

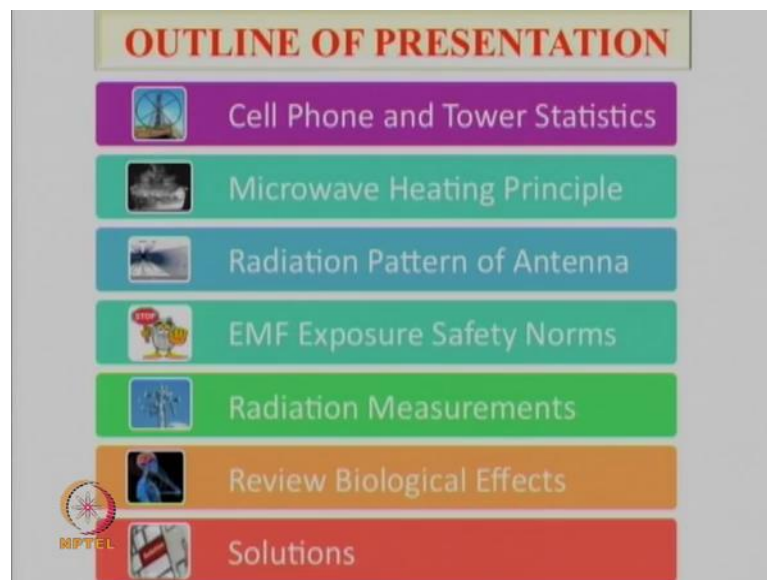
Antennas
Prof. Girish Kumar
Department of Electrical Engineering
Indian Institute of Technology, Bombay

Module - 02
Lecture - 06
Antenna Radiation Hazards-I

Hello and welcome. Now, in the last lecture we had looked into how to calculate the radiation density at a faraway distance from cell tower then we also looked at a 5 minute video which we had recorded at IIT Bombay. So, today I am going to discuss about cell phone and cell tower radiation hazards and what are the solution.

So, let us start with the title cell phone tower radiation hazards and solution, but in our first lecture I will focus mainly on cell phone. You can note down my email ids - one this is at IIT, Bombay and this is the Gmail id which is very simple prof dot gkumar at gmail dot com.

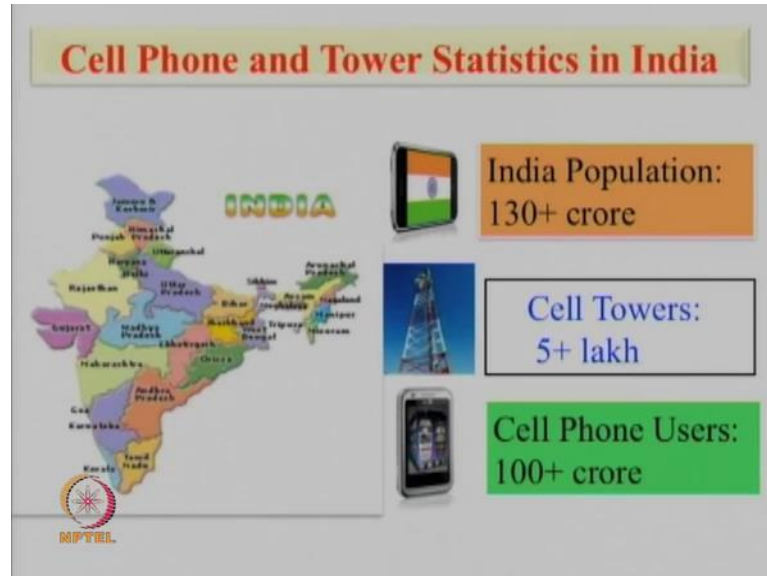
(Refer Slide Time: 01:01)



Outline of the presentation will be cell phone and tower statistics in India. So, I am actually going to mention about the statistics in India, but I will also tell what is happening around the world also then we will very quickly look into what is a microwave heating principle because people are aware how a food can be cooked in a microwave oven. Then we will talk about radiation pattern of the antenna safety norms

around the world radiation measurements which we have done at least more than at thousand places and what we found, will review biological effects and then solutions.

(Refer Slide Time: 01:39)



So, let us say in the India the population is 130 plus crore which is equal to 1.3 billion people and out of this population of 130 plus crore more than 100 plus crore cell phone users are there which is equal and to 1 billion.

Now, in the world we have a population of around 7 billion and there are about more than 6 billion cell phone subscribers. So, one can see that cell phones are very good fantastic with that you can connect to anybody at any place, you can do banking, you can do chatting, you can see the video, you can now a days with 4G technology you can do video conferencing, you can book a cab, you can see so many things which you can do. So, it is a wonderful technology, but the problem is over use of the technology.

Now, let us just say that suppose you like an ice cream, now if you eat ice cream let us say once a week it may be a good, maybe you want to eat once a day it might still be acceptable not. So, good, but if you eat ice cream let us say every hour 7 am, 8 am, 10 pm and then you do the same thing for next 15 days. So, what will happen? You may probably get sick and tired of eating ice cream and also you may have so many health problems. So something which you like it same thing you can say for chocolate, you know once in a while you can chocolate is good, but all the time eating chocolate is not

good. So, same thing cell phone limited use of cell phone is good, unlimited use a cell phone is not good.

So, we will see today what is the limit where we should draw the line and what are the guidelines for that and what is happening across the globe. Now for a cell phone to work what cell phone does is cell phone transmit some power to the cell tower and in India again a cell phone typically may transmit about 1 watt of power, cell towers typically transmit about 20 watt of power and then this cell tower through the switching network will go to the another cell tower that another cell tower will make a call to the cell phone whom you have called.

Now, in this process let us say this cell phone transmits 1 watt cell tower 20 watt, the cell tower 20 watt and the cell phone here 1 watt. So, total 42 watt of power is getting transmitted where as the actual used by the cell phone and cell tower is only about 0.00001 watt; that means, 41.9999 watt is getting dissipated in the atmosphere and roughly about one-third of that power is getting absorbed.

Let us say if you are talking cell phone like this. So, roughly one-third of that is getting absorbed by your own head and then part of that is getting absorbed by the person who is sitting next to you and rest of the power is getting absorbed in the atmosphere and in the atmosphere there can be birds, bees, animals, trees, plants everything. So, all that radiation is getting absorbed in the atmosphere. So, nothing about in India if 1 billion people are using and 41.9999 watt power is getting dissipated. So, you can imagine now how much microwave power is getting dissipated in the atmosphere and all over the world there are 6 billion people using the cell phone.

So, you can actually see that so much RF radiation pollution is getting created in the atmosphere. In fact, we have proposed to the government that radiation pollution should not be considered as the fourth pollution the other three positions are water pollution, air pollution, and noise pollution. So, this radiation pollution is very very significant people are using cell phone left and right all the time, cell towers are transmitting power 24 hours a day. So, many places there is a Wi-Fi and Wi-Fi is radiating exactly at the same frequency at which microwave oven works.

(Refer Slide Time: 05:56)

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 mainly based on the thermal effects, which are inadequate.

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

MIPTTEL

So, let us see what is the principle of microwave heating know when we put food inside a microwave oven that is the water in the fluid which is observing the radiation. So, what happens when microwave radiation impinges on the water molecule then the water molecule starts vibrating at a speed of 2.45 billion times per second and when that vibration is there at such an high intensity it leads to the friction and that friction leads to heating and that is how a microwave oven food gets cooked.

But when this microwave radiation impinges on the human body for cellular band it can be 900 mega hertz or 1800 mega hertz or for 3G it can be 1900 or 2100 or for Wi-Fi it is same as microwave. So, when that radiation impinges on the human body, now human body consists of seventy percent liquid when this microwave radiation impinges now microwave radiation can penetrate the skin and it will go inside the body and all those water molecule fluid blood they start vibrating.

So, let us say at 900 mega hertz they are vibrating at a speed 900 million times per second. So, because of this vibration friction is there and because of the friction DNA damage occurs and also friction leads to heat and the body temperature also goes up. Now this body is acting as a insulator from sun when there is a sun radiation skin access an insulator, but in case of microwave radiation microwave radiation penetrates and it is inside the body those water molecule, blood molecule are vibrating that say DNA damage is happening, friction is there, the temperature is increasing, but now that is

getting trapped by the skin. So, that heat is confined within it. So, within the body let us say at 900 mega hertz wavelength is 33 centimeter that is in air.

Within the dielectric material wavelength will be much lesser than the free space wavelength. So, there are multiple hot and warm spots which are formed in the entire body. So, the entire body is feeling that heat effect. So, there are two effects which are known - one is a non thermal-effect, non-thermal effect is because of the DNA damage which is caused because of the friction and thermal is because of the heating. And non thermal effects are several times more harmful than thermal effect and unfortunately many of the international guidelines are governed by these thermal effect and they have ignored these non thermal effect which are much more harmful.

(Refer Slide Time: 08:50)

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°C when cell phone is used for approx. 20 minutes.

Warm sensation \rightarrow pain \rightarrow irreversible hearing loss

All these effects lead to Ear Tumor

MPTEL

The slide features a thermal image of a human ear, showing a color gradient from blue (cooler) to red (warmer) on the earlobe area. A small legend on the right side of the image shows a color scale from blue to red.

So, let me ask a very very simple question that have you noticed that if you use your cell phone for about 20-30 minutes have you noticed that your ear gets warm. In fact, when I asked the audience 80 to 90 percent people raise their arm. So, what is really happening? So, when you keep the cell phone let us say next to your ear when we are making a call, there is a radiation from the mobile phone. Now since the ear is the closest, so blood in the ear lobe starts getting heated up and it has been reported that if you use the cell phone for approximately 20 minute the blood low temperature goes up by 1 degree centigrade.

Now, body temperature is 98.4 Fahrenheit now if you add one degree centigrade which is 1.8 Fahrenheit. So, we have 100.2 degree fever. So, every time when you use the

phone for 22 to 30 minutes the blood lobe temperature goes up by 1 degree centigrade and we have a fever and then the brain realizes there is some problem. So, there is a process known as thermoregulatory mechanism. So, that process gets kicked in and there is a blood circulation happening so the temperature becomes relatively normal.


But again we used for 22 to 30 minutes, again the body temperature or specially in this case the ear temperature goes up and then the again the thing up. So, what is happening? This hot blood is getting circulated again and again. So, if we use for much longer time. So, it starts with the warm sensation and then it leads to pain and also to irreversible hearing loss which can be partial to full hearing loss as well as ear tumor.

In fact, actually speaking I have started my own news letter on cell phone tower radiation and there in the newsletter specially the third newsletter we are actually given the interviews of 5 different ENT doctors, and they have very strongly said that they are getting a very large number of cases where people are developing irreversible or partial hearing loss to ear tumor and their largest customers are or you can say patients are teenagers because teenagers use cell phone for very long time they keep chatting. Of course or the next number of the patients which they said is the sales people and even the media people because they use cell phone for long time for hours and hours and after few years of use they start getting the pain in the ear and tumor.

In fact let me also ask you one question that if you use cell phone for more than 20 to 30 minutes do you feel headache, if you do feel headache after 20 to 30 minutes let me tell you and fore warn you that you are getting into stage two, because that headache leads to so many other diseases it can lead to the headache, it lead to irritation, it can lead to memory loss, it can leads to concentration problem and ultimately to brain tumor.

(Refer Slide Time: 12:09)

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).

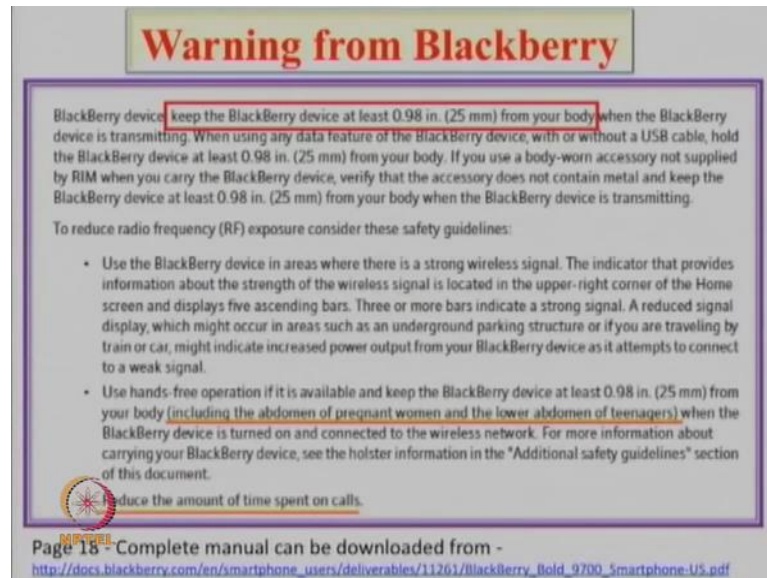
In USA, max. SAR limit for cell phones is **1.6W/Kg** which is for **6 minutes**. It has a safety margin of 3 to 4, so a person should not use cell phone for more than **18 to 24 minutes per day**.

This information is not given to people in India.

So, let me define now how we define the SAR value. So, the cell phone is defined by its SAR value. So, what is SAR? It is a specific absorption rate that is the rate at which radiation is absorbed by human body and it is measured in watt per kg and this limit has been set as a 1.6 watt per kg. Now this limit was set in 1998 and those days cell phone uses per minute was very expensive and this limit was set for 6 minutes. So, today when we say that the cell phone is safe it is really safe for about 6 minutes.

However, all the safety guidelines have some safety margin; it has a safety margin of three to four. So, in a reality people should not be using 18 to 24 minutes per day and if you use for longer time you can develop some of the health problems. But let us see; what are the warning signs given on some of the mobile phone.

(Refer Slide Time: 13:12)



So, I have just listed here the blackberry, but similar things are given by Iphone and other phone also. So, let us say here what it says the blackberry says that keep the device at least 0.98 inches or 25 mm from your body; that means, now when you want to make a call you should actually measure the distance about 25 mm 1 inch and you keep the phone like this and then you should make a call do you really make a call like this I do not think. So, you make a call like this or maybe you make a call like this. So, maybe you do some multi task also right. So, while you do driving we will also like that way. So, (Refer Time: 13:55) where is the radiation there the radiation is going to, let say entire body.

Let us just look at what is the next thing which I have underlined. It actually says do not keep the cell phone next to the abdomen of pregnant women and here in India they are used to be an advertisement on TV about 4 years back where a pregnant lady calls her husband and ask him do you want to listen to the kick off the baby and she puts the phone right next to her stomach and probably baby kids trying to say take the damn thing away.

Let us see the last line here what it says reduce the amount of time spent on call. Now start thinking about it why a cell phone manufacturer tells you reduce the amount of time spent on calls because they know that there is a problem and if you use for longer time. But unfortunately in India we see these advertisements were people are using cell phone

for hours and hours there was a one advertisement where one person starts using cell phone in the evening then he does all the calling cause to various people and all that and then in the morning he waste hunt to the or says goodbye to sunshine and goes to sleep.

That means, they are actually saying that right from 8-9 pm till about 5-6 am you can use cell phone well that is really really bad. You should not be using cell phone for more than as I said 18 to 24 minutes in the maximum possible scenario and if you use cell phone for longer time let us see what all can happen to you.

(Refer Slide Time: 15:35)

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

MPTEL

Now, this is the result of revaluation of interphone study I just to tell you interphone study actually started in 2000 the year 2000 and they followed all the protocol of WHO World Health Organization. So, this study actually took ten years the report came in May 2010 and this study actually took cases from 13 countries it was the largest study taken at that time and they actually studied 5000 brain tumor cases so; that means, these many cases of brain tumor did happen that is how they could take the cases and do the study.

Now, just that is why I said if you use cell phone for longer time if you are feeling a death well that could be the earlier stage and this could be the last stage here. And of course, 25 million dollars was spent and roughly one-third of this many came from cellular operator. So, now, what was the conclusion? So, conclusion actually says no overall increase in the risk and so you can actually think about and said to yourself all is well there is an overall increase in the risk; however, it also says there is a suggestion of

increase in the glioma for heavy user and for on the side which site they are using the cell phone for longer time.

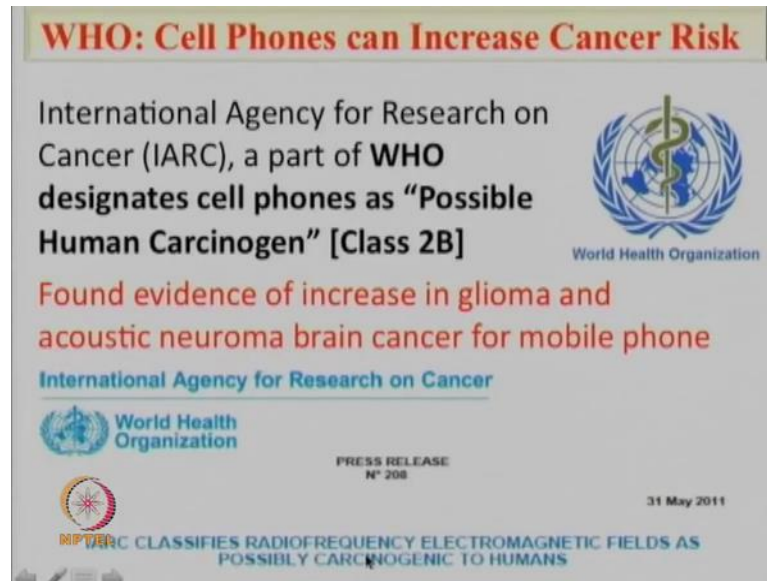
So, what is the definition of heavy user? The definition of heavy user was half hour per day over 8 to 10 years, so what happens if you do that? Well you have a doubled to quadrupled brain tumor risk. So, now, can you correlate which I mentioned earlier 18 to 24 minute and half hour is something like 30 minutes per days in about 10 years of time there is a doubled to quadrupled brain tumor risk. However, I also want to mention here since then mobile phone technology has improved slightly. So, there is now concept of that if the signal is weak it will transmit more power if the signal strength in that area is strong then it will transmit less power. So, there is an auto ranging concept is there.

So, now there is a little less effect you can use for slightly longer time and in the next lecture I will show you the study which had actually linked number of hours used versus odd ratio, but for that you have to wait for next lecture.

But now I just also want to mention that this inter phone study which actually had excluded children and young adults. In fact, they took healthy adults in the age group of 30-59 years and children and young adults are definitely more susceptible. In fact, there is a new study going on which is known as Mobi-kids and we are waiting for that study to come and we will see what is really happening. But however, there are many countries in the world which they have strongly recommended that children under 12 years should not use cell phone and whereas in India you can actually see that the parents are giving mobile phone to their even one or two years old children who are using the cell phone for long time.

So, please avoid that and listen to what the world is telling us. So, now, let us see this report which came in May 2010. So, what happened after that?

(Refer Slide Time: 19:19)



Well WHO finally, declared a one year later and I want to bring certain things over here, so that was May 2010 when inter phone study came which followed all the protocols of WHO yet it took one full year and let us see what actually happened. So, one year later international agency for research on cancer they classified IARC classifies radio frequency electromagnetic field as possible carcinogen to human being which is known as Class 2B.

However WHO made it little bit simple that said WHO designate cell phone as possible human carcinogen Class 2B and they found evidence of increase in glioma and acoustic neuroma brain cancer for mobile phone. Now see it is very interesting now, what it says here is radio frequency electromagnetic field so in fact, this includes cell tower also it includes high radiation from fm radio, TV signals and radar systems and so on where as they actually modified cell phone.

So, now, why WHO did that? So, now, let us just think about how WHO works and also I want to ask think about so why government of India is not telling people that it is a Class 2B. Now whereas this is almost have 5 year old study. So, let us say if you are let us say go for a movie or you watch TV, if somebody is smoking. So, few years' back it used to say smoking is injurious to health, nowadays it says smoking kills so. In fact, the same thing which we have been also telling government of India and I would like to tell

to the government of the world that should also start saying that over use a cell phone is injurious to health.

But; however, why governments are not telling the people why government is not creating awareness. So, we have to first understand that cell phone auction, cell tower auction is going on all across the globe. So, in India also government is making lot of money by spectrum auction. So, just to give you some numbers within India. So, let us say in the last 4 years there have been 3 rounds of spectrum auction. So, there is 61000 [FL] then there is 67000 [FL] rupee and then in the last March 2015 they raised 1.1 lakh [FL] and now the next round of spectrum auction is going to take place in October 2016 and government is planning to raise about 5.6 lakh [FL].

So, from where government is raising money by spectrum auction from cellular operator and this is happening all over the globe all the governments of the world are raising lots of money. So, today cellular business is a trillion dollar business. So, lot of money is riding on it and in fact just to tell you the next technologies which are going to come 5G and IOT, IOT is internet of thing and I recently attended one meeting and they are projecting that these technologies could be worth 6 to 7 trillion dollars. So, they are going after the money and ignoring completely the health hazards associated with this high radiation which is going to be 24 hours radiation.

So, now, why WHO also took? So, again think about it from where WHO gets funding? WHO gets funding from all the governments of the world, they contribute to the world health organization now governments are making so much money by spectrum auction and WHO is also making lot of them by getting money from the governments. So, they are also getting pressure. In fact, I want to mention here that for the last two years scientists around the world they are actually telling WHO to convert this Class 2B to Class 2A which is known as probable carcinogen and there are some scientists who are even saying it should be made Class 1.

Now in fact, the scientists have very categorically mentioned that whatever are the criterias of WHO regarding Class 2A all those criterias have been met, but however, WHO has not listen to that thing yet. So, in 2014 when scientist approach them they simply said we will come out with the report in 2015, but nothing happen. Then 200 scientist of the world they signed the petition and they submitted that to president united

nations and that was in may 2015 and we are still waiting for that response to come and now again scientist are talking to WHO and WHO has actually said that they will come out with their report in December 2016.

So, I want that all the people across the globe should unite and try to convince WHO and their government that they should be serious about high power cell tower radiation and overuse of cell phone and Wi-Fi radiation and so on.

(Refer Slide Time: 25:06)

SUGGESTED
POPULAR SCIENCE
'Are cell phones injurious to your health' by
Prof. Girish Kumar
Sep. 2011.

POPULAR SCIENCE
Better, Smarter, Faster

MPTEL

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

So, now we know that this is a fantastic technology we still would like to use the technology. So, this article was written by me for a popular science magazine or this article I wrote in about September 2011. So, almost 5 years back now we know that cell phone is a wonderful technology we can do so many things with the cell phone yet I strongly recommend that limit your use.

So, please do not use your cell phone for long time. I can just tell you from my example my maximum talk time per day is about 5 minutes per day. In fact, any call which I take is generally I do not talk for more than one minute because cell phones were invented for in emergency use. So, there is an emergency you talk and you do that so in fact, when people call me I always tell them that I will call you back from my land line number or you call me for to my land line number.

Also please talk for short duration do not talk for very long time. As I said if you use cell phone for longer time you can feel the ear warming, you can have a hearing problem, you can even have headache and so on and so forth. Now if possible use SMS or these days people use whatsapp now see when you are using SMS. So, while you are typing your message or for whatsapp while you are typing a message the radiation is very little only then you let say press the send button there is a radiation from that, but; however, what I am notice people do not use SMS 1 or 5 or 10 they use probably 100 of SMS or maybe they do 100 times whatsapp so that means, they are exposed to a much longer radiation now if possible use cell phone with lowest SAR value. It is very easy you can actually go to the internet just say SAR mobile phone and you can choose a cell phone which has the lower SAR value.

If possible use speaker phone. So, you can put the phone in the speaker mode and then you can talk or you can actually use ear plug. So, what you can do you can plug the wire over here and put it over here, but then what I noticed many people what they do let us say they plug over here and they are holding the phone in their hand then your hand will receive more radiation, some people put here in the shirt pocket then your heart will receive more radiation, some people put in their pant pocket so then that area of the body will receive more radiation. So, you decide which part of the body you do not like.

Now, of course, some people also use Bluetooth. Now yes there is a good thing about Bluetooth that Bluetooth transmits maximum 10 milli watt of power where is a cell phone can transmit 1 watt of power which is about 1000 milli watt. So, it definitely transmits 1 by 100 of that, but again what I noticed that people put a Bluetooth thing on their ear and then let us say they put the phone in let us say in the shirt pocket then the Bluetooth will transmit 10 milli watt then the Bluetooth of the mobile phone will transmit 1000 milli watt communicate to this one here and this is any way transmitting 1000 milli watts. So, actually increase your radiation exposure. So, the best way to use Bluetooth is that you put a Bluetooth over here keep the cell phone away from you and then you can do the talking.

Now, if possible please use landline. I know that many places people are removing their land line I strongly urge people that start using landline because there is no radiation there. Also I recommend that do not keep cell phone in your hand pocket for long the reason is that even if you are not using the cell phone, it is still transmitting 1 pulse per

minute to the base station. So, let us say if you are keeping cell phone for let us say 6 hour so 6 into 60 - 360 minutes you are putting cell phone in your pocket and then if it is transmitting 1 pulse per minute so roughly 360 pulses are going towards the base station and it is slowly slowly slowly causing problem to you. And also I notice that lot of people keep the cell phone next to their pillow in fact, that is not good.

You may try to sleep, but your cell phone is not sleeping. So, it is constantly every minute making some transmission and it is radiating towards your head. So, I strongly recommend that you keep the cell phone at least at one arm length or if possible keep it in the different room. Also I would like to recommend that in the night please switch off the data because. So, you are not going to check while you are sleeping any messages or any email because you can actually make a quick check that if you charge your mobile phone in the night and put the phone.

Let us say in the airplane mode you will see that by the morning the battery is still almost full the next day you can try just keep the you can say cell phone on, but all the other data should be off then we see how much it is. And then the next time what should you do you keep the data on and everything you will see that the battery drainage is much more so; that means, that data is actually speaking consuming lot of power also because the mobile phone keeps communicating and trying to see if there is a some activities or not.

So, I strongly recommend that you please do these simple precautions. So, that you can protect and spread the message to all your friends, also your known people you can use blog, you can use email, you can use twitter, you can use Whatsapp to create awareness. So, please do that and use this beautiful fantastic wonderful technology carefully in fact, I always tell people live safely have safe radiation.

So, in the next lecture I will talk about the radiation health regard from cell tower what are the radiation norms in India and in the rest of the other countries and what are the health effects which can happen to the people who are living next to the cell tower.

Thank you very much; see you soon.