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LIGHTNING INJURY CONTINUES TO BE A PUBLIC HEALTH THREAT INTERNATIONALLY

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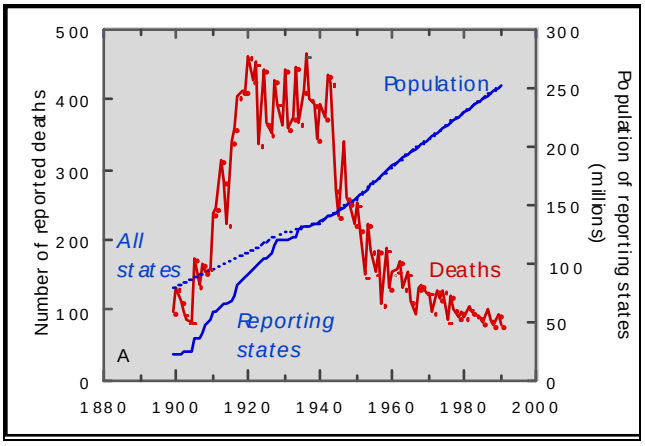
ABSTRACT: Although lightning injuries and fatalities in the United States (US) have been reduced to a minimum, lightning continues to be a major environmental threat to people living in less developed, high lightning exposure countries or those without effective injury prevention efforts. Reliable statistics on lightning injury are often difficult to obtain internationally but will be reviewed as they are available. Many of the recommendations used for the US may not be applicable to less developed, remote or rural areas and need to be tailored to the individual people's cultural and living situations. It is always advisable to include local people to provide the knowledge, influence and contacts to make a lightning safety campaign effective in their countries. We also recommend using multidisciplinary teams which can bring many talents, contacts, and creative ideas to any campaign.

LIGHTNING DEATHS IN DEVELOPED COUNTRIES

In the early 1900's, the weighted United States (US) lightning fatality rate was about 6 per million.[1] In recent years, this index had dropped to under 0.3 per million (Fig 1). This coincided with several factors:

1. significant population shifts to urban areas with a consequent reduction in the at risk rural population
2. industrialization of agriculture which further decreased the individual risk exposure associated with previous labor-intensive agriculture
3. substantial improvement in US construction with indoor plumbing and wiring providing Faraday Cage effect and grounding of most buildings where people live and work.
4. greater availability of metal vehicles to provide safe shelter for persons who are outdoors or traveling between locations.



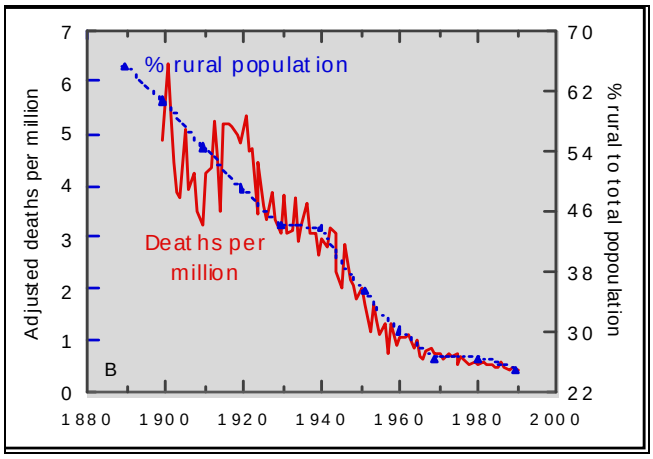


Fig 1-A - Red line shows annual lightning deaths reported by the US Bureau of the Census and Public Health Service from 1900 to 1991. Dashed blue line is total population of U.S. and District of Columbia; solid blue line is population of reporting states and District of Columbia. 1-B - Solid red line is adjusted yearly lightning deaths normalized by population. Blue line shows percent of population in rural areas. (From López RE, Holle RL: J Climate 11:2070, 1998.)

Similar reductions have occurred in other developed countries such as Australia, Canada, England and Wales, France, Japan, and Sweden. All show current rates of less than 0.5 while some had rates exceeding 2 a century ago in areas where the lightning frequency is not as high as in the US (Figs 2,3).[2]

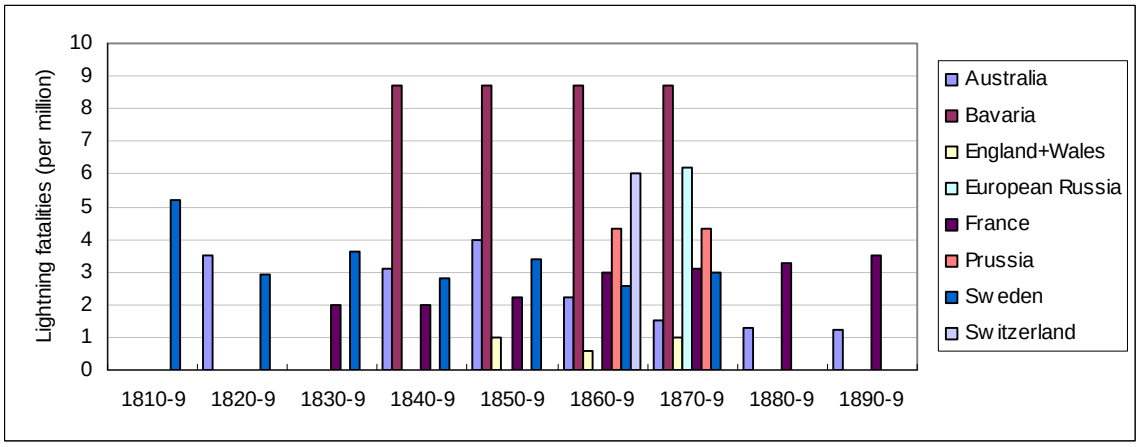


Fig 2 - Lightning fatality data in 'developed' countries during the nineteenth century when agriculture was still labor intensive and before homes and workplaces had indoor plumbing and wiring which provided a 'Faraday Cage effect' with at least some grounding. (From Holle RL: Annual rates of lightning fatalities by country. Preprints, International Lightning Detection Conference, April 21-23, 2008, Tucson, Arizona, Vaisala).

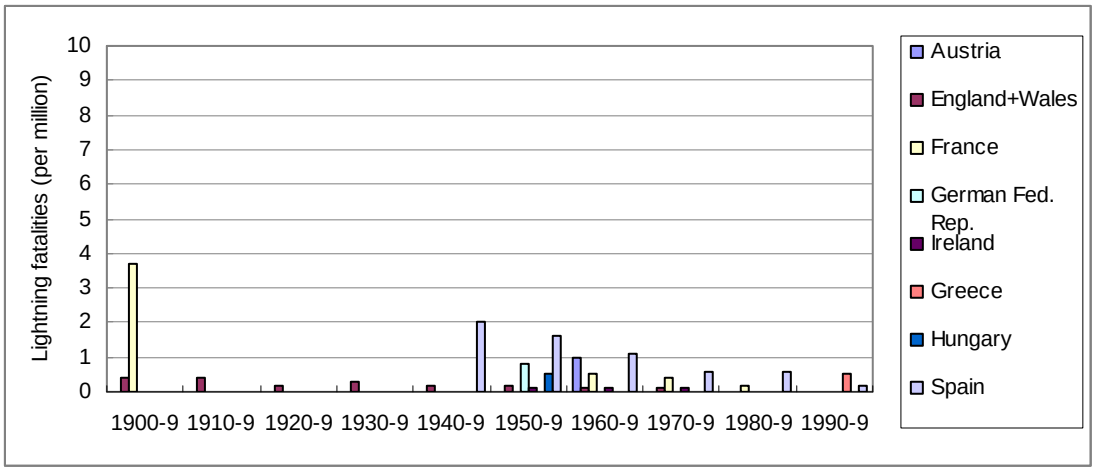


Figure 3 - Lightning fatality rates in developed countries in the twentieth century showing rates under 1 per million by the end of the century. (From Holle RL: Annual rates of lightning fatalities by country. Preprints, International Lightning Detection Conference, April 21-23, 2008, Tucson, Arizona, Vaisala).

Despite these population shifts and changes in risk exposure over the last century, lightning continued on average to kill more people in the United States annually than any other storm related disaster except floods.[3] However, since 2000, US lightning deaths have decreased to an average of about 50 per year due at least in part due to two decades of persistent lightning safety efforts and the ten year National Lightning Safety Awareness Week (www.lightningsafety.noaa.gov) campaign.[4]

REPORTING OF LIGHTNING DEATHS IN DEVELOPING COUNTRIES

Governments vary widely in requirements for reporting lightning injuries as well as in data collection and coding. Even when medical care is readily available, some victims do not seek treatment at the time of the injury so that statistics about lightning injury gathered from medical data sources are even more unreliable than lighting death data making the true incidence of injury unknown in most countries.

Just as in the US, most lightning injury statistics in Asia are based on newspaper reports and medical records.[5] The actual number of injuries may be considerably higher than reported. This is especially true in areas such as Bangladesh, where information on deaths and injuries in rural areas is rarely spreads beyond the individual village in which the incident occurs.

In less developed countries, many people continue to participate in labor-intensive agriculture and live in ungrounded buildings. Lightning frequency is high in many of these areas and outdoor workers and villagers are vulnerable. Many cases involve outdoor activities such as fishing, agriculture, recreation and sheltering in unsafe or unsuitable places. Lack of recognition of lightning danger and education about the warning signs may also contribute to the number of injuries.

Observations of damage to people, animals and property in several states in India and other countries in South Asia including Sri Lanka, Bangladesh, Bhutan, Maldives, Nepal and northern parts of Pakistan indicate that there is a higher lightning hazard in South Asia compared with many other parts of the world.[5] According to the National Crime Record Bureau of India, 1507 persons died from lightning in India during the year 2001, about 1% of all deaths due to natural and other accidental causes. In Orissa State in Eastern India alone, about 300 persons were killed by lightning in 2004. According to the few studies that have been done in Sri Lanka and Bangladesh during the recent past, the number of lightning-related deaths is about 70 per year in Sri Lanka and about 130 in Bangladesh.[5] Figures 4 and 5 show data for deaths in some Asian countries for 2008.

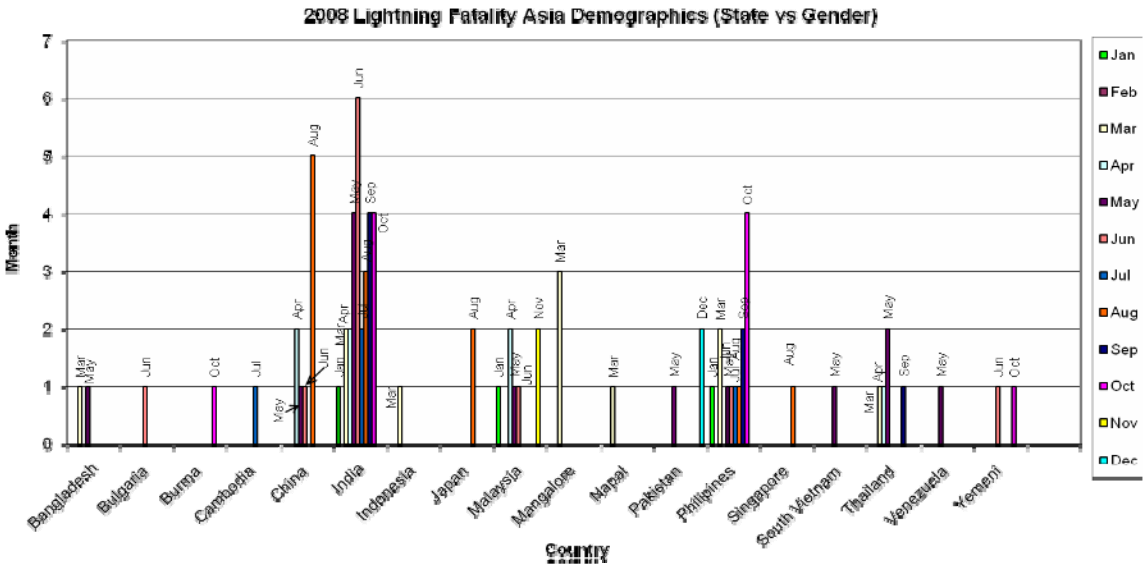


Fig 4 - Lightning Fatality Data in Asia in 2008 by Month

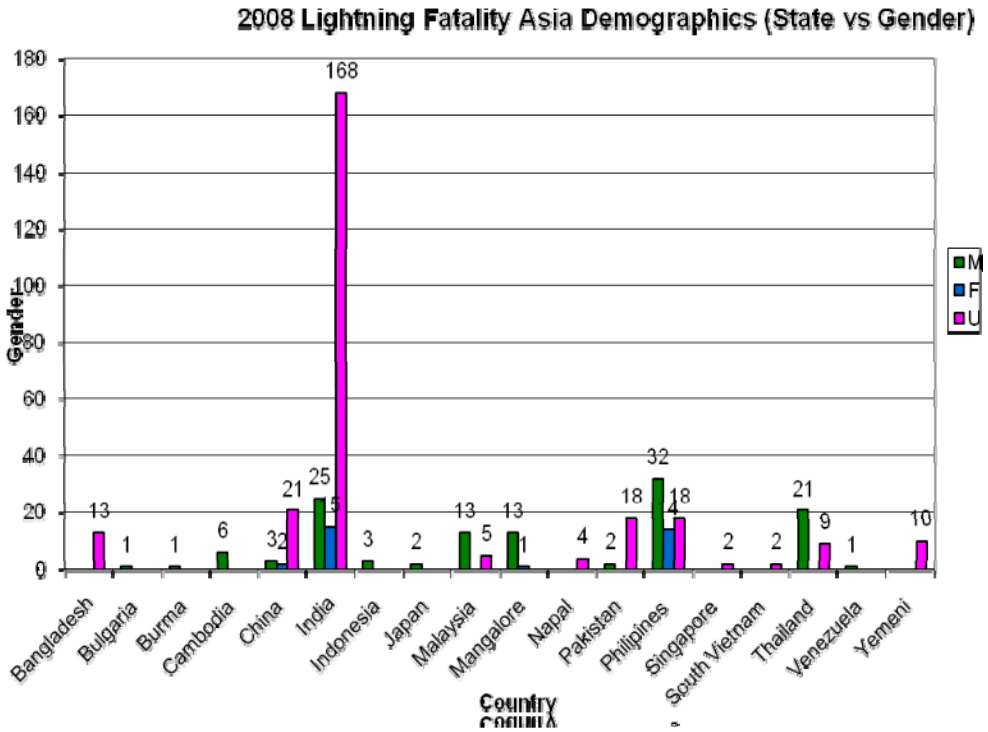


Fig 5 - Lightning Fatality Data in Asia by Gender

Little information is available about lightning incidents in Pakistan. Lightning strikes often involve more than one victim when the current "splashes" to other individuals or spreads electrical energy as ground current. In 2007, lightning killed up to 30 people when it struck Ushari Dara, a remote mountain village in northwestern Pakistan.[6]

A study of lightning casualties in and near dwellings and other buildings showed that large losses of life occur in schools, huts, and agricultural field shelters in these regions.[7] Also in these countries, people

spend less time inside the safety of fully-enclosed metal-topped vehicles while working or traveling between school, work, and home than in more developed regions.[8]

ESTIMATING LIGHTNING DEATHS AND INJURIES IN DEVELOPING COUNTRIES

Since accurate data collection is difficult in almost all countries, one way of estimating the problem is to apply a reasonably accurate rate measured under similar exposure circumstances from another country or time. Holle used the rate from a century ago in the US, a time when labor intense agriculture was still common, construction and grounding of buildings and homes was inadequate, and there were no appreciable metal vehicles to provide shelter.[2]

Africa, South America, and Southeast Asia have as many as 4 billion people who are vulnerable to the lightning threat, although urbanization taking place makes it difficult to know the number of agriculturally-dependent people living in unsafe structures. If the annual rate of 6 fatalities per million is used for four billion people, a total of 24,000 lightning deaths per year is obtained.[2] If there are 10 injuries for every death[9], then 240,000 injuries occur per year in these areas. It is possible that fatalities and injuries in tropical and subtropical areas may be even greater than this estimate predicts since temperate areas tend to have less lightning, fewer thunderstorm months, as well as perhaps less population exposure during colder months.

To corroborate the initial estimate, Holle later looked at all known published estimates of the lightning totals, and converted them to fatality rates per population. Some of the countries indeed reached the rate of 6 per million per year, while other lesser-developed countries have much lower rates.[2]

DECREASING LIGHTNING INJURIES AROUND THE WORLD

At first glance, it would seem reasonable to approach lighting injury prevention in any country by employing the factors that decreased injuries in other countries. Unfortunately, the factors most responsible for the decrease in lightning fatalities in developed countries including population shifts, urbanization, and industrialization of farming, are economic and social factors and not a factor of lightning injury prevention programs. Even factors such as substantial construction, good grounding, and large numbers of metal vehicles may be unattainable, impractical to expect or unaffordable in developing countries. Even the messages used for public education in one country or area may not be effective in another country due to cultural, religious or employment differences.

There are usually several steps in any lightning injury prevention program.

1. RECOGNITION OF THE RISK

To effect change, lightning injury must be recognized as a substantial risk to a population. It is helpful to have data on injuries and fatalities to use with government officials, to convince populations that they are at risk, and to raise awareness of lightning danger for groups and individuals.

2. OPPORTUNITY

While injury prevention efforts are sometimes mundane and methodical, involving studies of the ongoing risk to a population, bringing them to the attention of the local government, public health officials, or others in power to bring about change, sometimes a multi-casualty incident or an incident involving a prominent citizen may occur that can be used as a catalyst for change. Sometimes injuries to a particular worker population may have such an economic impact that business owners develop an interest in prevention.

3. MULTIDISCIPLINARY TEAM

There are many advantages to forming a team with members from a number of disciplines and interests who can contribute their expertise, ideas, energy, and contacts to reach out and effect change in many different venues. Some of these may be parents, media personnel, educators, and local activists. At least some of the members might be atmospheric physicists/meteorologists with a particular expertise in lightning and an interest in injury prevention, medical personnel who care for the injured to provide expertise and stories, public health, public safety, and other government officials, lightning protection

specialists, and risk managers to lend their expertise, authority and contacts. Sometimes sports figures or other prominent role models can be solicited to contribute as spokespersons.

4. TAILORING THE MESSAGE / RECOMMENDATIONS

The 'message' needs to be tailored to the population and include risks and solutions that they will recognize as practical and attainable. Recommending that someone seek shelter in a substantial building or metal vehicles is useless when neither of these is available to a seasonal farm worker on the high planes of Kenya.

5. DELIVERING THE MESSAGE

The means of delivering the safety message and solutions also needs to be tailored to the targeted population. In Bangladesh, street theatre with actors simulating lightning, thunder, victims, with an off-set Voice of Authority explaining dangers of being outdoors during thunderstorms has been used. In Nepal, community education through seminars and teaching has been done with training by a recognized and respected authority has been done (see http://www.youtube.com/watch?v=yWDgHNGNXAY). Use of lightning safety information in soccer coach training and other sports has been effective in populations where the sport is popular. In some areas, the media may be invaluable if they are trusted sources of information for the population.

Use of local spokespersons, shamans or community leaders may be essential to help tailor the information as well as in reaching the targeted groups. There are cultures where lightning carries a taboo aspect (shunning of a family in the Peruvian Andes whose home has been hit or family member killed), social effect (revenge killings in South Africa), or other beliefs that will need to be addressed or worked with to make any progress in injury prevention.

6. BUILDING CODES / PUBLIC SAFETY

It may be possible to decrease lightning deaths by changing or instituting building codes consistent with accepted lightning codes.[11-13] In other areas, the economic impact of injury may make it practical for lightning safety measures to be employed. Sometimes lobbying for government worker safety regulations of at risk industries, schools, parks or other places where people may be at risk may be effective.

7. INNOVATIVE TECHNOLOGY

Creative solutions may be developed using existing technology or materials (Fig6). These are most effective when they are inexpensive, easily installed and modified, and low maintenance.[14-16] They must also be perceived as reliable by the population using them.

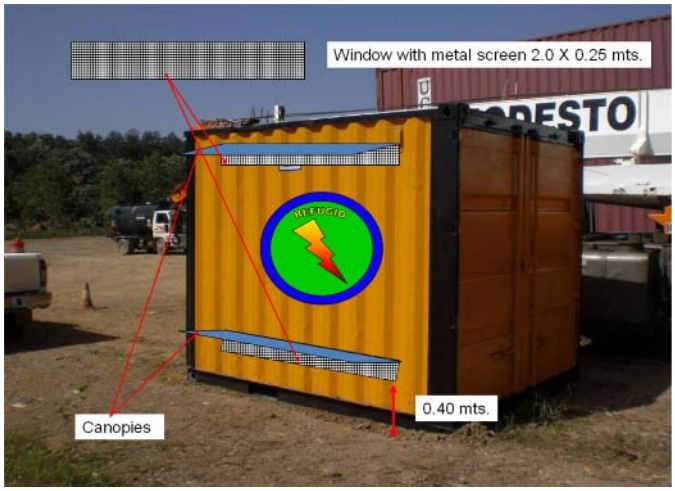


Fig 6 - Modification of metal shipping container to provide lightning shelter at remote mining sites in Papua New Guinea, Tanzania, and Peru. These could also used in agricultural areas. (courtesy Rich Kithil, National Lightning Safety Institute)

SUMMARY

Lightning injury remains a substantial public health risk in many countries. Factors such as population shifts and economic changes that have decreased fatality and injury rates in developed countries may not be practical or attainable in countries with the highest risk, particularly in less developed, labor intensive economies.

Effecting substantial injury prevention, then, requires a multi-faceted approach. Each group may be able to incorporate or modify approaches other groups have developed . However each group should also be flexible and open to creative ideas that are more suited to their target populations. We challenge the experts who study lightning to become involved in their communities in decreasing fatalities and injuries from lightning.

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