noise (enHealth Council 2004). Besides hearing loss, workplace noise exposure is related to many other adverse effects (Berglund et al. 1999). Noise interferes with speech perception and alters sustained attention both of which can cause workflow interruptions (Sbihi et al. 2010). Noise in the workplace also induces annoyance; increases fatigue and stress (Jansen & Schwarze 1988; Topf & Dillon 1988; Lazarus 1998; Berglund et al. 1999). Noise is associated with an increase in the number of errors in work for complex cognitive tasks (Mosskov & Ettema 1977a, b; Smith 1990; enHealth Council 2004) whereas for repetitive manual tasks, noise can enhance vigilance (Ising et al. 1980; Auburn et al. 1987). In hospital settings, the World Health Organization (WHO) recommends to limit the noise to an equivalent continuous noise level (L_{Aeq}) lower than 30 dBA inside the room not to disturb patient's sleep and rest (Berglund et al. 1999). However, the quality of the acoustic environment in hospitals is often very noisy (Busch-Vishniac et al. 2005). Studies have showed that noise levels varies in “quiet” hospitals between 40 to 50 dBA, from 50 to 60 dBA in “moderately noisy” ones and between 60 to 70 dBA in “very noisy” hospitals (Mazer 2002; Pereira et al. 2003; Busch-Vishniac et al. 2005).

In hospital pharmacy, workflow interruptions have been associated with dispensing errors (Flynn et al. 1999). Since noise has been associated to workflow interruptions, one could predict that dispensing errors would also be related to noise levels and signal-to-noise ratio (Flynn et al. 1996; Lambert et al. 2010). Only a few studies have been conducted about noise in hospital pharmacies. Reported noise levels vary from 55 to 68 dBA (Pai 2007; Otenio 2007). Given the paucity of data on ambient noise levels in hospital pharmacies and the recent introduction of robotic technology to prepare and track medications, this study measured the noise levels in different working areas of the central pharmacy of Centre hospitalier universitaire (CHU) Sainte-Justine in Montreal Quebec, Canada.

METHODS

Measurements were carried out in nine working areas of the central pharmacy. Figures 1 to 4 show the floor plans of the nine different zones (1-9) and indicate the sampling sites (A-X) used for noise level measurements. Two technicians work in zone 1 (Figure 1) picking unidose medications and loading ward carts for the dispensing to the inpatients. One technician works in zone 2 (Figure 1) preparing the narcotics. Five to seven employees work in zone 3 (Figure 2) that is devoted to the compounding of non-sterile preparations. One technician works in zone 4 (Figure 3) and prepares prescriptions for outpatients. One employee is assigned to zone 5 (Figure 3) which is used for storing medications. Zone 6 (Figure 2) is the anteroom to the sterile compounding room (zone 7 – Figure 2) where positive air pressure is maintained. Up to six employees work within this room processing sterile pharmaceutical preparations. There are seven laminar airflow hoods in this room and two of these are equipped with a sterile pressure pump. Zone 8 is a working space shared by students and clerical support staff. Zone 9 (Figure 1) is devoted to packaging; an automated packaging machine regularly runs in this space. With the exception of zones 6 and 7, the central pharmacy is laid out as an open-space. A large number of noise sources were identified in this environment: ventilation system, computers (constant operation), radios, refrigerators, printers, pneumatic delivery system, packing machines, ventilation hoods, pumps, phone ringing and employees' conversations.

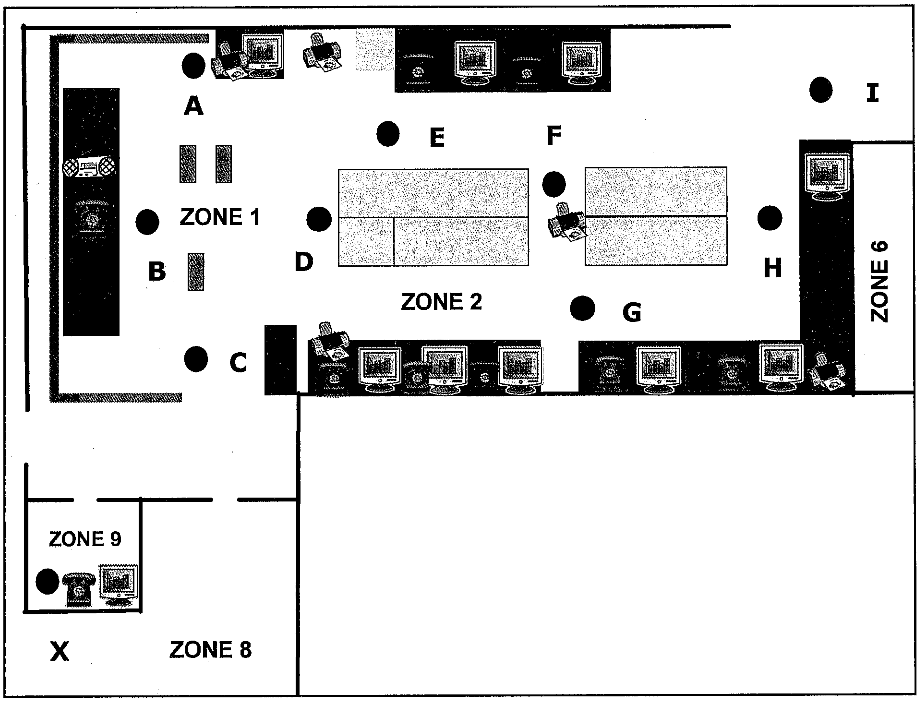

Figure 1: Floor plan zones 1, 2 and 9. Sampling sites (●).

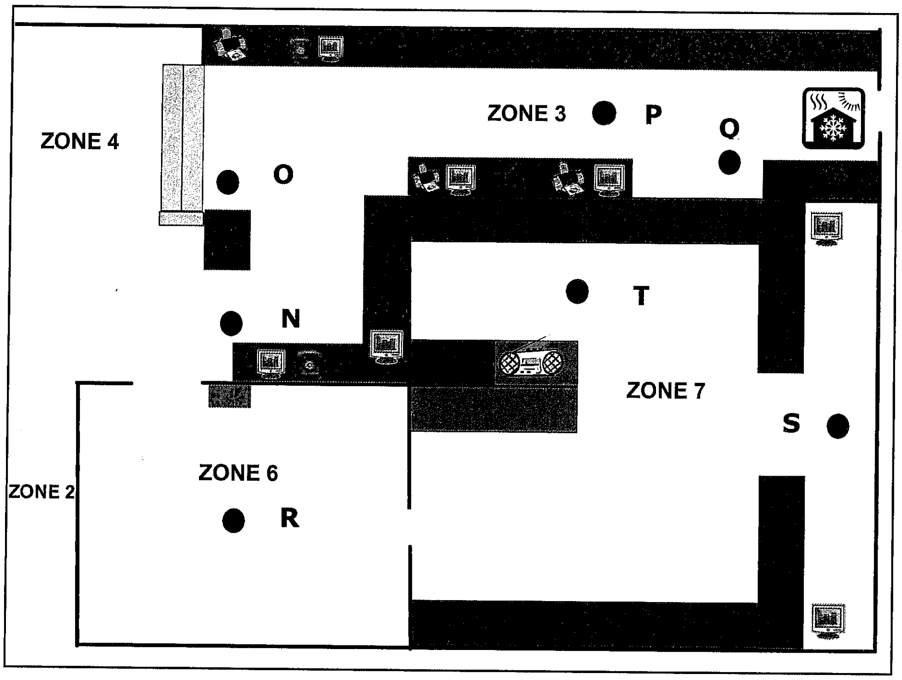

Figure 2: Floor plan zones 3, 6 and 7. Sampling sites (●).

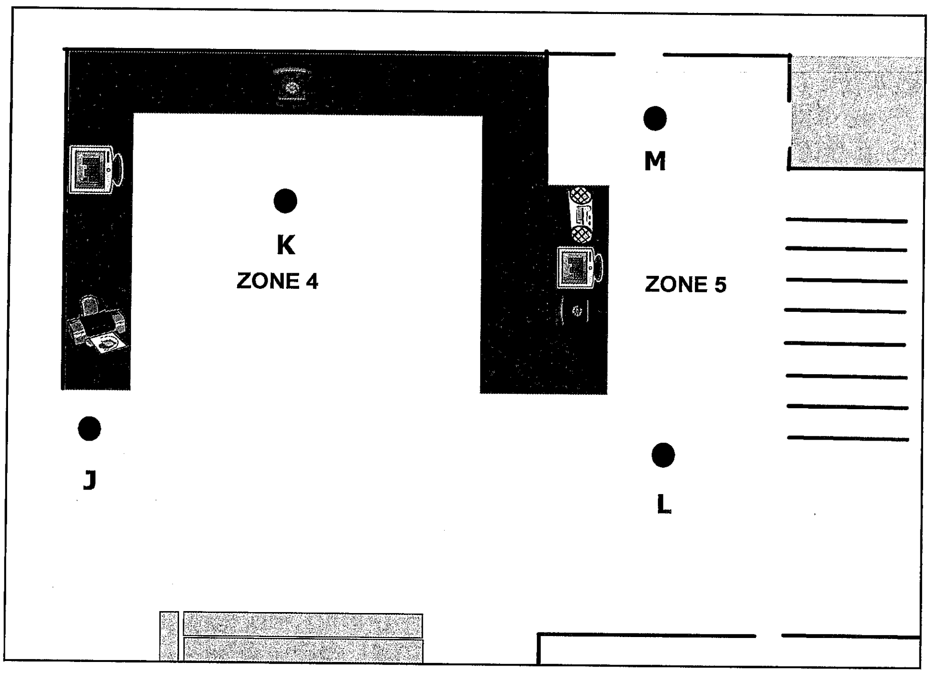

Figure 3: Floor plan zones 4 and 5. Sampling sites (●).

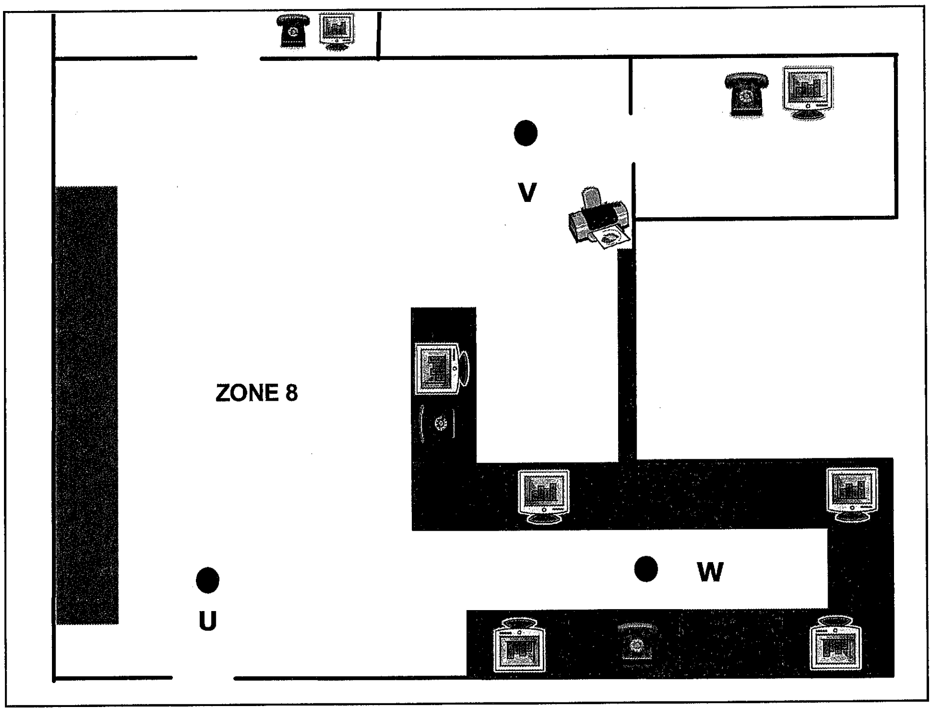

Figure 4: Floor plan zone 8. Sampling sites (●).

Noise levels were measured during three measurement periods, Day 1 and Day 2 from 9 am to 4 pm and Day 3 from 6 pm to 8:30 pm. An integrating sound level meter (TES-1353, type II) was set on slow response and installed on a 1.45 m tripod with the microphone oriented upward. The sound level meter was calibrated *in situ* by the use of an acoustic calibrator (94 dB SPL, 1 kHz) prior to and following each measurement session. $L_{Aeq\text{-}5min}$ were obtained twice for each sampling site. This sampling duration was considered long enough to include fluctuations usually found in this environment. Equivalent noise levels were averaged over measurement periods [day (Ld), evening (Le)]. In each zone, day and evening levels were compared with Student t-tests using $p<0.05$ for level of significance.

RESULTS

Data from different sampling sites were pooled across working zones and daytime period of measure. Repeated daytime measurement led to fairly similar levels with a few exceptions. Average noise level (in dBA) was higher during the day (Ld = 59.4 ± 5.3) than the evening (Le = 52.8 ± 8.2) [$p<0.001$]. The zones, in increasing order of maximum average noise level in dBA observed during the day (Ld) or the evening (Le), were the shared office area [Le:43.0; Ld:50.5], storage area [Le:53.8; Ld:57.8], dispensing/narcotics area [Le:51.4; Ld:58.5], dispensing/unidose manual picking area [Le:47.2; Ld:58.7], packaging [Ld:60.5], dispensing/outpatient area [Le:57.0; Ld:60.6], non sterile compounding area [Le:50.3; Ld:62.0], sterile anteroom [Ld:62.1; Le:63.4] and the sterile compounding area [Le:69.9; Ld:70.4]. Noise levels were found higher in areas with controlled positive ventilation, automation and higher number of workers. Table 1 provides detailed results.

Table 1: $L_{Aeq\text{-}5min}$ measured in nine working zones of the central pharmacy

Sampling sites	Day (Day 1)	Day (Day 2)	Evening (Day 3)	p value
Zone 1 - Dispensing/unidose manual picking area				
A	60.5	60.2	45.6	NA
B	54.3	57.0	47.0	NA
C	58.6	59.1	48.2	NA
D	59.6	60.1	48.1	NA
Mean	58.7		47.2	<0.0001
Zone 2 - Dispensing/narcotics area				
E	59.7	62.6	47.8	NA
F	59.0	56.2	53.2	NA
G	57.5	59.0	46.9	NA
H	57.4	57.0	57.0	NA
I	58.6	57.8	51.9	NA
Mean	58.5		51.4	0.0004
Zone 3 - Non sterile compounding area				
N	59.4	58.8	53.5	NA
O	61.2	60.9	54.6	NA
P	63.5	68.0	50.3	NA
Q	62.4	61.9	42.8	NA
Mean	62.0		50.3	0.0005
Zone 4 - Dispensing/outpatient area				
J	61.3	60.6	60.0	NA
K	59.8	60.8	54.1	NA
Mean	60.6		57.0	>0,05
Zone 5 - Storage area				
L	59.0	59.0	53.1	NA
M	53.2	59.8	54.4	NA
Mean	57.8		53.8	>0,05
Zone 6 - Sterile anteroom				
R	62.3	61.9	63.4	NA
Mean	62.1		63.4	>0,05
Zone 7 - Sterile compounding area				
S	68.9	69.3	69.7	NA
T	71.5	71.8	70.1	NA
Mean	70.4		69.9	>0,05
Zone 8 –Shared office area				
U	51.3	51.8	43.1	NA
V	44.8	49.8	38.6	NA
w	55.2	49.9	47.4	NA
Mean	50.5		43.0	0.02
Zone 9 – Medication packaging				
X	60.5	ND	ND	NA
Mean	60.5		ND	NA
Overall mean	59.4		52.8	<0.0001

NA: not applicable; ND: not done

CONCLUSIONS

Overall mean noise levels were significantly higher during the day (59.4 dBA) compared to the evening (52.8 dBA) a finding similar to available data collected by others researchers. Pai (2007) conducted a study in Taiwan in a large hospital (1,650 beds) and reported average noise levels for the pharmacy at 62.5 dBA in the morning, 63.9 dBA in the afternoon and 55.8 dBA at night. Otenio et al. (2007) sampled noise levels in a smaller hospital in Paraná, Brasil (222 beds). The noise levels measured between 7 am and 7 pm, varied from 58 to 66 dBA, with a mean value of 63.3 dBA. Night noise levels were lower, between 58 to 60 dBA most of the time. However, it is difficult to compare the absolute noise levels across studies because of methodological differences in the noise measurement methods (duration of integration time and exchange rate to cite a few), architectural and equipment differences in pharmacy's settings.

In our study, some working zones were markedly noisier than others (sterile compounding area > medication packaging > shared office zone). Higher noise levels can be explained by the presence of mechanical equipment (ventilation hoods, automated packing machine) and the number of employees simultaneously present in the open-space. Similar observations were made by Mendoza-Sánchez et al. (1996) who measured noise levels in various zones of a hospital. These authors found that high noise levels in the intensive care unit (ICU), above 59 dBA, were caused by the presence of numerous devices such as monitors, continuous infusion pumps, mechanical ventilation devices and alarms. Similar results, noise levels around 61 dBA, were reported for a neonatal ICU by Laroche & Fournier (1999). For hospital pharmacy, the introduction of robotics and automated machines could have the same cumulative effect and progressively increase the noise levels in this working environment.

Our results show preoccupying noise levels for hospital pharmacy given the demands imposed by the nature of the work: sustained attention required to complete complex processes, interference-free communication and frequent interruptions (Flynn et al. 1999). In open-space office, insuring interference-free speech communication imposes a limit for the level of noise of 48 dBA (Bradley 1985). The average daytime noise level obtained in this study exceeded this criterion by more than 10 dB (a ten-fold difference). Using this sole criterion, leaving aside other important aspects of the problem such as the adverse effect of noise on sustained attention and number of errors during complex cognitive tasks, one would predict that such noise levels could be associated to dispensing errors in hospital pharmacy practice. Flynn et al. (1996) reported that the dispensing error rate increased with sound pressure levels up to 74 dBA ($L_{Aeq\text{-}30m}$) and decreased for higher levels. In a study, conducted mainly in community pharmacies, Flynn et al. (2002) found a significant association between dispensing errors and ambient noise made from radio or television for sound pressure levels lower than 75 dBA. In a laboratory controlled study conducted with pharmacists, Lambert et al. (2010) showed that the verbal recognition of drug names was significantly influenced by the signal-to-noise ratio. Signal-to-noise ratios of 8, 5 and -2 dB were roughly associated with error rates of 25, 50 and 75 % respectively. Our results suggest that the noise levels within the hospital pharmacy might create challenging communication situations in terms of low signal-to-noise ratio which may interfere on different demanding tasks.

While this study has a number of limits (restricted number of sampling days, short duration of the integration time, possible influence of level of activity within the pharmacy, noise levels not taken at ear level for the workers), the results are solid enough to justify a more detailed study. Such a study would have to include a more thorough assessment of the acoustic environment (assessment of signal-to-noise ratio) and specific outcomes measures about work-related and noise-related stress, fatigue and systematic observation of dispensation errors. However, pharmacists and management teams should not wait to integrate the "noise aspect" in their plans before buying or installing robotic and automated equipments in order to maintain or create a better auditory environment for pharmacy practice in hospitals.

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