Introduction

Liquefied Petroleum Gas (LPG) geysers are deployed very frequently for heating water due to the perennial problem of erratic electrical supply in many areas in India. This simple and economical device, used on a daily basis in many Indian households may cause certain significantly disabling neurological events.

Sudden loss of consciousness in the bathroom can be due to a number of causes like seizures, head injury, stroke, cardiac events, syncopal episodes, due to various poisonings and toxin exposures.[1] Such an episode is highly distressing and may have long lasting or even life threatening after effects.

We report 26 such cases of unexplained neurological collapse in the bathroom presenting as seizure like episodes, carbon monoxide intoxication and as a precipitating factor for epilepsy. The possible attributable cause for these events could be exposure to high amounts of various toxic gases, mainly carbon monoxide (CO) released due to incomplete combustion of LPG in gas geysers in small ill ventilated bathrooms in homes. Increased awareness of gas geyser induced epilepsy and associated carbon monoxide intoxication, both of which are entirely preventable conditions. We also wish to emphasize the importance of stringent and universal implementation of gas geyser usage and installation laws.

Case Reports

Twenty six cases of predominantly three distinct prototypes, as described below, were observed over three years from 2008 to 2011 in Sir Ganga Ram Hospital, New Delhi.

The three distinct prototypes noted were – 1) Seizure like episodes seen in 11 patients, 2) Carbon monoxide intoxication in 13 patients with near cardiac arrest in 4, and as a precipitating factor for epilepsy as seen in 2 cases. Out of the 13 cases presenting as carbon monoxide intoxication 4 had subtle cognitive defects and 2 developed early Parkinsonian features on follow up. To increase awareness regarding gas geyser induced epilepsy and associated carbon monoxide intoxication, both of which are entirely preventable conditions. We also wish to emphasize the importance of stringent and universal implementation of gas geyser usage and installation laws.

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found in an unconscious condition on the bathroom floor with some frothing from the mouth. Her vital signs were normal and she regained complete consciousness in about an hour without evidence of any neurological deficit. Her MRI brain as well as MR Angiogram was normal. All other routine blood tests, ECG and EEG were normal. She returned after a week with similar symptoms. She was advised to discontinue the flu less gas geyser usage. This has solved her problem till date.

**Group 2: Carbon Monoxide Intoxication**

A 23 year old engineer was found in an unconscious state in the bathroom without any associated frothing at mouth, tongue bite or incontinence. He was not responding to verbal commands, pupils were semi dilated and sluggishly reacting. He had marked hypotension (BP 80/40) and required ventilatory support. Blood gas analysis revealed elevated pCO2. Routine blood tests, ECG and EEG were normal.

MRI of the brain, which could be done only later in the second week of illness, revealed areas of altered signal intensity in bilateral globus pallidii [Figure 1]. The globus pallidal lesions were bilaterally symmetrical, appeared mildly hypo intense on T1 and hyper intense on T2 images. He later developed memory deficits and early parkinsonian features. He had recently installed a gas geyser in the bathroom which was functional at the time of the incident. This event has had a lasting negative impact on both his personal and professional life.

**Group 3: Trigger factor for Epilepsy**

A 14 year old male child was found unconscious on the bathroom floor with some frothing from the mouth. He was taken to a nearby hospital where he was treated for a probable seizure. A MRI brain was done which was normal. An EEG revealed spike discharges in anterior leads. All the routine blood and biochemical tests were normal. He had no history of any previous seizure episode or head injury. There was no family history of epilepsy.

He reported again with a convulsive episode while he was at school after a few weeks. At present he is seizure free for about a year and on regular antiepileptic medications. The family would routinely use a gas geyser which was functional at the time of the episode. The geyser has now been reinstalled in their balcony, which is well ventilated. No such incidents have occurred again with any other family members using it.

In all the 26 such cases recorded, consciousness was altered only transiently. There were 15 males and 11 females in the age group of 14 to 46 years. 17 cases were from semi-urban areas while 9 cases were from a rural setting. Out of the 13 cases presenting as carbon monoxide intoxication 4 had subtle cognitive defects and 2 developed early Parkinsonian features on follow up.

**Discussion**

All the twenty six cases recorded have an uncanny similarity in terms of the setting of the event that is in a small ill-ventilated bathroom with a functional gas geyser at the time of the episode. All these events were usually in winter months and in young to middle aged individuals without any significant risk factors. Also all the patients regained normal consciousness very fast and made an excellent neurological recovery except for 2 patients of carbon monoxide intoxication who developed early Parkinsonian features. None of the patients had a previous history of seizure, stroke, head injury, any cardiovascular risk factor for syncope or any panic attack. Hence the evidence, though not infallible, gives a strong suggestion that the root cause of these events could lie in the usage of gas geysers.

The domestic use of gas geysers for supply of hot water in bathrooms and kitchens has been on the rise due to its cheap initial installation and non requirement of electricity. However, LPG gas geysers if not installed and used in the recommended conditions can have hazardous and sometimes fatal effects.

Incomplete combustion of LPG due to inadequate ventilation leads to accumulation of mainly carbon monoxide and nitrous oxide. Clinical features of acute carbon monoxide poisoning include headache, dizziness and confusion.\(^3\) Coma or seizures can occur in patients with prolonged exposure.\(^3\)

Magnetic resonance imaging is the modality of choice for suspected CO poisoning seen as symmetrical T2 hyper intensities in the basal ganglia.\(^6\) However, only symmetrical affection of the globus pallidus may also be seen.\(^5\)

Depending on the type of flue (vent) system used gas geysers are of three main types:

1. Room sealed (balanced flue)
2. External flue

Flue less (Room-sealed (balanced-flue) gas water heaters are the first choice for new installation. Fresh air for combustion and combustion products are taken from and discharged directly to outside air, without contaminating room air.

Flue less gas water heaters are considered dangerous if used to supply hot water to a bath or shower, because the products of combustion containing CO, discharge directly into the room, and may build up to dangerous levels. They are now obsolete in Hong Kong and the ordinance specifies...
that even a flue less (sink) gas water heater for the kitchen must provide a warning label: Do not use for more than 5 minutes continuously.\[^6\] In the United Kingdom the gas safety (installation and use) regulations have prescribed specific criteria of ventilation for flue less gas appliances. \[^7\] [Table 2]. Canada recommends against the use of flue less gas appliances because they can “pose a serious health and safety risk to the occupants.”\[^8\]

There have been numerous studies on flue less gas heaters used in various settings which reveal that these heaters emit numerous combustion products including Nitrogen dioxide, carbon monoxide, carbon monoxide and formaldehyde [Table 2]. In conclusion a common phenomenon observed was that pollutants released by flue less gas heaters were often higher than the stipulated guideline levels, especially when the heaters are operated at low gas pressure. This also suggests that flue less gas heaters are potentially vulnerable to incorrect installation, misuse and disrepair.

In Australia as per the Gas installation manual rules all flue less gas appliances have to be labeled with the following wordings:\[^9\]
1. Do not operate this appliance before reading the instruction (user guide) booklet.
2. Do not place articles on or against this appliance.
3. Do not store chemicals or flammable materials, or spray aerosols near this appliance.
4. Do not operate with panels, covers or guards removed from this appliance.
5. Do not operate in a bathroom or bedroom.
6. Do not operate in an unventilated room.
7. Do not operate in a room with volume less than (a value dependent on heater capacity).
8. Emissions from this space heater may affect persons susceptible to respiratory problems.

### Table 1: Ventilation for flueless gas appliances

| Flueless appliance type | Maximum appliance rated heat input | Volume of room, space (m²) | Free area of permanently open air vent (mm²) |
|------------------------|-----------------------------------|-----------------------------|---------------------------------------------|
| Instantaneous water heater | 11 kW (net) | 5 to 10 | 10,000 |
|                        |        | 10 to 20 | 5000  |
|                        |        | >20      | No permanently open vent needed |

Notes: These guidelines are as per the Gas Safety (Installation and use) Regulations in the United Kingdom. [Additional provisions for gas burning appliances with a rated input up to 70 kW (net), Gassafety (Installation and use) Regulations. DocumentJ; Section 3:38-40. www.documentj.co.uk (Last accessed on 1/7/11)

### Table 2: Summary of studies on pollutants released from Flueless Gas Heaters

| Study Setting | Location | Pollutants measured | Reference |
|---------------|----------|----------------------|-----------|
| Emission chamber | South East Australia | Carbon Monoxide, Formaldehyde, Nitrogen Dioxide | Brown et al. 2004\[^9\] |
| Schools | New South Wales | Nitrogen Dioxide | Pilotto et al. 2004\[^10\] |
| Homes | New South Wales | Fine particles, nicotine, formaldehyde and nitrogen dioxide | Sheppeard et al. 2002\[^11\] |
| Homes | Canberra | Carbon Dioxide, Carbon Monoxide, Formaldehyde, Nitrogen dioxide | AWN consultants and team, Ferrari environmental 2004\[^12\] |
| Experimental setting and homes | United Kingdom | Nitrogen Dioxide, Carbon monoxide, formaldehyde | HSE 2004 a and b\[^13\] |
| Homes | New Zealand | Nitrogen Dioxide | Kingham and Petrovic 2005\[^14\] |

### Conclusion

The key objective of this article is to increase awareness regarding gas geyser induced epilepsy and associated carbon monoxide intoxication, both of which are entirely preventable conditions.

Flue less gas geysers are proving to be the ‘modern day gas chambers’ with the stark contrast that these geysers are installed willingly and in good faith by innocent consumers.

We also wish to make an effort towards the implementation of stringent policies for gas geyser installations in India or any other place where these gas appliance installation laws are being freely flouted or are not existent.

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Correia, et al.: Gas geyser syndrome

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