INVESTIGATION ON AMBIENT AIR QUALITY IN J.N MEDICAL COLLEGE ENVIRONMENT

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ABSTRACT
A study has been performed to investigate the ambient air quality in hospital environment at Jawaharlal Nehru Medical College & Hospital Aligarh Muslim University Aligarh. Seven locations in the surrounding of JNMC & Hospital were selected to determine the concentration of major pollutants such as Nitrogen Dioxide (NO2), Sulphur Dioxide (SO2), and Suspended Particulate Matter (SPM). The outdoors are prone to high RSPM concentration due to prevailing urban air quality of Aligarh city and heavy traffic movement at medical road nearby the Hospital. The concentration of SO2 in the hospital environment ranges from 2.91 µg/m³ to 28.39 µg/m³ and NO2 concentration at all locations varies from 1.87 µg/m³ to 35.06 µg/m³.

Key words: JNMC, Hospital Air quality, NO2, SO2 and SPM.

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1. INTRODUCTION
The complex hospital environment requires special attention so as to ensure healthy air quality to protect patients and healthcare workers from hospital-acquired occupational diseases.

The Jawaharlal Nehru Medical College & Hospital is a 1269 bedded tertiary care hospital which is providing affordable medical care. Very few studies have been performed to investigate the ambient air quality in hospital environment some of them are listed below:

Research study in a university hospital in the eastern province of Saudi Arabia shows that outdoor levels of all air pollutant levels, except volatile organic compounds (VOCs), were higher than the indoor levels which meant that the IAQ inside healthcare facilities (HCFs) were greatly affected by outdoor sources, particularly traffic. Levels of particulate matter
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(both PM10 and TSP) were higher than the Air Quality Guidelines (AQGs) (El-Sharkwy & Noweir, 2014).

C.O. Ayodele also performed the similar study around Federal Medical Centre Ido, located in Ekiti state of Nigeria. The results of the study shows that the 24-h NH3 concentration of 0.44 ppm recorded at few sampling locations during dry season breached the National Air Quality Standards of the Federal Ministry of Environment Standard, Nigeria. Similarly NO2 levels were higher than other gaseous parameters measured in all the sampling locations during the wet season (Ayodele et al., 2016).

A case study of 524 successive deaths in a 800 bedded tertiary care hospital of Spain suggested that 21.3% of the total deaths of patients which occurred within 48 hours after admission were because of nosocomial (hospital acquired) infections (Curtis L.T., 2008).

A case study in a University Hospital in Tokyo demonstrated that NO2 concentration was high usually at a location where traffic was heavy but still it was in permissible limit set by Environmental Agency of Japanese Government. But the CO concentration barely met the Environmental Quality Standard by Environmental Agency (<10 ppm) (Nakata et al., 2002)

2. INTERNATIONAL STANDARDS

The 2005 World Health Organization's "WHO Air quality guidelines" offer global guidance on thresholds and limits for 4 key air pollutants that pose health risks - particulate matte(PM),ozone (O3), nitrogen dioxide (NO2) and sulphur dioxide (SO2)

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Time Weighted Average</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM2.5</td>
<td>Annual mean</td>
<td>10 µg/m³</td>
</tr>
<tr>
<td>PM10</td>
<td>24-hour mean</td>
<td>25 µg/m³</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20 µg/m³</td>
</tr>
<tr>
<td></td>
<td>Annual mean</td>
<td>50 µg/m³</td>
</tr>
<tr>
<td></td>
<td>24-hour mean</td>
<td></td>
</tr>
<tr>
<td>O3</td>
<td>8-hour mean</td>
<td>100 µg/m³</td>
</tr>
<tr>
<td>NO2</td>
<td>Annual mean</td>
<td>40 µg/m³</td>
</tr>
<tr>
<td></td>
<td>1-hour mean</td>
<td>200 µg/m³</td>
</tr>
<tr>
<td>SO2</td>
<td>24 hour mean</td>
<td>20 µg/m³</td>
</tr>
<tr>
<td></td>
<td>10 minutes mean</td>
<td>500 µg/m³</td>
</tr>
</tbody>
</table>

National Ambient Air Quality Standards by CPCB

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Time Weighted Average</th>
<th>Concentration in industrial, residential rural and other areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulphur Dioxide (SO2), µg/m³</td>
<td>Annual 24 hours</td>
<td>50 80</td>
</tr>
<tr>
<td>Nitrogen Dioxide (NO2), µg/m³</td>
<td>Annual 24 hours</td>
<td>40 80</td>
</tr>
<tr>
<td>Particulate Matter (size less than 10 µm) or PM10 µg/m³</td>
<td>Annual 24 hours</td>
<td>60 100</td>
</tr>
<tr>
<td>Particulate Matter (size less than 2.5 µm) or PM2.5 µg/m³</td>
<td>Annual 24 hours</td>
<td>40 60</td>
</tr>
<tr>
<td>Ozone (O3) µg/m³</td>
<td>8 hours 1 hour</td>
<td>100 180</td>
</tr>
<tr>
<td>Carbon Monoxide (CO) mg/m³</td>
<td>8 hours 1 hour</td>
<td>0.2 0.4</td>
</tr>
</tbody>
</table>
3. OBJECTIVE
To determine the concentration of major pollutants Nitrogen Dioxide (NO2), Sulphur Dioxide(SO2), and Suspended Particulate Matter (SPM) in the surrounding of JNMC as well as in the indoors.

Measures to prevent and/or remediate the problems have also been suggested.

In this study National Ambient Air Quality Standards by CPCB and international standards suggested by WHO were used for comparison.

4. DETAILS OF THE STUDY AREA
The Jawaharlal Nehru Medical College & Hospital’ is a 1269 bedded tertiary care hospital which is providing affordable medical care. The hospital has an ever increasing attendance of 6,55,223 patients in 22 OPD in 2014, the total number of employees comprises 1577, with 507 doctors, 481 nurses, 284 technicians, 244 allied health workers, 30 administrative employees and 31 other workers. The hospital has three types of department: Medical College, Medical diagnosis and administrative.

4.1. Map of Study Area
The following is the map of study area and location points

4.2. Details of Sampling Locations

<table>
<thead>
<tr>
<th>S.No</th>
<th>Sampling location</th>
<th>Location site</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sampling location-1</td>
<td>JN Medical college main gate</td>
</tr>
<tr>
<td>2</td>
<td>Sampling location-2</td>
<td>OPD Complex</td>
</tr>
<tr>
<td>3</td>
<td>Sampling location-3</td>
<td>Emergency and Hospital</td>
</tr>
<tr>
<td>4</td>
<td>Sampling location-4</td>
<td>Patients Wards</td>
</tr>
<tr>
<td>5</td>
<td>Sampling location-5</td>
<td>New OPD Block</td>
</tr>
<tr>
<td>6</td>
<td>Sampling location-6</td>
<td>Opthalmolgy Department</td>
</tr>
<tr>
<td>7</td>
<td>Sampling location-7</td>
<td>College Parking</td>
</tr>
</tbody>
</table>
5. MATERIALS & METHODS
Measurement of Respirable Suspended Particulate Matter (PM10) by Gravimetric Method using High Volume Sampler, Handy Sampler. The air is drawn through a size-selective inlet at a flow rate, which is typically 1132 L/min. Filter Media – A Glass fibre filter of 20.3 X 25.4 cm (8 X 10 in) size. The specified length of sampling is kept 8 hours or 24 hours. During this period, several readings (hourly) of flow rate have to be taken and average flow rate is used in calculation.

\[
C_{PM10} (\mu g/m^3) = \frac{(W_f - W_i) \times 1000000}{V}
\]

Where,

\(C_{PM10}\) = Concentration of Nitrogen dioxide, \(\mu g/m^3\).
\(W_f\) = Initial weight of filter in g
\(W_i\) = Initial weight of filter in g.
1000000 = Conversion of g to \(\mu g\).
\(V\) = Volume of air sampled, m³

5.1. Measurement of SO₂
Modified West & Gaeke Method. Absorbing Reagent, 0.04 M Potassium Tetrachloro mercurate (TCM). Place 30 ml of absorbing solution in an impinger and sample for eight hours at the flow rate of 1 L/min. Spectrophotometer: Capable of measuring absorbance at 560 nm equipped with 1 cm path length cells.

![Calibration Curve for SOx](image)

5.2. Measurement of NO₂
Modified Jacob and Hochheiser Method. Ambient nitrogen dioxide (NO₂) is collected by bubbling air through a solution of sodium hydroxide and sodium arsenite. Place 30 ml of absorbing solution in an impinger and sample for eight hours at the flow rate of 1 L/min. Spectrophotometer: Capable of measuring absorbance at 540 nm equipped with 1 cm path length cells.
6. RESULTS & DISCUSSION

6.1. Respirable Suspended Particulate Matter (PM10)

The summary statistics for showing concentration of Respirable Suspended Particulate Matter (µg/m³) in different months of 2017 obtained is shown below.

**PM10 concentration at different sampling locations in April 2017**

**PM10 concentration at different sampling locations in June 2017**

**PM10 concentration at different sampling locations in August 2017**
6.2. Sulphur Dioxide

The summary statistics for concentration of Sulphur Dioxide (µg/m³) in different months of 2017 obtained after analysis is shown below.
6.3. Nitrogen Dioxide

The summary statistics for concentration of Nitrogen Dioxide (µg/m³) in different months of 2017 after analysis is shown below
7. PROBLEMS FACED DURING SAMPLING

The placement of High Volume Sampler at the sampling locations involved lots of complexities due to production of noise by it. A continuous 8-hour power supply was also the chief requirement for carrying out the sampling properly. It was also made sure that there should be very little movement around the sampler during sampling period.
8. RECOMMENDATION
Adopting the measures to control the traffic on medical road. Use of bio-fuel in motor vehicles. Replacement of old auto-rickshaws by new E-rickshaws. By increasing the no. of trees in the surrounding of hospital. By regular cleaning and sweeping of roads nearby the hospitals. By increasing the use of solar energy in place of generators for power supply to hospital.

9. CONCLUSIONS
As indoor locations of JN Medical College & Hospital are safe from air quality point of view but outdoors are prone to high RSPM concentration. The reasons for high RSPM concentration are prevailing urban air quality of Aligarh city and heavy traffic movement at medical road nearby the Hospital.

The mean value of RSPM concentration was found out to be 66.2 µg/m³ which is less than the permissible limit of 100 µg/m³ 24 h mean by NAAQS but more than WHO limit of 50 µg/m³ for 24 h mean.

The concentration of SO2 in the hospital environment ranges from 2.91 µg/m³ to 28.39 µg/m³ which is very less than NAAQS limit of 80 µg/m³ for 24 h weighted average but at two locations the concentration of SO2 is more than WHO limit of 20 µg/m³ 24 h mean.

NO2 concentration at all locations varies from 1.87 µg/m³ to 35.06 µg/m³ which is less than both 80 µg/m³ at 24 h weighted average limit by NAAQS and WHO limit of 40 µg/m³ annual mean.

REFERENCES