

Original Article

Recent Cyclones Causing an Increased Incidence of Intracranial Haemorrhage in India — A Cross-sectional Study

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Background : Seasonal variations in the incidence of Intracerebral Haemorrhage (ICH) have been extensively evaluated in the studies conducted in various parts of the world. The prevalence per 100,000 person-years of spontaneous cerebral haemorrhage is regularly highest in the winter and lowest in the summer. However, these seasonal variations of ICH in India have not been comprehensively described in any published literature.

Methodology : In this retrospective cross-sectional study, data of 15000 patients were collected from various State Government-owned Hospitals of India of the months April, May and June. The present study examined the association between temperature variations and spontaneous ICH incidence during recent severe Cyclonic Storms 'Yaas', and 'Tauktae' in India with the brain's Computed Tomography (CT) scans. A CT brain persists in being the investigation of choice in the initial diagnosis of ICH, as it is readily available, accessible and fast.

Results : During these Cyclones, there was a significant temperature drop associated with an increased incidence of ICH in the specified time.

Conclusion : Sudden temperature drop during a Cyclone can cause spontaneous Hypertension, which causes rupture of arteries in the brain and results in Stroke. The Government, Physicians and the general public need to be made aware of such associations.

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Key words : Intracerebral haemorrhage, Hypertension, Temperature.

Acute Stroke, due to spontaneous (non-traumatic) ICH, is a major global health issue that creates death and permanent weakness in several million people Worldwide every year¹. ICH, also known as intraparenchymal bleed, Cerebral bleed and Hemorrhagic Stroke, is sudden bleeding into the brain's tissues, into its ventricles or both. It is one of the classifications of bleeding inside the skull and one kind of Stroke. ICH is a lethal type of Stroke due to which the brain is deprived of blood and oxygen supply. ICH is twice as common as Subarachnoid Haemorrhage and has an associated risk of 40% death. Symptoms can include headache, seizures, vomiting, unilateral weakness, decreased level of consciousness and neck stiffness. Often, symptoms get worse with time. Fever is also common among these patients. ICH occurs quite more-ordinarily among men than women and is more frequent among young

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Editor's Comment :

- During cyclones, hypertensive patients should be alarmed to take proper medications and regularly monitor their Blood Pressure to keep a strict watch with the weather change warning.
- The Government should declare a health guideline for such hypertensive patients in the Cyclone-affected area.
- Investigation of choice in ICH and regular monitoring & follow up is the CT brain.

and middle-aged Indians. Approximately 70% of patients developed long-term deficits after an ICH. Hypertension and advancing age are the most critical risk factors for ICH. Other causes include head trauma, arteriovenous malformations, or amyloidosis etc².

Few small arteries supply blood to brain areas deep inside. These thin-walled arteries are ruptured due to high Blood Pressure, which releases blood into the brain tissue. Clotted blood and fluid build-up within the rigid skull increase the pressure to shift and herniate the brain against the bone. As blood leaks into the brain, the area is now deprived of oxygen-rich blood – leading to a Stroke. As blood cells enclosed by the clot die, toxins are liberated that damage brain cells in the region nearby to the hematoma. Haemorrhages within cerebral parenchyma are frequently categorized into the primary injury - the sudden tissue injury from the haematoma and the secondary injury – the

subsequent pathological change resulting from the haemorrhage. An ICH can occur in deep areas of the brain or close to the surface. Sometimes deep haemorrhages may extend into the ventricles. Blockage of the normal Cerebrospinal Fluid (CSF) circulation may enlarge the ventricles. Although ICH is usually examined as a single event disease, recently it is being supposed as an operational condition with multiple phases³, these being:

(1) The initial discharge of blood into the parenchyma -An acute ICH causes an abrupt increase in mass effect confined by the brain's parenchyma, which causes disruption and compression of the surrounding brain tissue, leading to a potential loss or compromise of the nearby cell signalling pathways and causing a focal neurological deficit⁴.

(2) Due to expansion around the clot, subsequent bleeding occurs - Blood released within white matter causes small foci of intact brain tissue to be surrounded by the haematoma, which is recoverable in theory⁵.

(3) Oedema or swelling around the haematoma.

Initial manifestations of brain haematoma can be decreased levels of alertness to unconsciousness and suppression of the Cardiopulmonary axis that may cause arrest. Repeat CT scan is a crucial factor to predict prognosis and patient's functional outcome, measured by expansion of the haematoma as a volume increase of 33 to 55%⁶.

Usually, Hypertension causes spontaneous ICH and is responsible for almost one-fifth of all Stroke cases. It is one of the critical types of Stroke which causes severe morbidity and mortality. Seasonal and climate variations in Blood Pressure have been studied with unappreciated and contradictory results. Detection of patients with high Blood Pressure increases in number across the colder months of Winter & Spring and decrease during Autumn & Summer. Due to seasonal variations and temporal patterns, as already known, ICH occurrence is highest during winters or a sudden drop in temperature⁷. The aetiology has been not explained fully; however, it may be associated with seasonal and climate variation in some blood components, Serum Lipids, Blood Pressure and a Hypercoagulable state (plasma fibrinogen concentration and viscosity) during the winter & spring season.

Extremely severe Cyclonic Storm Tauktae was a powerful, deadly and damaging tropical Cyclone in the Arabian sea that became the giant tropical, robust Cyclone to make landfall in the Indian state of Rajasthan and Gujarat between 14 to 19 May, 2021. Tauktae prompted heavy rainfall and flash floods to affected areas. Due to the enormous area of convection over the Cyclone, it dumped heavy rainfall over the affected states of the country that caused a sudden

drop in temperature by about 5-6°C due to heavy rains, gusty winds and heat dissipation. The Cyclone also caused widespread agricultural and infrastructure damage to the affected areas of India.

On May 28, 2013, Yaas's cyclone brought a destructive landfall in Odisha, West Bengal and Bihar with significant and damaging effects. The moderate shear winds, the low-level circulation centre, large masses of rainbands in the storm contributed to the cyclone causing floods, heavy rains, heat dissipation and gusty winds, which caused a wide range of destruction to farmlands and power outages. All of this lead to a sudden fall in temperature by about 6-8°C.

Because of Cyclones, the sudden temperature falls caused a significant increase in the number of patients with hypertensive ICH in the affected areas. There were almost ten times surges in the incidence of ICH observed in these states.

In this study, we conclude the association of cold temperature and its risk with haemorrhagic Stroke. Sudden fall in temperature and cold temperature have independent associations with haemorrhagic Stroke. Addressing environmental risk factors concerning such a fall in temperature would increase public awareness, help in prevention and planning a better approach if such situations are encountered. Environmental alerts and public awareness campaigns should be encouraged to inform the public about such medical conditions.

Seasonal variations in the incidence of ICH have been extensively evaluated in studies conducted in Worldwide. However, seasonal variation of ICH in India has not been comprehensively reported in the literature. This is the first large scale study done in India as per our knowledge.

The aim of the present study was to examine the seasonal variation of spontaneous ICH incidence the Indian population.

Here we have discussed spontaneous intracranial haemorrhage with hypertensive bleed at the time of Indian Cyclone Yaas and Cyclone Tauktae.

METHODOLOGY AND RESULTS

The primary data source for the present study was hospital discharge statistics from district hospitals of Rajasthan, Bihar & West Bengal of India qualified to treat patients with Stroke. From April, 2021 to June 2021, all patients with ICH were included in the discharge diagnosis was coded as ICH under the World Health Organization's International Classification of Diseases, 11th revision (ICD-11). In all cases, CT scans of the head confirmed the diagnosis. Demographic details and Neurological Imaging Examinations were recorded for all patients.

Patients who transferred within one or more

hospitals were considered as an only single admission. Some patients who died outside the hospital with a death certificate diagnosis of ICH were also included in the study. Patients whose residence was outside of the affected area were not included in the study.

Approximately 15000 patients who underwent CT scans of the head for various reasons were studied over three months in the year 2021(April to June). Approximately ten times increase in the patients with CT scans confirming ICH during the Cyclone period.

DISCUSSION

This study is a retrospective based on hospital registration, which does not analyze the components or causes associated with ICH's temperature variation. To establish the mechanisms causing these seasonal (temperature variation) trends, longitudinal data for the associations between variations in environmental factors, physical activity and Stroke occurrence among Cyclones would be needed.

The variation in brain temperature is highly dependent on the metabolic activity of neural tissue. In medical emergency situations also monitoring the brain temperature is suggested in the case of brain injury as it is extremely sensitive and venerable to small variation in temperature. Mechanism behind the increase incidence of ICH in winter or during sudden fall of temperature is explained however disturbed auto regulation by the sympathetic nervous system is the probable suggested cause⁸.

A non-contrast CT brain persists in being the first choice of imaging modality in the initial diagnosis of

ICH, as it is readily available, accessible and fast⁹. A non-contrast CT brain can reveal and differentiate between the several intracranial & extracranial pathology, including Ischemic Stroke, Subarachnoid Haemorrhage, and ICH. It can also demonstrate the extension of the haemorrhage regarding surrounding oedema, size, intraventricular clot extension, the mass effect (Fig 1) and raised intracranial pressure.

Spontaneous or acute ICH appears on the CT head as an area of hyperdensity within the Parenchyma (Fig 2) or extended into the ventricle (Fig 3), with surrounded hypodense perivascular oedema.

The prompt risk factors affecting 38% of ICH is clot expansion and rebleeding. The investigation of choice for ICH is CT head and CT angiography of the intracranial vessels to exclude the vascular pathology. The vascular abnormalities should always be diagnosed before clot removal, especially for surgeons to deal with vascular malformations. Many signs on imaging help identify clot or active bleeding, eg, the hyperdense signal within the hematoma indicates active bleeding on CECT scans, also known as 'spot sign' and other signs like the presence of SAH, hematoma shape and its location to major territorial vessels¹⁰.

Such sudden changes in temperature may trigger events of acute Stroke. Temperature variations have been reported as a significant contributor to an increased rate of such Stroke incidences¹¹.

Like Blood Pressure, which tends to stay elevated during cold weather and lower in warmer conditions, the chances of Stroke increase in the colder temperature. Additionally, there is an association of



Fig 1 — Axial CT scan of brain at the level of posterior fossa demonstrates an area of high attenuation in the right cerebellum which denotes acute hematoma.(white arrow) Also note the effacement of the adjacent fourth ventricle and compression of the brainstem.



Fig 2 — Computed tomography axial image of head demonstrating an ill-defined ovoid, hyperdense focus at left thalamic nucleus level, in keeping with a hematoma. (white arrow)



Fig 3 — Non-contrast axial image of head CT showing acute intracranial haemorrhage involving the left thalamus and basal ganglia(white arrow) with extension into the ventricle. (black arrow)

increased Blood Pressure with increased chances of Stroke, especially during the winters¹².

Spontaneous, non-traumatic ICH remains a consequential cause of mortality and morbidity worldwide. ICH results from increase Blood Pressure that cause bursting of intracerebral arteries, with majority of mortality or deaths occurring in the first two days of the onset of symptoms. One fifth patients of ICH have neurological deterioration in the pre-hospitalization period and one fourth in hospitalization period. ICH patients present with focal neurological deficits, headache, vomiting, high Blood Pressure and with sudden onset decreased consciousness. But in majority of cases clinical history (hypertension) is needed to reach the diagnosis. CT scan is the gold standard imaging investigation for ICH but in few cases magnetic resonance imaging can be an alternative to differentiate between the chronic and acute stage of haemorrhage¹³.

So far, the Government focus has been limited to evacuating the affected areas and disaster management. We propose that hypertensive patients be alarmed to take proper medications and regularly monitor their Blood Pressure to keep a strict watch with the weather change warning. Physicians should be advised to take extra care of hypertensive patients. We also feel that more detailed studies should be done worldwide to form a hypothesis to prompt policymakers to form new guidelines.

The environment is changing drastically because of Global Warming that is causing a larger number of natural calamities to happen. Cyclones and heavy rainfalls are becoming more frequent and causing a sudden drop in temperature level, increasing the chances of hypertensive bleeds in chronic untreated cases. Thus, Government should emphasise on making the general public aware about such disasters and possible health problems associated with the same.

On literature review, only a Letter to Editor by Kumar Pradeep, *et al* in 2015 is found, that described a small group observation was done in All India Institute of Medical Sciences, New Delhi¹⁴. In this study, the authors also found highest incidence of ICH in winter seasons.

CONCLUSION

Seasonal climatic fluctuations cause various changes in vital parameters such as Blood Pressure, leading to increased Stroke chances. Blood Pressure tended to be elevated in colder weather and lowered in warmer conditions. Sudden climate changes cause a sudden spike in Blood Pressure, which reaches beyond the body's regulatory mechanisms and results in Stroke. These changes become significant in population when predictable climatic changes such as Cyclones or floods occur. As these events are

predictable, measures must be taken quickly to avoid extra health burdens. A health guideline/advisory must be circulated, including avoiding skipping any medication or increasing the doses if required before such predictable natural events. Advisory for the vulnerable population should also include avoiding sudden variation in body temperature by any means.

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