Assessment of Roadway Noise Level and Potential Mitigation Measures

Sayeeda Bint Ayaz[1] and Md. Mafizur Rahman[2]

[1]Dept. of CE, Dhaka University of Engineering & Technology (DUET), Gazipur, Bangladesh
[2]Dept. of CE, Bangladesh University of Engineering & Technology (BUET), Dhaka, Bangladesh

E-mail: Sayeeda_cebuet@yahoo.com

ABSTRACT

Noise, commonly defined as an unwanted sound, is an environmental phenomenon to which human are exposed throughout their life. Noise can also be considered an environmental pollutant, a waste product generated in conjunction with various human activities. Noise is not simply an annoyance rather a hazard to one's physical and mental well-being. This study attempts to assess the traffic induced noise and suggests some mitigation measures which are likely to reduce the level of noise. Maximum, average & minimum noise levels are measured at some severely exposed as well as sensitive locations of Dhaka city. The collected data are analyzed using GIS symbological analysis. Results reveal that level of noise at roadside exceeds the allowable limit to a great extent even in the sensitive locations like hospital, school, mosque etc. The deviation from standard limit is found awfully high. There exists a constant level of pollution resulting from unbounded movement of traffic throughout the city due to commercial, social, educational, recreational and other activities at working as well as holiday. This alarming level of noise is signaling to take immediate measures. Several measures are proposed which include staggered timing of schools and jobs, flexible work schedule, planned tree plantation along footpath, construction of noise barriers etc. Along with these, enhancing mass consciousness and implementation of proper monitoring system may significantly reduce the level of noise.

1. INTRODUCTION

With rising population growth, the urbanization in Bangladesh is also taking place at a quick pace. The current population of the country stands at 140.5 million out of which 12.7 million people live in the capital city, Dhaka. One estimate says by 2050, 57% of people will be living in cities, compared to 26% in 1990. By 2015, Dhaka may become one of the densest cities of the world. The unplanned urban development coupled with urban population growth result in increased demands for transport and in turn vehicle induced noise contributes to problems of high noise levels [1].

Noise is any sound – independent of loudness – that may produce an undesired physiological or psychological effect in an individual and that may interfere with the social ends of an individual or group.
Noise pollution can be defined as unwanted or offensive sounds that unreasonably intrude into our daily activities. It has many sources, most of which are associated with urban development: road, air and rail transport; industrial noise; neighborhood and recreational noise. A number of factors contribute to problems of high noise levels, including:

i. Increasing population, particularly where it leads to increasing urbanization and urban consolidation and activities associated with urban living generally lead to increased noise levels.

ii. Increasing volumes of road, rail and air traffic.

Community awareness of environmental noise has increased and there is a higher expectation for commonwealth, state and local government to reduce noise levels.
Although noise is a significant environmental problem, it is often difficult to quantify associated costs. An OECD report on the social costs of land transport identified four categories of impact from transport noise (OECD 1995) as

i. Productivity losses due to poor concentration, communication difficulties or fatigue due to insufficient rest

i. Health care costs to rectify loss of sleep, hearing problems or stress

ii. Lowered property values

iii. Loss of psychological well-being

1.1 Sources of Roadway Noise

Noise on roads is caused by engine of the vehicles, its exhaust, horn, brakes, friction between tires and road surface. Noise from the motors and exhaust systems of large trucks provides the major portion of highway noise impact, and provides a potential noise hazard to the driver as well. In the city, the main sources of traffic noise are the motors and exhaust systems of autos, smaller trucks, buses, and motorcycles. This type of noise can be augmented by

narrow streets and tall buildings, which produce a "canyon" in which traffic noise reverberates [2].

The noise from locomotive engines, horns and whistles, and switching and shunting operations in rail yards can impact neighboring communities and railroad workers. For example, rail car retreads can produce a high-frequency, high-level screech that can reach peak levels of 120 dB at a distance of 100 feet (EPA, 1974), which translates to levels as high as 138 or 140 dB at the railroad worker's ear [3]. In Dhaka vehicles create 95 decibel. Microphones about 100 dB(A) , scooters 80-90 dB (A) and trucks or buses 92 to 94 dB (A) [4].

1.2 Noise problems in Bangladesh

In Bangladesh noise problem is severe due to some special reasons which includes, vehicles horns are abused by drivers, horn is used to get right of way, strength of horn decides the power of vehicles, existence of non motorized vehicle on the same track encourage the use of horn, many vehicles have no side/rear view mirror especially non motorized vehicles- compel follower to use horn, use of hydraulic horn, most drivers like horn signal than light indicator signal for lane changing.

1.3 Health Effects in Dhaka City

The survey regarding noise pollution was performed by Geography & Environment department of Jahangirnagar University. 100 people were interviewed among different professionals like doctor, traffic police, driver, teacher, student, businessman and service holders. It was found that all of them were invaded with diseases due to excessive exposure of noise pollution [5].

The diseases which attacked among 100 people were as bad headache, temporary hear loss = 12.31%, fatigue = 17.58%, insomnia =14.36%, irritability = 27.57%, hear diseases = 25.80%, others = 2.64%

Therefore, if the prevention of environmental pollution and the preservation of the nature i.e. environment are to be achieved, then consideration for the environment must become an indispensable part of the development of road plans. Especially for a city like Dhaka which has over the years grown into a mega city, the roadside pollution problem is severe and is reported to be serious and damaging to public health.

1.4 Acceptable Limits of Noise (Bangladesh Standard)

To combat the hazards of noise pollution, standardization and fixation of tolerance limits of noise pollution is essential. The acceptable noise levels for different areas recommended by Bangladesh Department of Environment (DOE) are as shown in Table 1.

Table 1: Acceptable Noise Level for Different Areas

Description of area	Noise level dB (A)	
	Day Time	Night Time
i) A sensitive area where quietness is of primary importance such as schools, hospitals, mosques etc.	45	35
ii) Residential areas	50	40
iii) Mixed areas, which are, used as residential areas as well as commercial and industrial purposes.	60	50
iv) Commercial areas	70	60
v) Industrial areas	75	70

2. OBJECTIVES OF THE STUDY

The objective of this study is to investigate the level of noise pollution produced from traffic vehicle movement for a selected zone in Dhaka city from the perspective of public health and transportation planning. The above objective of the study thus focuses on the following specific objectives as follows:

i. Study of the existing condition, effects and mitigation of roadside noise pollution.
ii. To evaluate the maximum, average & minimum noise level at different points for both working and holiday in the study area.
iii. To determine whether the noise level at a particular place is unacceptable limit or not with respect to maximum, average & minimum noise level for both working day and holiday in the study area.

3. METHODOLOGY

The method was designed and conducted in such a way that it accomplished the basic requirements for a successful research work as follows:

i. The first was the attempt of spreading of the data collection effort in different areas in such a way that the obtained results may be regarded as representative of the actual situation.
ii. The second was the attempt of collection of enough data to allow conclusions to be drawn regarding level of noise pollution in different areas.
iii. The third was the attempt of making maps of the affected areas in various levels of noise pollution in the study zone using GIS.
iv. The fourth was the attempt of analyzing the level of noise pollution using GIS.

3.1 Field Survey and Data Collection

A preliminary survey was performed in order to get an overall idea of the study area and also to prepare a schedule of the data collection procedure of the entire area in a systematic way.

3.2 Site Selection

The site selection was done in such a way that almost all categories of noise affected areas could be represented in this study so that the scenario of noise pollution in Dhaka city could be reflected. These areas were taken as per the recommendation of Bangladesh Department of Environment (DOE).

The study location was a part of Dhaka city which included mainly Ramna Thana. Fig. 1 and Fig. 2 show the location map of the study area. Site location points were shown in the map. Data were collected at 48 places.

The data collection places were as follows:

T.S.C, Charukola Bhobon, I.B.A Building, Shahabag, BSMMU (Main Gate), BSMMU (Inside), Sheraton, Telecommunication Building, Padma Officers' quarter (Poribag), Opposite Side of Manob Jomin (Bangla Motor), 21/3-Banglamotor (World Literature Centre Side Road), Banglamotor intersection, Sonar Tori Building, Janakantha Bhaban, Holy Family Medical College & Hospital, Opposite Side of Judges Residence & Newly Constructed Building, Eskaton Garden Officers' Quarter, Mintu Road intersection (Sheraton End), Mintu Road intersection (Moghbazar Road End), Orunodoe Gate (Ramna Park), Ramna Botomul, Ostachol Gate (Ramna Park), Kakrail Mosque, Matshaw Bhobon, Supreme Court, Press Club, Doel Chattar, Three Leaders' Mazar, PWD Building, Ramna Lake End (Near Ostachol Gate), Sishu Park, Over Bridge of Ramna Park, High Court intersection, High Court Mazar, Karjon Hall, Arts Faculty (Dhaka University), Holy Family Medical College & Hospital Boundary Corner, Department of Women Affairs, Eskaton Garden High school, Red Cresnt Borak Tower, Tenament House Gate, State Guest House 'Megna', Baily Road-Mogbazar Road intersection, Kakrail intersection (Mogbazar intersection end), National Monument (Ramna), Mogbazar intersection, Aziz Super Market and Akbar's Nakshi Palace. The study area is shown in Fig. 1 and Fig. 2.

The study area was one of the most important parts in Dhaka city which was surrounded by the centre of the city Motijheel, the industrial zone Tejgaon, the residential as well as commercial area Dhanmondi, Khilgaon area, Lalbagh and kotwali thana. All these areas constitute the major commercial, social, educational and other activities in the city. Therefore, a huge quantity of traffic generated from all of these areas contributed to the increased traffic generation along the roads of the Ramna area, thus had greater impact on increasing the traffic induced noise in that zone.

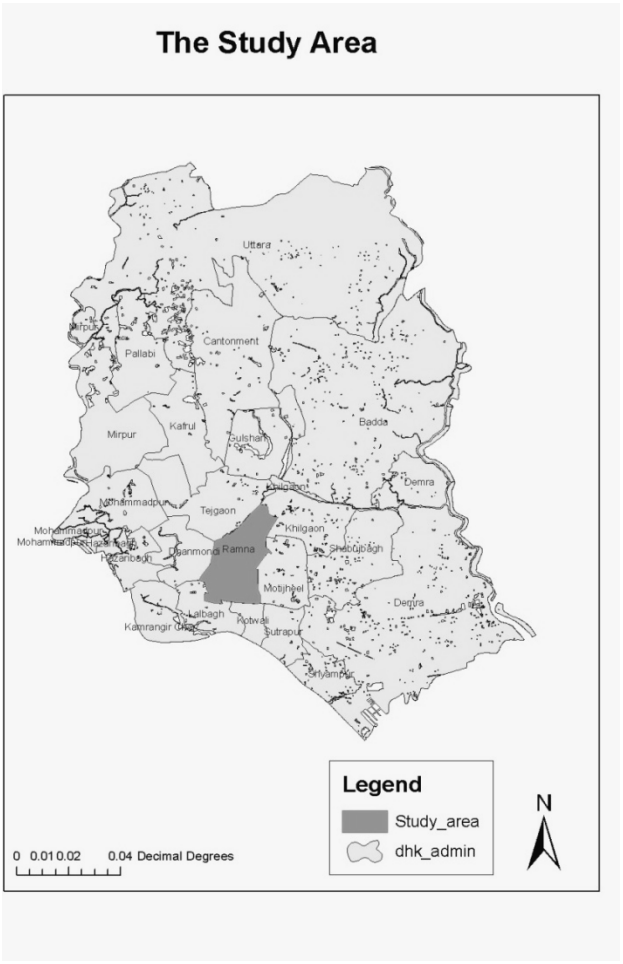

Fig. 1: The Study Area in Dhaka City.

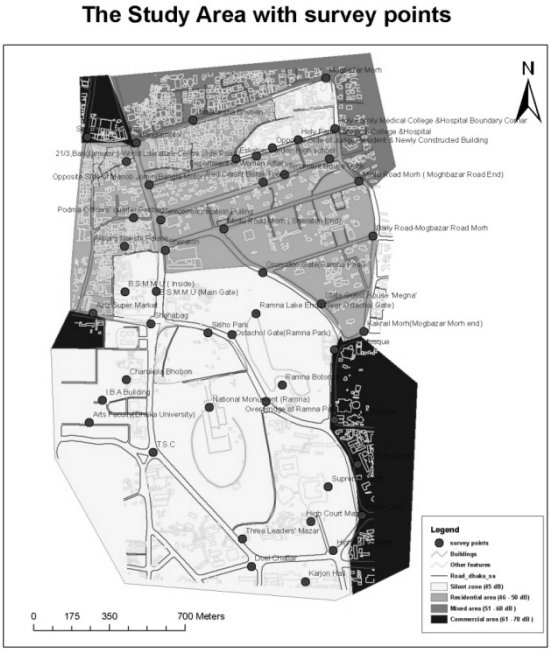

Fig. 2: The Study Area with Survey Points Based on Acceptable Noise Level for Different Areas. (Source: DOE, BD).

There were three hospitals viz. the Holy Family Hospital, the Bangabondhu Sheikh Mujib Medical University (BSMMU) and the BIRDEM Hospital which were all sensitive areas under the study zone.

The biggest Dhaka University area in our country was also included in the study zone. The study area included Supreme Court, High Court, Ramna Park, Shisu Park and also a five star hotel named Sheraton.

There were mixed areas like Maghbazar, residential areas like Pori bag, and commercial areas like Banglamotor which were also included in the study zone. As a result, almost all categories of noise affected areas were represented in the study zone.

3.3 Noise Level Measurement

Noise level data were collected from the study zone using noise meter. The data showed by the noise meter was directly in decibel (dB). The instrument for measuring noise is the basic sound level meter, which consists of a microphone that converts the pattern of sound pressure fluctuations into a similar pattern of electrical voltage, amplitudes, and a voltage meter that is normally calibrated to read in decibels. Data were collected for different specific locations in the study zone in hourly interval. These were taken for both working and holiday.

Decibels are measured, most commonly, on the A, B, and C weighting scales. There is also a G-weighting scale that is used to measure infrasound [6]. C-frequency-weighting was used during data collection.

3.4 Geographical Information Systems (GIS)

GIS provides a comparatively new mechanism for capturing geographic knowledge. A GIS is a system for management, analysis and display of geographic knowledge, which is represented using a series of information sets. These information sets include maps and globes, geographic datasets, data models, processing and work flow models, metadata, and descriptive attributes.

The noise level data were analyzed using GIS. Using these date several maps were plotted showing the maximum, average and minimum noise level of the survey points. Finally, analysis was done to determine whether a particular point was at alarming level or not with respect to the allowable limit of that specific category of area.

4. DATA ANALYSIS & RESULTS

The noise data were collected at forty eight points in the study zone from 6am to 7pm and the noise level variation was classified into following ranges: less than45 dB, 45-50 dB, 51-60 dB, 61-70 dB, 71-80 dB and greater than 80 dB for both working day and holiday.

4.1 Noise Level for Working Day and Holiday

Among the noise level data which were collected from various points, the maximum, average & minimum values of noise at the respective points between 6 am to 7 pm were determined for both working day and holiday.

Fig. 3 to Fig. 5 shows the maximum, average and minimum noise level of the survey points for working day and holiday. These were obtained from GIS symbological analysis.

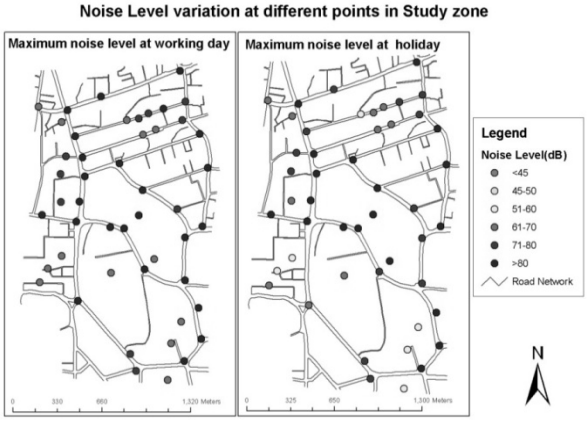

Fig. 3: Maximum Noise Level for W.D and H.D.

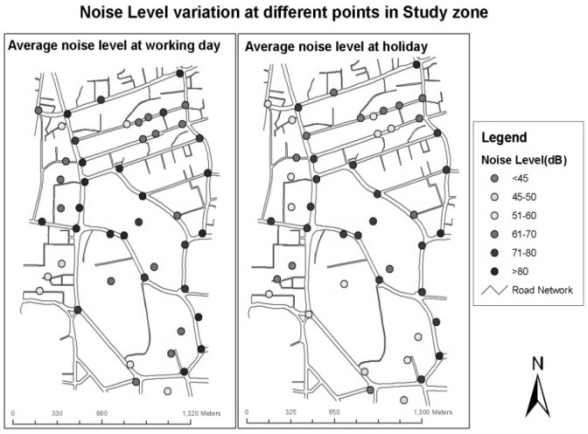

Fig. 4: Average Noise Level for W.D and H.D.

4.2 Alarming and Non-alarming Areas with respect to different Noise Level

The maximum, average & minimum values of noise level at various points were represented as alarming or non-alarming with respect to the acceptable limit of that specific category of noise area from 6am to 7pm for working day and holiday. The results were obtained using GIS symbological analysis.

Fig. 6 shows that among 48 places Sonar Tori Building was only within acceptable limit (less than 70 dB) in case of maximum noise level for both working day and holiday.

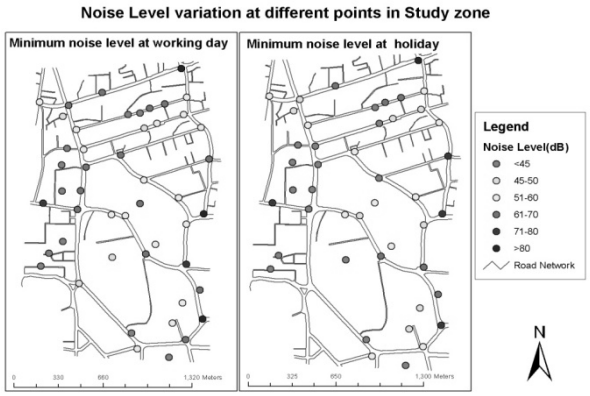

Fig. 5: Minimum Noise Level for W.D and H.D.

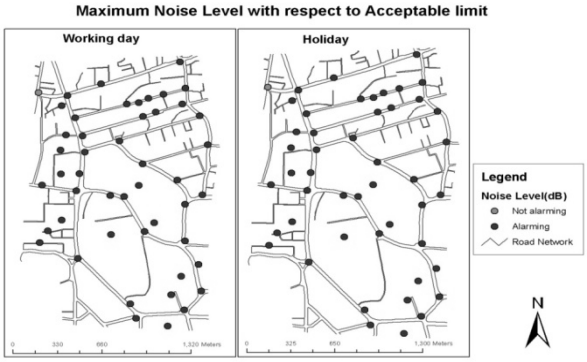

Fig. 6: Alarming and Non-alarming Areas with respect to Maximum Noise Level.

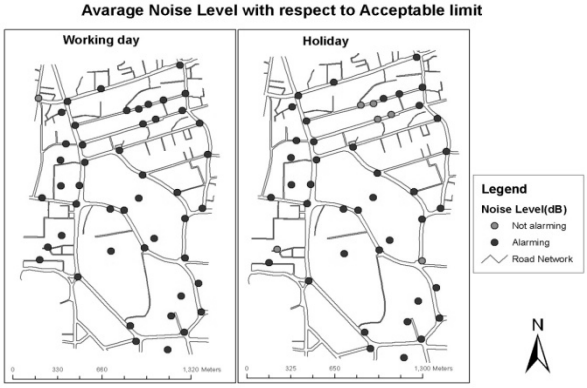

Fig. 7: Alarming and Non-alarming Areas with respect to Average Noise Level.

Fig. 7 shows that among 48 places Sonar Tori Building was only within acceptable limit (<70 dB) in case of average noise level for working day.

However, for holiday, in case of average noise level several areas were within acceptable noise level which includes:Eskaton garden high School, Department of Women Affairs, Red Crescent Borak Tower, Tenament house gate, Matshaw Bhaban and Charukola Bhaban.

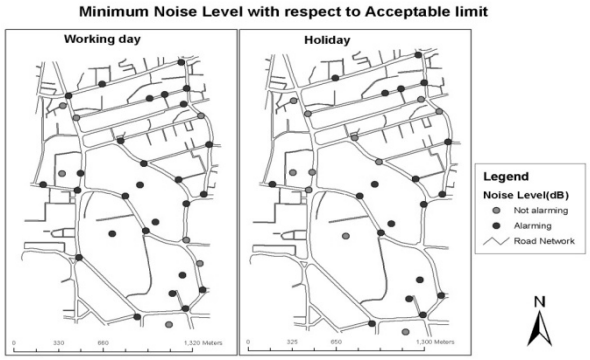

Fig. 8: Alarming and Non-alarming Areas with respect to Minimum noise level.

Fig. 8 shows that among 48 places 6 points were within acceptable limit for working day, whereas 11 points were within acceptable limit for holiday in case of minimum noise level.

5. DISCUSSION

From analysis it was found that 52% points had maximum noise level greater than 80dB, 20% points had around 71-80 dB and 27% points had around 61-70 dB for working day. On the other hand for holiday 40% had maximum noise level greater than 80dB, 27% had 71-80 dB and 21% had 61-70 dB. Analysis of these values showed that 12% points were very much affected by commuter traffic as well as traffic from other commercial, social & educational activities. The Holy Family Hospital, BSMMU, Dhaka University area, High Court and Supreme Court region which were all silent zone had a maximum noise level of 60-100 dB which indicate high level of noise pollution. In case of average noise level it was observed that 33% points were above 80 dB and 33% had 61-70 dB in working day. For holiday 38% points had average noise level around 71-80 dB. For the case of minimum noise level 33% points had noise level around 51-60 dB at working day and 23% had around 51-60 dB at holiday. These values indicate severe noise pollution scenario because the minimum noise level at all categories of places remained around 51-60 dB whereas the acceptable noise level for a silent zone was 45 dB at daytime. The analysis regarding maximum, average and minimum noise level with respect to acceptable limit showed that for both working day and holiday almost all the places were at alarming noise level.

6. CONCLUSION

From the present study it was found that the maximum value of the 48 points ranged from 62-99 dB, the average value ranged from 47-91 dB and the minimum value of the 48 points ranged from 17-84 dB. Analysis showed that 2% places had maximum noise level within acceptable limit for working day and holiday. On the other hand 2% places had average noise level within acceptable limit for working day and 10% places had average noise level within acceptable limit for holiday. However, 10% places had minimum noise

level within acceptable limit for working day whereas 20% places had minimum noise level within acceptable limit for holiday. Therefore, it can be concluded that the noise pollution level in Dhaka city is signalling to take immediate measures to reduce noise level.

There exists a constant level of pollution resulting from unbounded movement of traffic throughout the city due to commercial, social, educational, recreational and other activities and thus results the alarming level of pollution both at working day and holiday.

7. RECOMMENDATION

The following conclusion may be drawn based on the present investigation.

i. Planned tree plantation along footpath and road divider will be effective but proper care should be taken so that these might not create any obstruction to the traffic as well as to the pedestrian.
ii. The exterior walls, window glasses and doors of the hospitals and other roadside buildings should be thick enough to reduce the intensity of noise. Use of heavy curtains in doors and windows can also reduce the intensity of noise.
iii. In the hospitals the cabins of post operative patients, severe ill patients, patients having chronic diseases and also in operation theater, intensive care unit, coronary cardiac unit, neonatal unit should be distant from roadside.
iv. Strict regulations; particularly in Bangladesh-enforcement of laws is very necessary.
v. Increasing people awareness; mass media like television, radio, newspapers may be helpful to a great extent in this purpose.
vi. Source control in roadway noise has provided little reduction in vehicle noise, except for the development of hybrid vehicle.
vii. The most fertile area of roadway noise mitigation is in urban planning decisions. Hospitals should not be placed adjacent to commercial roads. Also roadway design, noise barrier design, roadway geometries, surface pavement selection will be effective in this purpose.
viii. Therefore, in built up areas there could be strategic regulations which would be fruitful to reduce the level of pollution.
ix. The roads beside residential buildings such as Red Crescent Borak tower, hospitals such as Holy Family Hospital should be restricted for commercial traffic, particularly at office hour these roads should be banned for all traffic.
x. Staggered timing of various activities such as different timing of offices & schools may contribute to a significant reduction. Also job rotation, work scheduling may help to a great extent in this purpose.
xi. Speed control is effective since the lowest sound emissions arise from vehicles moving smoothly at 30 to 60 kilometers per hour. Above that range sound emissions double with each five miles per hour of speed.
xii. Noise barriers are probably the single most effective weapon in retrofitting an existing roadway, and commonly can reduce adjacent land use sound levels by ten decibels.
xiii. Noise barrier may be installed along the road beside BSMMU and Holy Family Hospital.

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