

**Microwave Theory and Techniques**  
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**Module – 01**  
**Lecture – 04**  
**Effects of Microwaves on Human Body – I**

Hello, everyone. Today, we are going to talk about effect of RF and microwave radiation on human body.

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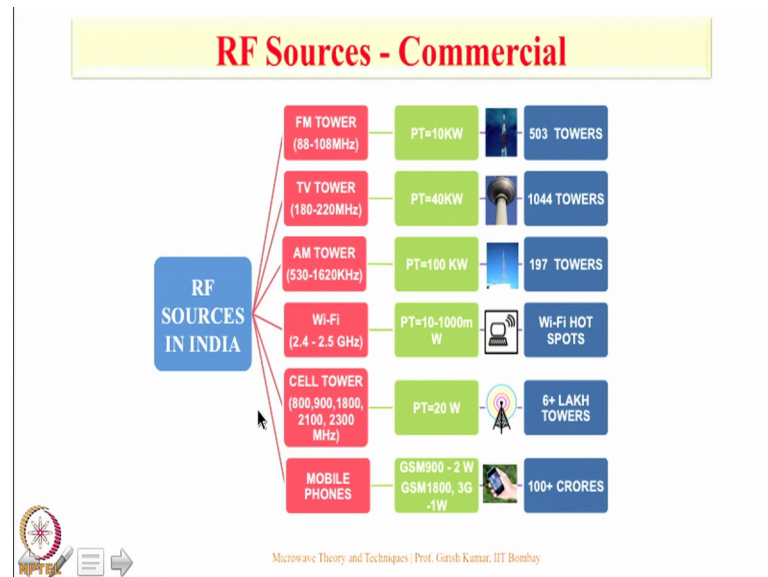


So, the outline of the presentation today is we will first talk about RF sources which are present for the commercial as well as defense application. Then, we will talk about microwave heating principle, I am sure all of you might have use microwave oven or seen somebody using microwave oven and you are familiar with that microwave oven can do the cooking. Then, we will talk about radiation pattern of a antenna, we will talk about safety norms in India and in other countries, we have done radiation measurements at more than thousand places, then we will tell you what to we have found.

And, then we are going to review biological effects. Yes, I just want to tell you neither I am your biology professor and most of you are not biology student that our human body is a biological body. So, I am sure you will be able to correlate with this biological effect. And, the last one is my most favorite one that is solutions. In fact, my definition of

engineers is that engineers are born to solve practical problems. So, first we will identify what are the problems and then we look at the solutions. So, let us look at what are the different RF sources in the commercial domain.

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So, these are RF sources in India, but it would be similar thing in other countries also. So, we can see here FM towers are there. Typical frequency a range of FM towers is between 88 to 108 megahertz and then maybe actually you transmitting about 10 kilowatt of power. Of course, there are some FM towers which are there inside let us say colleges or community services there may be allowed only to transmit 50 watt of power.

Now, there are TV towers this particular frequency band I have written specifically for tower in Mumbai which is situated in Worli and that particular tower transmits about 40 kilowatt of power and in fact, that is a lot of power. Now, the antenna which transmits this particular power is mounted roughly at a height of 300 meter and in fact, till about 10 years back most of the buildings around this Worli area were not even had a height of 50 meter. But now, in the Worli sky phase because it is very expensive area now multiple buildings have come which have a height of 200 to closed to 300 meter. And, now these buildings are coming in the main beam radiation of the antenna and I can already forewarn people that in another 5 to 10 years there may be a lot of health problem occurring in those high rise buildings which are in the main beam of the antenna.

Then there are AM towers are there typical frequency range is 530 to 1620 kilohertz and these AM towers may transmit about 100 kilowatt of power up to even 1 megawatt of power. However, these people take precaution and at least within a 1 kilometer radius there is a no residential building or complex. So, they do know that these are causing a health hazards and hence they take that precaution.

Now, we have Wi-Fi. Wi-Fi works even they have written 2.4 to 2.5, but actual frequency range is from 2.4 to 2.483 gigahertz and these days Wi-Fi modems are there almost everywhere. We have Wi-Fi enabled airports, railway stations, colleges, schools and various campuses and now in fact, there are proposes to make Wi-Fi enabled cities. In fact, this is going to cause a lot of health problem to various people also in time to come.

Then, we have cell towers in India we have a several technologies which are 800 megahertz which is basically CDMA, 900 is GSM 900, then GSM 1800, then we have 3G and then we have 4G. And, in India we allow them to transmit 20 watt of power and there is a extra concession given to a 4G operators, they can transmit up to 40 watt of power and we have more than 6 lakh towers in India.

And, then of course, mobile phone I think almost all the people today have mobile phones and in the mobile phones again depending upon the technology there may be a 2 watt power transmission allowed for GSM 900 phone and for other GSM 1800, 3G, 4G generally 1 watt power is allowed. But, however, there are 100 [FL] plus subscribers in India and just to tell you let us say if you initiate a call using a cell phone, what really happens?

Let us take a case where a mobile phone is transmitting 1 watt of power it goes to the nearest base station and that base station actually transmits 20 watt of power to communicate with this particular cell phone. Then, this base station through let us say some switching network communicates through the other base station, that base station will transmit another 20 watt of power to the mobile phone which is going to transmit a 1 watt of power.

So, for one mobile phone connection 1 plus 20 plus 20 plus 1 total 42 watt power has been consumed and you will be surprised that affective power used by cell phones as well as cell tower is only 0.0000001 watt. So, that means, 41.99999 watt power is getting dissipated in the atmosphere. And of course, when you initiate a call roughly a one-third

of the power is getting absorbed in your own body; specially if you keep that cell phone like this and then one-third of the power is going towards your head. But as far as the cell towers are concerned, people living in the close vicinity are getting affected; the birds flying in that particular region are getting affected also.

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**RF Sources - Defense**

- Radar Systems – Pulsed and Continuous
- High Power Microwave Sources
- HF, VHF, UHF, and Microwave Transmitters
- Microwave Bomb
- Microwave Weapon

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Now, there are several sources for defense also, but I just tell briefly about these things so, they do use radar systems which can be pulse and continuous and in several defense application there may be even transmitting 1 megawatt of power. However, these defense forces do take precaution. Of course, they do use lot of high power microwave sources and they use transmitters and almost all these band HF – high frequency, VHF – very high frequency, UHF – ultra high frequency and microwave. So, they do use a lot of high power for many of their communication requirement.

Of course, there is a microwave bomb also. So, microwave bomb what is does it actually transmits the very high power impulse and what happens because of that the receivers in that particular area get burnt and that is causes a total damage. And, of course, microwave has been used as a microwave weapon if that microwave high power beam is targeted towards a certain person of people and those people can gets seriously affected. In fact, this is being also used as a non lethal weapon specially for crowd dispersion.

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**Microwave Heating Principle**

Microwave radiation causes vibration in the water molecules, which leads to friction and heating. The radiation effects are classified as:

- Non-thermal
- Thermal

Current exposure safety standards are based on the thermal effects, which are inadequate.

Non-thermal effects are several times more harmful than thermal effects.

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So, now let us talk about a microwave heating principle. Now, you might wonder that we are talking about RF, why we are talking about microwave heating principle I will come to that in a short while. But, what really happens when we put a food inside a microwave oven, it is the water in the food which actually receives this microwave radiation. And these water molecules start vibrating and you know at what speed they vibrate at 2.45 gigahertz they vibrate at a speed of 2.45 billion times per second. So, when that vibration takes place that vibration causes friction and that friction causes heating and that heating is responsible for cooking the food.

So, now: how that is related with the human body? So, let us say human body consists of 70 percent liquid and in fact, our human brain consists of 80 percent liquid. So, what happens let us say if we keep the phone like this here so, this microwave radiation which are coming so, they start vibrating water, fluid and blood molecules. And these things start vibrating, let us say if it is a 900 megahertz technology. Then they are vibrating at a speed of 900 million times per second and inside the body then these things actually cause DNA damage which is known as non thermal effect and that friction then leads to heat and that is known as thermal effect. So, non thermal effects are several times more harmful than thermal effects.

So, I also want to tell you that there is a bit debate going on all over the world people says it is sun heating is more versus microwave heating, but just to tell you the two

heating processes are totally different and let me explain in a very simple manner. So, these people specially the operators and their supporters they talk about while sun density is something like 1 kilo watt per meter square whereas, we are talking about microwave power which could be as 1 milliwatt per meter square or maybe 100 milliwatt per meter square. So, 1 kilowatt versus 1 milliwatt sounds huge difference, but let me explain the concept here.

So, what happens when sun we are going outside in the sun first of all we are not going to stand in the sun for 24 hours, whereas, a microwave radiation is absorbed 24 hours especially if you are living next to the cell tower. So, now, this radiation when you stand in the sun so, what happens the sun rays come here and it actually basically skin acts as a protective layer. So, the heating if at all takes place that is from outside then it goes inside, but that skin heating takes place and the body start sweating or there may be a breeze so, it really speaking becomes better of course, you do not stand for a long time and even a cloth will protect you from that.

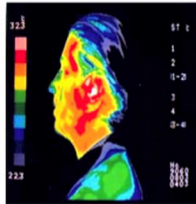
Whereas, a microwave radiation it actually penetrates the body, entire body wherever it falls and then what happens that heating goes deep inside the skin and then the water, blood fluid molecules start vibrating and that internal heating is now trapped by the same skin. And that is why there are more problems because, of the microwave heating. Another very simple example if you put let us say a one cup of water in the sun, it is never ever going to boil but, if you keep one cup of water inside a microwave oven it is going to boil within 1 to 2 minutes. So, you can see that the two phenomena's are totally different.

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**Cell Phone - Ear Warming?**

Have you ever noticed warm sensation in ear after using mobile phone for a long time?

Temp. of ear lobes increases by  $1^{\circ}\text{C}$  when cell phone is used for approx. **20 minutes**.



**Warm sensation**  $\Rightarrow$  **pain**  $\Rightarrow$  **irreversible hearing loss and/or Ear Tumor**

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So, let me just ask you people only a very simple question and you can actually think about it. And the question is simple that if you have use cell phone for more than 20 to 30 minutes have you notice you ear gets warmed I am sure majority of you would have notice it is getting warmed. So, what is the reason? In fact, when we keep the cell phone like this the ear lobe is closest to the mobile phone and the blood inside the ear lobe does not circulate much.

So, what happens when this is impinging microwave radiation it is heating the blood and it has been reported that after about 20 minutes or so, the ear lobe temperature goes up by 1 degree centigrade. And then the brain realizes that something is wrong and then a process known as thermo regulatory mechanism starts and the body becomes uniform.


But, think about this damage of one degree centigrade if body temperature is 98.4 degree Fahrenheit you add 1 degree centigrade which is equal to 1.8 degree Fahrenheit and if you add the two things it becomes 100.2 degree fever. So, every time you use. So, 20 minutes or 30 minute you are getting a fever of 100 degree and I am sure most of you people will not like to have the fever. So, anyway this warm sensation in the beginning leads to the pain and then slowly that pin then converts to irreversible hearing loss which can be partial or full hearing loss as well as it can also lead to ear tumor.

In fact, I have started writing my own newsletter also cell phone tower newsletters you can you can just Google search it and you can download or you can send me an email

and my emails are given on my first slide itself. So, you can send me and I will mail you these three newsletters and in one of the newsletters I have actually given the interviews of five different ENT specialist and they have unanimously agreed that there are getting very large number of cases these days where people are suffering from partial or full hearing loss as well as ear tumor. So, please take care of your ear.

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### SAR and Cell Phone Use Time Limit




### 6 minutes/day usage.

A cell phone transmits  
1 to 2 watts of power

**SAR (Specific absorption rate)** - Rate at which radiation is absorbed by human body, measured in watts per kg (W/kg).

In USA, max. SAR limit for cell phones is **1.6W/Kg** which is for **6 minutes**. It has a safety margin of 3 to 4, so a person should not use cell phone for more than **18 to 24 minutes per day**.

This information is not given to people in India.

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So, now, how do we define a radiation from cell phone? In fact, the radiation from the cell phone is defined by its SAR value. SAR is known as specific absorption rate and this limit has been set as 1.6 watt per kg. However, this limit was set in 1998 and this limit was set for only 6 minutes per day use. So, the cell phones which you people are using they were actually designed only for 6 minutes per day use. However do not be too much afraid also there is a safety margin of 3 to 4; that means, really speaking a person should not use cell phone for more than 18 to 24 minutes per day.

In fact, I would like to recommend that next time when you are going to buy your next cell phone you check what is the SAR value. So, and that is easy to check these things are available on the internet or on the smart-phone you can actually say a star hash 0 7 hash and then you can check the SAR value. So, the lower the SAR value better it would be. So, typical SAR value may vary from 0.3 up to about 1.59 just below 1.6. Now, this information is not at all available to people in India in fact.



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**iPhone 7 RF Exposure information**

<http://www.apple.com/legal/rfexposure/iphone9,1/en/>

The highest SAR values of Models A1660, A1780 are:  
**1.6 W/kg (over 1 g) SAR Limit**  
Head: 1.19, Body: 1.20

To reduce exposure to RF energy, use a hands-free option, such as built-in speakerphone, the supplied headphones, or other similar accessories.

**Carry iPhone at least 5mm away from your body to ensure exposure levels remain at or below the as-tested levels.**



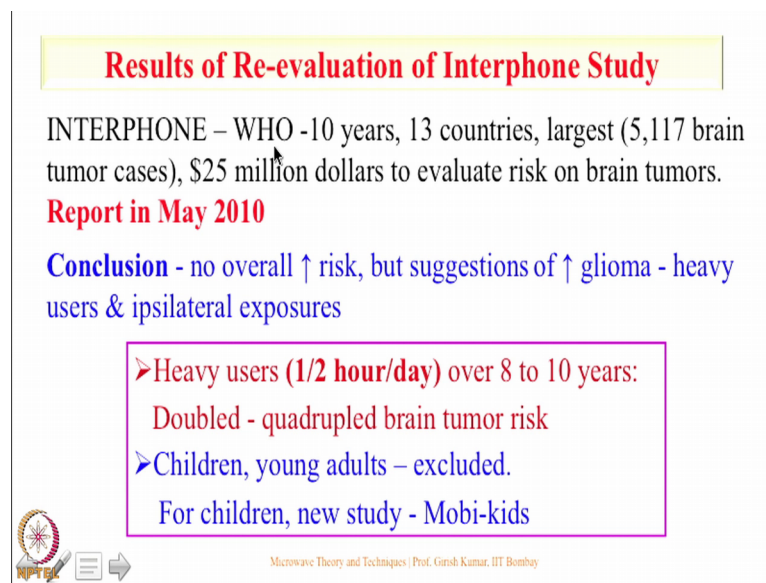
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I just want to tell you many people are using iPhone or other phones, but just to tell you. So, if you look at this here that iPhone of course, is from apple dot com, you have to go through the legal. So, then no there are legal issues are there and there are some RF exposure and what it says? Well, the limit is 1.6 watt per kg and their phone has a SAR value of 1.19 for head and full body is 1.2. Hence it is within the limit.

However, how they test the cell phone they test their cell phone; read this here carry i phone at least 5 mm away from your body to ensure exposure levels remain at or below the as tested level. So, that means, they are testing the mobile phone by keeping 5 mm away and then they are saying this is the SAR value. So, let me ask you people do you really you know measure 5 mm keep the cell phone like this no not really many people use cell phone like this or they hold cell phone like this and there are of course, much smarter people they do multi tasking and they use cell phone like this.

Now, in this situation 90 percent of the radiation is going towards your body and the same apple iPhone also tells you that to reduce exposure to RF energy use a hands free option such as built-in speaker, supplied headphones or similar accessories. So, if there was a no health problem because of the RF radiation then why take precaution? Why these people are telling you to reduce exposure to RF energy. So, one you would really think about yes there is definitely a problem and we will see: what are these problems and when these things start coming.

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**Results of Re-evaluation of Interphone Study**

INTERPHONE – WHO -10 years, 13 countries, largest (5,117 brain tumor cases), \$25 million dollars to evaluate risk on brain tumors.

**Report in May 2010**

**Conclusion** - no overall ↑ risk, but suggestions of ↑ glioma - heavy users & ipsilateral exposures

- Heavy users (**1/2 hour/day**) over 8 to 10 years:  
Doubled - quadrupled brain tumor risk
- Children, young adults – excluded.  
For children, new study - Mobi-kids

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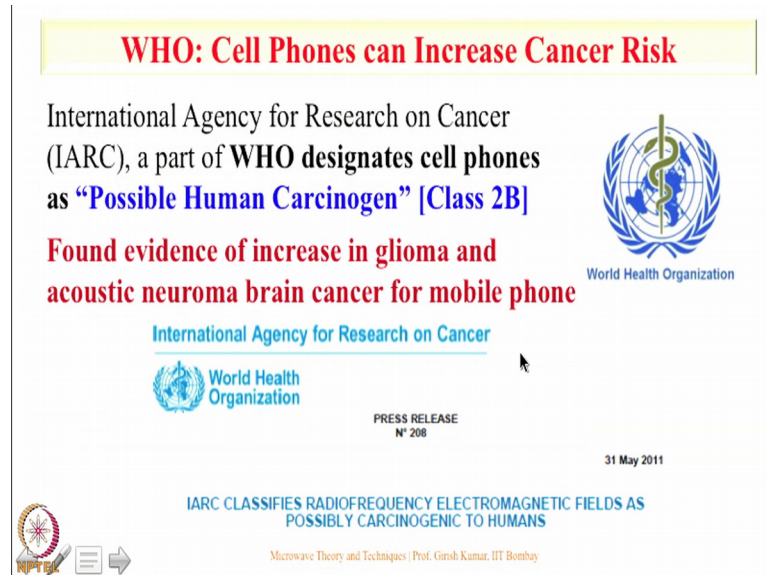
So, I want to mention an interphone study was actually started in 2000 and you have to followed all the protocols of who which is world health organization and the study started at 2000 and it actually took 10 years the report came in may 2010 it actually took cases from 13 different countries and it actually studied about 5117 brain tumor cases and of course, the study involved about 25 million dollar and one third of that money came from the cellular industry.

So, now let us see what is the conclusion? The conclusion says no overall increase in the risk and we start thinking, Oh, good! We are safe. No, let me tell you this is no overall increase in the risk is for average user and what is the definition of average user? 2 hours per month and 2 hours per month comes out to be 2 into 6000 20 minutes per month that really comes out to be 4 minutes per day. So, if you use cell phone only for a 4 minutes per day no problem, but if you use 4 longer time then there is a problem and what is the heavy user definition half hour per day over 8 to 10 years and what I found double to quadrupled brain tumor risk.

Now, I just want to tell you since then the mobile phone technology has improved now the cell phone technology has improved. Now, it actually checks: what is the radiation intensity in that particular area and if it is small then it will transmit a high power and if it is high then it will transmit low power. So, in fact, I do recommend that when you are inside a building or if you are inside a lift where the signal strength maybe low and that

you can see by one or two bars on your mobile phone. So, in that case take precaution do not use for longer time. So, but those precautions actually have resulted into a little better thing and after a few slides I am going to tell you what are those things.

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**WHO: Cell Phones can Increase Cancer Risk**

International Agency for Research on Cancer (IARC), a part of WHO designates cell phones as **“Possible Human Carcinogen” [Class 2B]**

**Found evidence of increase in glioma and acoustic neuroma brain cancer for mobile phone**

World Health Organization

International Agency for Research on Cancer

World Health Organization

PRESS RELEASE  
N° 208

31 May 2011

IARC CLASSIFIES RADIOFREQUENCY ELECTROMAGNETIC FIELDS AS POSSIBLY CARCINOGENIC TO HUMANS

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The slide features a yellow header with the title 'WHO: Cell Phones can Increase Cancer Risk'. Below the title, the text states that the International Agency for Research on Cancer (IARC), a part of the World Health Organization (WHO), has designated cell phones as 'Possible Human Carcinogen' [Class 2B]. It also mentions 'Found evidence of increase in glioma and acoustic neuroma brain cancer for mobile phone'. The WHO logo is visible on the right side. At the bottom, there is a footer with the text 'IARC CLASSIFIES RADIOFREQUENCY ELECTROMAGNETIC FIELDS AS POSSIBLY CARCINOGENIC TO HUMANS' and 'Microwave Theory and Techniques / Prof. Girish Kumar, IIT Bombay'. There are also logos for NPTEL and a mouse cursor on the slide.

So, now I want to tell you that this study which came in May 2010; that International Agency for Research on Cancer took a one full year and their report came in 31st May 2011. And now, IARC classified radiofrequency electromagnetic fields as possible carcinogen to human that is known as class 2B. However, WHO even though this is a part of WHO; WHO designated only cell phones as possible human carcinogen and they are designated as class 2B.

Now, it is really strange then their own agency says radio frequency electromagnetic field which will actually encompass radiation from all sources which can be a radar which can be TV towers, which can be cell towers, which can be a Wi-Fi, however, who simply made it only cell phone. So, now, the question comes why WHO did that. So, you have to really think about WHO gets funding from whom? Well, WHO gets funding from various governments of the world and the various governments of the world are making lots of money from cellular operators.

So, just to give you a little bit of an idea between 2013 and 2016 Indian government did this spectrum option and they raised about 3 lakh [FL] rupees and this is just by spectrum auction. They are getting huge money by income tax, sale tax and now GST. So, it is a

one of the biggest revenue today for the government of India and again in 2018 they are planning to have another round of spectrum auction and they are hoping to garner more than 1 lakh [FL] and that is why government is also relatively silent about the health hazard.

And of course, cellular industry will never tell that there are health problems associated with the overuse a cell phone, just like cigarette industry, cigarette industry never admitted that there are health problem. Even 40 – 50 years back we knew that cigarette smoking is bad, yet it was only about a 5 years back when if you go to watch a movie or if you see some TV channel though there was somebody is smoking then it says cigarette is injurious to health and now, for a last 1 year it has started showing smoking kills.


However, now even though cell phone is class 2B what class 2B really means it is possible human carcinogen and what it really means there are limited evidences. However, I will tell you since this report came in may 2011 now 7 years have almost coming or 6 and a half years are gone and there are several more evidences have come. And a now, scientist are after WHO and they are telling who to norm make this thing as class 2A which is known as probable carcinogen or even class 1, which is known human carcinogen. So, we have to wait, WHO has promised that they will come out with their report in May 2018. So, let us see what will be that particular report.

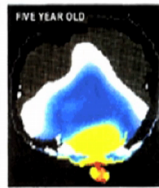
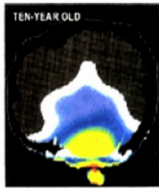

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### Risk to Children


Children are more vulnerable as:

- Skulls are smaller & thinner - ↑'s radiation absorption
- ↑rate of Cell division - more susceptible to genetic damage
- Myelin sheath not developed - Electrical brain-wave activity
- Immune system not well developed - less effective against fighting cancer growth





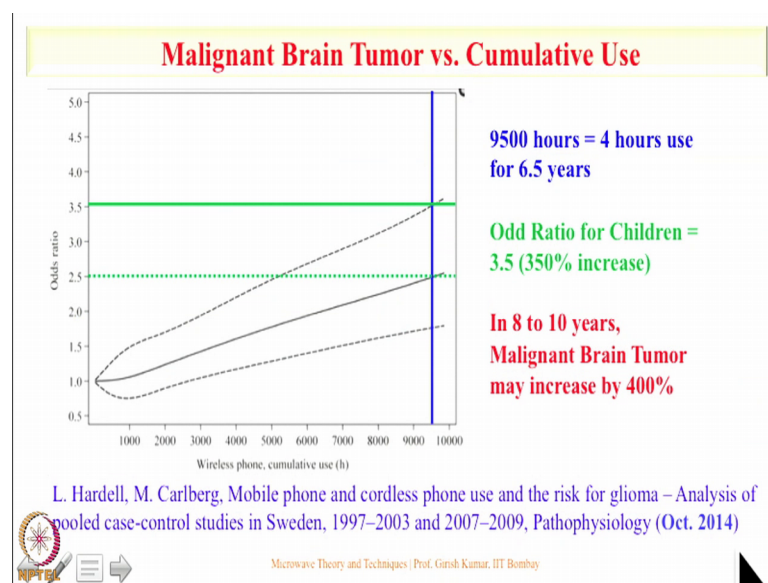
**RF penetration in the skull of an adult (25%), 10 year (50%) and 5 year old (75%)**

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So, now, I just also want to tell you that a risk to the children is much more compared to an adult and in fact, this study has been reported where let us say a child is using cell phone. So, for a 5 year old the penetration is almost 75 percent, for a 10 year old or teenagers the penetration is about 50 percent and for an adult the penetration is 25 percent. So, for children because their skulls are smaller and thinner so, they absorb the more radiation and also their cells are growing. So, they get affected much more.

In fact, there are many European countries they have actually banned use of cell phone by children. In fact, they are advocating that children below 12 year should not use cell phone or if at all they use cell phone they should use it only for emergency use. In fact, actually I want to tell you all people that the invention of cell phones was actually meant only for emergency use and it was never ever meant to be used for hours and hours every day.

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So, now I want to mention that the recent study after 2011 this study is October 2014 and what that study is this is a very interesting study. So, I just want to tell you what it shows here malignant brain tumor versus cumulative use. So, here you can see along this axis the usage from 0 to 10000 hour and this is the odd ratio of getting malignant brain tumor I have actually put a line somewhere over here and the reason for that is this corresponds to about 95000 hours.

And, I know that there are several younger people and even some of the sales people they use cell phone for 4 hours per day and if you have been using it for 6.5 year you will consume 95000 hours. So, now, here what these plots are? So, there are three plots are there. So, basically you can say this is the lower end to the maximum and this is the average or mean thing, and this is valid more for children.

So, if you look at the odd ratio for children corresponding to this if you look at it here that is 3.5. So, that means, odd ratio for children of getting brain tumor is 350 percent and even for a normal person this is about 2.5 which is 250 percent and this is all in 6.5 years. So, in about 8 to 10 year malignant brain tumor may increase by 400 percent especially for young children. So, please take care of your health.


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**Brain Tumor among children on the rise in India**

**THE ASIAN AGE: July 10, 2017**

According to a study in 2016, every year 40,000-50,000 persons are diagnosed with brain tumour in India, out of which 20 per cent are children. The study showed a drastic increase in the cases of brain tumour in children post 2015. Doctors said that this could be attributed to long-term mobile use.

“There is a lot of literature that establishes a link between mobile radiation and brain tumour. Mobile phones emit radiation from their antennas and kids are at high risk as they possess soft tissues near the ear. It is advisable for children, adolescents, and also pregnant women, to use headphones while on call or use the speaker,” said Dr P.K. Sethi, professor and consultant of the neurology department at Sir Ganga Ram Hospital.



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So, now of course, we know that these things are very dangerous and this is becoming now more and more evident also. So, this is the report in Asian Age newspaper July 10, 2017 and I just want to mention here what they are saying. Every year 40000 to 50000 people are diagnosed with brain tumor in India and out of which 20 percent are children and you can actually even say that doctor said that this could be attributed to long term mobile phone use.

So, even here another doctor is also claiming that these are the things which are causing health problem. So, we want specially the younger generation to use cell phone only for short duration. We understand that cell phone is absolute fantastic technology. In fact,



these days you can do so many things with your cell phone, but yet you need to take precaution. So, I am going to tell you now; what are the precautions to be taken.

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**SUGGESTED SOLUTIONS**

**POPULAR SCIENCE**  
‘Are cell phones injurious to your health’ by Prof. Girish Kumar  
Sep. 2011

**POPULAR SCIENCE**  
Better, Smarter, Faster  
Your Science Magazine is Rebooting the Car.

While the cell has become an additional appendage for most of us, all this, of course, does not mean that we have to stop using cell phones. Just ensure you take precautions:

- Limit your use
- Talk for short durations
- If possible, use SMS
- Use cell phone with lower SAR value
- Use the speakerphone or wired hands free or Bluetooth, but keep the cell phone at a distance of at least 12 inches from your body
- Use the land-line, when available
- Do not keep cell phones in your hand/pocket for long.
- At home/office, keep the phone away from you

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In fact, this article was written by me for popular science magazine it came in September 2011. So, what precautions I suggest first is limit your use and I do not advise anybody to use cell phone for more than 20 minutes talk for short duration now if possible use SMS. Now, in 2011 WhatsApp was not there, but nowadays WhatsApp is there and you know when you are actually typing SMS or WhatsApp there is a very little radiation, just to tell you that even if you are not using cell phone it is still transmits about 1 pulse per minute to the base station. But, if you have Wi-Fi on and Bluetooth on and so, many applications on then it maybe 2 to 4 pulses per minute to the base station.

So, let us say when you are typing it is a normal 1 or 2 pulses per minute it is only when you press the send button then there is a larger radiation. So, I would advise that use even SMS or WhatsApp lesser number of times uses cell phone with the lower SAR value because lower the SAR value lesser will be the radiation. However, please remember if you have making call for a longer time cell towers are going to radiate continuously. So, you all are responsible for creating electromagnetic pollution. In fact, we have been telling the government now, but let electromagnetic radiation be classified as fourth pollution the other three pollutions are water, air and noise.

Use speaker phone or wire hands free. In fact, you can have a mobile phone and put it in the speaker phone and you can talk. Of course, in the public you cannot do that, but at least when you are inside the home you can do that. You can use wire hand free, but the thing is how you are using is now let us say you put the wires hand free, then where is your phone are you holding it in your hand, then your hand will receive more radiation. If you are putting in the shirt pocket then your heart will receive more radiation, if you are putting in the front or a back pocket then that body area will receive more radiation. So, you have to decide which part of the body you do not like.

Of course, you can use Bluetooth; just to tell you Bluetooth transmits maximum 10 milliwatt of power whereas, a mobile phones may transmit 1 watt of power. So, naturally Bluetooth transmit a power of 10 milliwatt is 100 times less than the mobile phone, but again how you use it. So, what I have seen many a times that people put this Bluetooth over here and let us say put the cell phone like this. So, now, what is happening Bluetooth is transmitting 10 milliwatt, this mobile phone is transmitting 10 milliwatt to this Bluetooth and it is anyway transmitting 1 watt of power.

So, you have actually speaking increase your exposure to the microwave radiation. So, the best thing is if you are using Bluetooth keep the cell phone and the cell phone communication can take place through Bluetooth till about 5 meter distance. So, you can be at a distance you can do some exercise also, you can do walk and talk and in fact, suppose if the other party is giving you too much stress you can do some yoga exercise also breath in breath out, so that you can relax.

So, in fact, I do recommend that use the landline wherever it is available because landline has no radiation. Do not keep cell phone in your hand pocket for a long remember it is transmitting a 1 pulse per minute to may be to several pulses per minute to the base station. So, if you are keeping the cell phone for 6 to 8 hours in your pocket you are going to get larger exposure. So, I will always recommend that you know when you go to home, your office keep the cell phone away from you at least 1 foot distance and especially when you are sleeping do not keep cell phone next to your pillow.

You may be sleeping, but your cell phone is not. So, it is actually sending radiation towards your body. So, I recommend that you keep the cell phone at an arm's length so;



you can reach the cell phone in emergency. So, in the night please sleep properly. So, you also sleep properly and you let your friends and relatives also sleep properly.

So, I will conclude my lecture today at this particular point and in the next lecture I am going to talk about radiation health hazards to the people who are living or working close to the cellular towers.

Thank you very much and see you next time, bye.