Summer Training Report By

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This summer training project opportunity was a great chance of learning and professional development. I express my wholehearted appreciation to all those who have contributed to the summer training project and supported me in one way or the other during this period.

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I perceive this opportunity as a big milestone in my professionalism development. I will endeavor to use the gained skills and knowledge in the best possible way and will continue to work on their improvement, to attain the desired career objectives.

Sincerely,

Neelaksha Kumar Singh Yaduwanshi

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List of Abbreviations

nCoV	Novel Corona Virus
WHO	World Health Organization
COVID-19	Coronavirus Disease 2019
CDC	Centers for Disease Control and Prevention
RNA	Ribonucleic acid
GAD	Generalized Anxiety Disorder
SPSS	Statistical Package for the Social Sciences
MS	Micro Soft
FDA	Food and Drug Administration
US	United States
NDC	National Drug Code
INDs	Investigational New Drugs
POR	Proof-Of-Concept
APEM	Asia Pacific and Emerging Markets
IHC	International Conference of Harmonization
USA	United States Of America
EU	European Union
EFTA	European Free Trade Association
CTD	Common Technical Document
PBM	Pharmacy Benefit Management
ACA	Affordable Care Act
SPAPs	State Pharmacy Assistance Programs
PDLs	Preferred Drug Lists
CMS	Center for Medicare and Medicaid Services
P&T	Pharmacy & Therapeutics
ASMR	Autonomous Sensory Meridian Response

R&D	Research & Development
OTC	Over The Counter
QALY	Quality Adjusted Life Years
NICE	National Institute for Health and Care Excellence
UK	United Kingdom
NHS	National Health Service
STA	Single Technology Assessment
PMA	Pre-Market Approval
ASC	Ambulatory Surgery Centre
CPT	Current Procedural Terminology
HCPCS	Healthcare Common Procedural Coding System
ICD	International Classification of Diseases
DRG	Diagnosis Related Group
AMI	Acute Myocardial Infarction
APC	Ambulatory Payment Classification
MACs	Medicare Administrative Carriers
CE	European Conformity
OBGYN	Obstetrics and gynecology
SILS	Single Incision Laparoscopic Surgery
CDRH	Center for Devices and Radiological Health
CT	Computed Tomography
PET	Positron Emission Tomography
MRI	Magnetic Resonance Imaging
CEO	Chief Executive Officer

PART 1- RESEARCH REPORT

1. ABSTRACT:-

In December 2019, A nCoV has been identified as a new strain that has not been previously identified in humans. On February 11, 2020, WHO renamed the COVID-19 from formerly named the 2019-nCoV. This phenomenon has resulted in a massive public reaction; the media has been reporting on a regular basis across borders to keep everyone informed about the pandemic situation. All these things are creating a lot of concern for people leading to increased levels of anxiety. Pandemics can result in increased levels of stress; Anxiety is a common rejoinder to any stressful situation. This study attempted to assess the awareness about prevention strategies against COVID-19 infection and stress level among adult Indian population during the Lockdown period of COVID-19 pandemic. An online survey was conducted using a semi-structured questionnaire. A total of 100 responses were received. The responders had a moderate level of anxiety levels identified in the study. More than 95% of the people were aware about the prevention strategies and were reported to take preventive actions to prevent themselves from COVID-19 infection. There is a need to intensify the awareness and address the mental health issues of people during this COVID-19 pandemic, which might result in mental stress among the population of India.

2. INTRODUCTION:-

An outbreak of unusual respiratory condition was first reported in Wuhan, China, due to the infection caused by nCoV, now known as COVID-19. Further, on 11th February 2020, the W.H.O., announced COVID-19 as the name of this disease and the "COVID-19 virus" as the virus responsible for this disease. Based upon the transmission rate, the W.H.O has declared the outbreak of the COVID-19 as a global health emergency.

Coronaviruses are a family of positive single-stranded RNA virus, classified under Nidovirales order. These viruses are enveloped and are round and sometimes pleomorphic of approximately 80 to 120 nanometer in diameter. The virion contains an internal helical RNA-protein nucleocapsid surrounded by an envelope made up of lipids and viral glycoproteins. These glycoproteins are spike protein, membrane protein, and small membrane. The spike protein or "S" is a type I glycoprotein that forms the peplomers on the virion surface, giving the virus its corona or crown-like morphology in the electron microscope. The coronaviruses attach to the cell surfaces through the spike. Let us now discuss about membrane and small membrane protein. The membrane protein or "M" is highly hydrophobic and spans the membrane three times. On the other hand, the small membrane protein or "E" spans the membrane twice, and in some group two Coronaviruses, an additional protein hemagglutinin esterase is present whose function, is unknown. All Coronavirus genomes are arranged similarly with replicase locus encoded within 5-dash end and the structural proteins encoded in the 3-dash end of the genome. The viral replicase is a huge protein complex comprising of 16 viral sub-units and plays an essential role in the coronavirus replication and transcription at the cytoplasmic membrane.

COVID -19 can be transmitted between people who are in close contact with one another or (within about 6 feet). The transmission is through the respiratory droplets produced by the infected person when he or she sneezes or coughs. Possible inhalation of the droplets landing in the oral cavities or noses of people in close proximity. Furthermore, as per the statistical records on 20th February 2020, in Shenzhen City, among two thousand eight hundred and forty two identified close contacts, eighty-eight

or (3 percent) were found to be infected with COVID-19. Recent reports from the W.H.O, human-to-human transmission of the COVID-19 virus is mainly occurring in families, especially in China. For instance, among 344 clusters, involving 1308 cases out of 1836 cases reported, 78 to 85 percentage of positive cases have occurred in families in Guangdong and Sichuan Provinces, respectively. As per the W.H.O, a person might be susceptible to COVID-19 if he or she touches a surface or object containing the virus and then touching their own mouth, nose, or face. However, this is not the main route of transmission.

According to the Centre for Disease Control or CDC, patients above the age of 50 are more vulnerable for the attack and persons with underlying diseases like Diabetes, Parkinson's disease and Cardiovascular diseases are at high risk. As per the World Health Organization or W.H.O statistics, the median age of affected people is 51 years with the majority of cases that is 77.8 percent aged between 30–69 years. Statistical data also reveals that 51.1% of the affected populations are males. Clinical Features of COVID-19 include: Decreased white blood cells, Coughing and sneezing, Runny nose, Shortness of breath, Breathing difficulties, Sore throat, Fever, Fatigue, Pneumonia, Severe acute respiratory syndrome, Lungs inflammation and congestion, Cardiovascular damage, Diarrhea, Decreased Kidney functions and Kidney failure.

The prime suspects for COVID-19 include patients with fever and lower respiratory tract symptoms. The geographical distribution and recent contact with the suspected patients should also be taken into consideration. According to CDC, diagnosis should be based on clinical and epidemiological factors. The clinical criteria for confirming the diagnosis of the severity of Coronavirus is broadly categorized into Mild, Moderate, Severe and Critical.

Globally, preventive and control measures are being implemented rapidly. They were first initiated in Wuhan city and other critical areas of Hubei, and then in the currently affected countries. The governmental measures for prevention include three stages: First, Second and Third. First stage, is the early stage of the outbreak it focuses on: Preventing the export of cases from the affected areas, Control the source of infection, block the route of transmission and prevent the further spread of infection. Second stage, focuses on reducing the intensity of the epidemic. Third stage, focuses on reducing the clusters of cases, Controlling the epidemic and Balancing between prevention and control.

The state of lock-down in India, which contributes to the Indian economy, has led to the hesitant of services and products. This has led to a halt in the supply chains and thus, affected the Indian economy brutally . Transport has been affected globally. Transport business even at national levels has desisted due to lock-down in different countries. Most company employees are working from home, which has its financial drawback. Educational institutions have been close down. The postponement and uncertainty of examinations is also a stressor for young minds. Along with the economic impacts, the ever-increasing mortality and morbidity due to COVID-19 is the biggest impediment.

The awareness and anxiety in society are globally affecting every individual to variable extents. The awareness and attitudes of the public are expected to largely impact the degree of adherence to the personal protective measures and eventually the clinical outcome. Hence, it is important to study these domains in the Indian population. The mental health issues are other main health concerns, which are predicted to increase day by day during this pandemic. One of the main stress prophesy may be anxiety, angst deflagrated by something the individual understood as a threat to his or her integrity. Anxiety is an emotional experience combating the possibility of living future situations which may be nasty to the individual. Anxiety would be one of the intuitive components from the stress process's, which ends up occurring when the individual's response capacity is transcended.

3. REVIEW OF LITERATURE:-

- Study of knowledge, attitude, anxiety & perceived mental healthcare need in Indian population during COVID-19 pandemic – This study describes the importance of mental health during COVID-19 and the need to intensify the awareness program and address the mental health issues of people during this COVID-19 pandemic.

- The COVID-19 outbreak: Crucial role the psychiatrists can play- This study describes the role of psychiatrists to deal with the psychological impact of the illness. Hence, psychiatrists are in an unique position to offer a balanced perspective to improve the knowledge, attitude and practices about the illness as well as addressing the generalized anxiety and apprehension.

- Coronavirus disease 2019 (COVID-19): A literature review- This article describes the clinical characteristics of COVID-19 disease.

- A Comprehensive Literature Review on the Clinical Presentation, and Management of the Pandemic Coronavirus Disease 2019 (COVID-19)- This study relates the individual parameters that influence the clinical course and management of COVID-19.

- Correlations between stress and anxiety levels in nursing students- This study describes that when there is increase in stress levels, anxiety levels also tend to increase. Hence, the elevated anxiety and stress level in nursing technician course students was verified in a social constructivist school.

4. MATERIALS AND METHODS:-

This is a cross-sectional, descriptive and correlational study of awareness and anxiety levels and of various social-demographic variables on 100 persons from India. An online semi-structured questionnaire was developed by using google forms, with a consent form affixed to it. The link of the questionnaire was sent through e-mails, WhatsApp, linkedin and other social media among the general population of India. On receiving and clicking the link the participants got auto directed to the information about the study and informed consent. Then a set of several questions appeared sequentially, which the participants were to answer.

It was an online study. Participants with access to the internet could participate in the study. Participants with age more than 18 years, able to understand English and willing to give informed consent were included. . We were able to collect data from across various states of India. The socio-demographic variables included age, gender, marital status, education, work status, domicile, area of residence and profession.

The online self-reported questionnaire developed by the investigators contained the sections related to awareness and anxiety due the lockdown period of COVID-19.

There were 4 multiple choice questions in the awareness section. Anxiety related to novel coronavirus infection was assessed through GAD Scale which had 7 items that were supposed to be rated on a 4-point Likert scale. Descriptive statistics have been used in the study to analyze the findings. Mean and standard deviation and proportions have been used to estimate the results of the study.

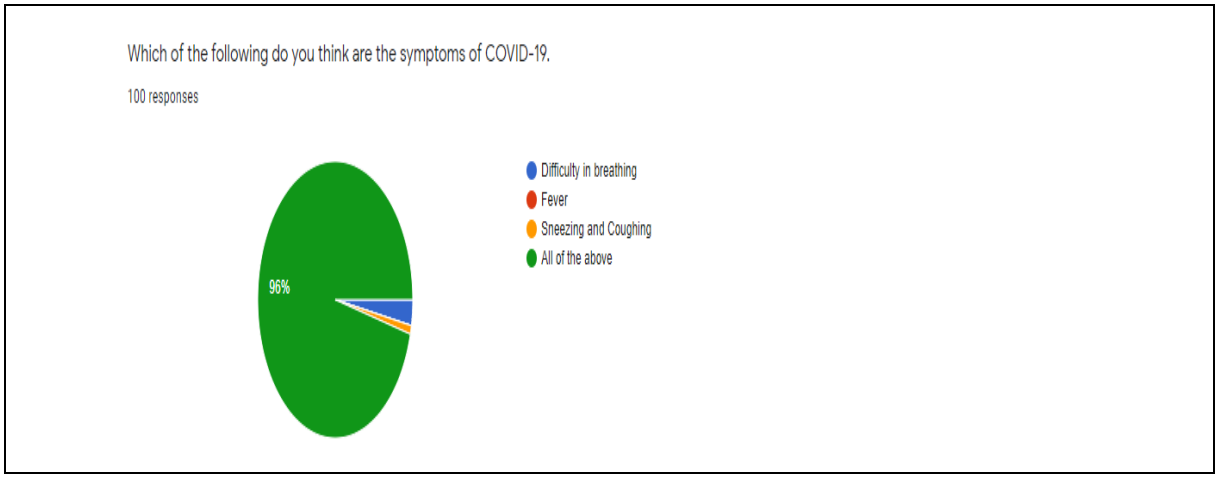
For data analysis, a MS-Excel spreadsheet was used for database elaboration, and afterwards the SPSS software version 22.0, for descriptive and inferential statistical analysis of data was also used. Parameters of mean and standard deviation were utilized for descriptive analysis, Pearson Correlation Test between awareness and anxiety trait, with test's descriptive level for $p < 0.05$.

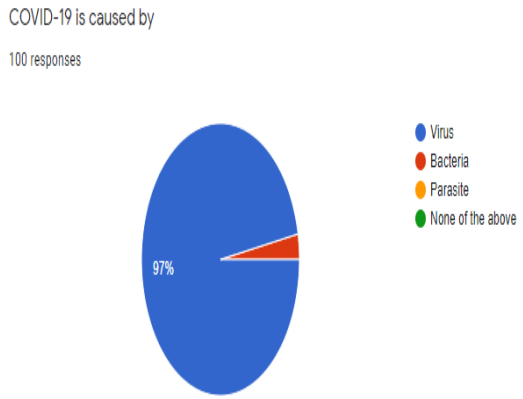
5. RESULTS:-

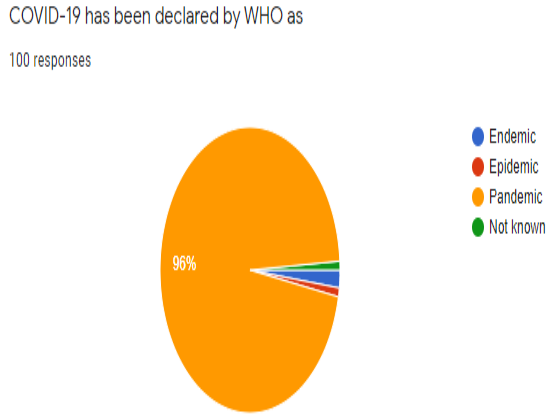
An online survey, related to awareness and anxiety experience during the lockdown period of corona pandemic, was conducted in the Indian population. A total of 100 responses were recorded. All the participants were above 18 years of age and Indian origin. The study included only those participants who understood English and had access to the internet. Hence, by default individuals with a higher level of education were included in the study. The lowest educational level in this study was observed to be standard 10th. The highest qualification of more than 95 % of the population was graduation and above. Approximately, half of the populations were healthcare professionals. The mean age of the participants was ranging from 18 to 40 years. Among the participants, 56 % were females and 44 % were males. More than 90 % of participants were from urban areas. The participants belong to 20 states or union territories of the country with maximum representation from Rajasthan, followed by Maharashtra, Uttar Pradesh and Delhi. Approximately 92 % of the participants were staying with their family during this COVID-19 lockdown period.

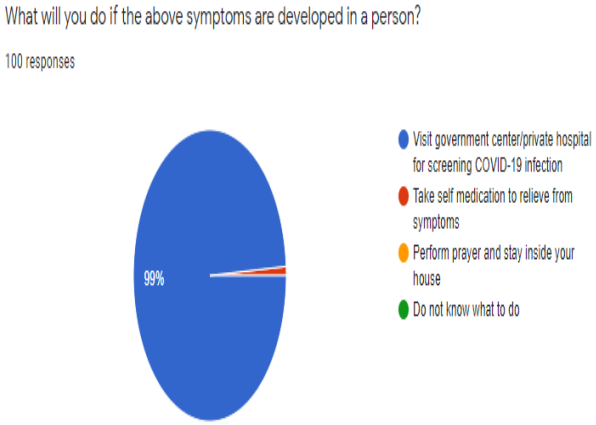
5.1. Part I: awareness about COVID-19 pandemic –

A considerable number of responders were quite aware about the basic elements of the disease, as shown below. Out of the total participants, 96% answered that the COVID-19 is declared as pandemic by WHO and 97% are aware that COVID-19 is a virus. Around 96% were aware regarding the symptoms of COVID-19 which include difficulty in breathing, fever and sneezing or coughing. Most participants (99 %) were aware about visiting the government or private Hospital for screening of COVID-19 infection if the symptoms of COVID-19 are developed in them.









5.2. Part II: anxiety towards the COVID-19 pandemic –

Drawing from the data given in Table 1 , around 44% participants had mild anxiety during this lockdown period. In addition to mild anxiety, around 22% of participants had moderate level of anxiety and 34 % of participants had severe anxiety. Nearly half the participants approximately 56% felt panic by the lockdown period and also by the reports of COVID-19 pandemic shared on the electronic and print media over the past two weeks.

Table 1.Anxiety related to COVID-19 pandemic.

S.NO	Items	% of responses who feel anxious (N = 100)
1	Mild	**44%**
2	Moderate	**22%**
3	Severe	**34%**

5.3.Part III: Pearson Correlation Coefficient between awareness and Anxiety Index-

		Awareness level	Awareness level	Awareness level	Awareness level	Stress level	Stress level	Stress level	Stress level	Stress level	Stress level	Stress level
Awareness level	Pearson Correlation	1	-.226*	.142	.008	-.021	.052	-.058	.021	-.114	-.054	.102
	Sig. (2-tailed)		.024	.159	.935	.839	.608	.567	.832	.258	.595	.315
	N	100	100	100	100	100	100	100	100	100	100	100
Awareness level	Pearson Correlation	-.226*	1	-.079	-.018	-.174	-.168	-.024	-.076	.062	.034	-.022
	Sig. (2-tailed)	.024		.435	.861	.084	.095	.815	.454	.539	.735	.825
	N	100	100	100	100	100	100	100	100	100	100	100
Awareness level	Pearson Correlation	.142	-.079	1	.019	-.084	.122	-.039	-.085	-.088	.052	-.073
	Sig. (2-tailed)	.159	.435		.849	.406	.227	.701	.398	.384	.610	.468
	N	100	100	100	100	100	100	100	100	100	100	100
Awareness level	Pearson Correlation	.008	-.018	.019	1	.119	.033	.122	-.077	.036	.020	.115
	Sig. (2-tailed)	.935	.861	.849		.240	.746	.227	.446	.726	.847	.255
	N	100	100	100	100	100	100	100	100	100	100	100
Stress level	Pearson Correlation	-.021	-.174	-.084	.119	1	.597**	.663**	.643**	.395**	.545**	.475**
	Sig. (2-tailed)	.839	.084	.406	.240		.000	.000	.000	.000	.000	.000
	N	100	100	100	100	100	100	100	100	100	100	100
Stress level	Pearson Correlation	.052	-.168	.122	.033	.597**	1	.613**	.638**	.534**	.479**	.487**
	Sig. (2-tailed)	.608	.095	.227	.746	.000		.000	.000	.000	.000	.000
	N	100	100	100	100	100	100	100	100	100	100	100
Stress level	Pearson Correlation	-.058	-.024	-.039	.122	.663**	.613**	1	.705**	.580**	.672**	.616**
	Sig. (2-tailed)	.567	.815	.701	.227	.000	.000		.000	.000	.000	.000
	N	100	100	100	100	100	100	100	100	100	100	100
Stress level	Pearson Correlation	.021	-.076	-.085	-.077	.643**	.638**	.705**	1	.670**	.588**	.502**
	Sig. (2-tailed)	.832	.454	.398	.446	.000	.000	.000		.000	.000	.000
	N	100	100	100	100	100	100	100	100	100	100	100
Stress level	Pearson Correlation	-.114	.062	-.088	.036	.395**	.534**	.580**	.670**	1	.519**	.409**
	Sig. (2-tailed)	.258	.539	.384	.726	.000	.000	.000	.000		.000	.000
	N	100	100	100	100	100	100	100	100	100	100	100
Stress level	Pearson Correlation	-.054	.034	.052	.020	.545**	.479**	.672**	.588**	.519**	1	.581**
	Sig. (2-tailed)	.595	.735	.610	.847	.000	.000	.000	.000	.000		.000
	N	100	100	100	100	100	100	100	100	100	100	100
Stress level	Pearson Correlation	.102	-.022	-.073	.115	.475**	.487**	.616**	.502**	.409**	.581**	1
	Sig. (2-tailed)	.315	.825	.468	.255	.000	.000	.000	.000	.000	.000	
	N	100	100	100	100	100	100	100	100	100	100	100

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Hence, it was possible to perform the Pearson Correlation test amongst the variables. During the analysis of correlations, as mentioned in above table the correlations showed themselves negative, that is, lesser the awareness higher is the stress level among the participants which might result in mental illness in coming future.

6. DISCUSSION:-

People in the community faced several challenges during the lockdown period of COVID-19. Lack of awareness often forefront to an unconcerned anxiety, which may adversely affect the preparedness to meet these challenges. Impacts of these epidemics and pandemics are often intense, which may critically affect the mental well-being of a given population. The fear and anxiety related to epidemics and pandemics also control the behaviour of people in the community. Hence, this study attempted to evaluate the awareness and anxiety level of people in the society which might result in stress among the people in the society.

Most of the participants in our study were educated - either graduate or post-graduate and 70% of them were Health care worker like Doctor, Nurse, Emergency Technician, Pharmacist etc. The participants had a moderate level of awareness regarding the symptoms, mode of spread and yet sufficient awareness about the preventive measures. It was mainly due to the government and media spotlighting more on the preventive measures.

The study participants recorded recurrent use of sanitizers, hand wash, and masks during the past two week of Lockdown. This implies the increasing concern of participants towards personal hygienic measures to avoid COVID-19 infection. Awareness about COVID-19 are seen in their behaviour and attitude significantly as most of the participants (more than 90%) agreed with – social and physical distancing, wearing mask while going out, washing or sanitizing hands frequently, avoiding travel, self-quarantine and adequate hygienic measures. Stigma is basically associated with many health conditions. Adequate awareness may reduce the stigma and facilitate acceptance in the general population.

On the contrary, meeting the individual mental health needs in typical clinical settings that need face-to-face interviews for evaluation is challenging in the current scenario considering the risk of the spread of COVID-19 infection. In this situation considering online mental health consultation through tele-consultation might be more beneficial and it can deliver the consultation at the doorstep.

This research has shown a higher incidence of moderate and high anxiety levels, and a higher mean anxiety score which directly affect the stress of a person. It is important to provide health education and create awareness during such pandemic situation for effective and efficient prevention of COVID-19 virus. Anxiety and stress among people in India are prevailing, as they are in direct and ceaseless contact with pain, suffering, anguish, fear, loss, and death, which may affect physical, emotional consequences, besides prying with the quality of care.

As for the correlation between awareness and anxiety, indeed there is a complexity of conceptualizing anxiety and stress, as these are lived in a personal manner, determined by individual traits which move according to the degree of uncertainty, self-esteem, self-concept, and internal resources available for problems solving. However, the positive correlations between awareness and anxiety resulting in the present study accept the hypothesis that when there is increase in awareness level, anxiety levels are also increased. This results in stress due to increased awareness and anxiety level.

7. CONCLUSION:-

The 100 people sample was composed of more female participants (56%) as compared to male participants. Strong negative correlation was verified between awareness and anxiety index (r=0.226) . These results reassure that when there is increase in awareness levels, anxiety levels also tend to decrease. Hence during the lockdown period of coronavirus pandemic, most of the educated people and health professionals are aware of this infection, possible preventive measures, the importance of social distancing and government initiatives were taken to limit the spread of infection. However, There is a need to intensify the awareness program and address the mental health issues of people during this COVID-19 pandemic.

PART 2- ONLINE COURSE

ABOUT THE COURSE

Name of the Course- Pharmaceutical and Medical Device Innovations

Course Description- This course in the Healthcare Marketplace specialization gives the learner an in-depth view of the intellectual property creation that is vital to creating breakthrough technologies. Included is an understanding of the strategy deployed for pricing drugs and new technologies as well as the market sizing exercise to identify where future research and development investments should be made.

Course Objective- To learn about innovation's in the field of medical device and pharmaceutical industry.

Course Contents-

a) **<u>The Pharmaceutical Industry: Bench Science to Bedside:-</u>**

i. **Pharmaceutical Industry: Trends in Drug Development** -In this module they have discussed about personalized medicine. One other major trend that's been going on over a period of time is the rise in the share of generics. Generic medications, are essentially pharmaceutical agents that are already branded, and their patents have generally expired, and they're being manufactured by somebody else and their costs could be substantially less once their patent expires, usually after 20 years. .

ii. **Pharmaceuticals: From Bench to Bedside -** For patients and health care providers, the objective here is to improve both the quality and quantity of life through prevention, cure, treatment, diseases, and symptoms. Then for the industry, which is really to keep some of this stuff and planning, is to make a product that is commercially viable on all sorts of ways, the cost of manufacturer, the marketing cost, to make sure that things don't go out of business. The drug development process include: Pre discovery; Drug discovery; Pre clinical; Clinical trials: Phase 1, 2 and 3; FDA review, LG- Scale MFG. So, drug discovery can take years of research that precedes discovery of a brand new drug and it takes a lot of things in terms of disease research, and then also the accumulated knowledge of the researchers to get to that drug target and move forward. Researchers involved in drug delivery are Pharmaceutical company (58%), Biotechnology company (18%), University (24%) which is responsible for training of scientists that will go into other two areas.

iii. **Pharmaceutical Industry: Drug Development Challenges** - This is another representation of the challenges faced in drug development. So again, looking at this number of compounds, 5,000 compounds just to get to one FDA approved drug. So again, 5,000 and it could be a long process to as we are noticing here, 10 to 15 years to go, and all these different stages into play. Hence, it's super important to file your patent. So, patent can take three to four and a half, five years, and then once all that's done you can then start the FDA approval process. That process might not occur until where you can actually now sell your drug the FDA in the United States 14 to 16 years later and clearly what you're operating here is a 20 year window for when your patent will go into exploration, which means you really only have say between four to six years to resell your product, get it from market up to sort

of this little hockey stick to get up to here to get your sales up and keep in mind that the pricing that you can charge is up to you but then after that it will generally expire your patent and you will go into the generic market space. So, prescription drug prices can decrease significantly over time and which is generally the rule of thumb is a cosmic generic medicine's typically up to 80 percent blasts of the brand-name medicine. A lot of them dollars have to be recovered obviously to pay for drug development and future pipeline and that's why brand name drugs are more expensive. Hence, cost of a generic medicine is typically up to 80 percent less than that of the brand medicine.

iv. **Pharmaceutical Industry: Intellectual Property –** It takes from six months to two years for the patent office to grant a patent and life of the patent is twenty years. There are several international intellectual property ground rules such as uniform floor of intellectual property protection worldwide, twenty year term of patent protection, restrictions on use of clinical trial data, restrictions discrimination against fields of technology i.e. medicines and against importation, transition periods for developing and least developed countries. Compulsory licenses and public non-commercial use licenses issued can be granted for local production or for importation. There may be patent, export quantity and data restrictions on exporters that limit the effective exercise of this right. Major generic producers are India, Brazil, South Korea and China. Right to import generics is illusory because products produces pursuant to a compulsory license must be predominantly for domestic use. Countries with or without patents, but with limited pharmaceutical capacity needed a way to import cheaper generic medicines of assured quality, for example: Pharmaceutical IP in U.S. and India.

v. **Pharmaceutical Industry: FDA -** A physician in the United States can legally prescribe a drug for a patient, the drug must be approved by the FDA. Until a drug is approved by the FDA, it cannot legally be given to anyone except through an approved clinical trial or through drug manufacturer's compassionate-use program approved by the FDA. There are some new as of 2018 new legislation just signed by the President that would potentially allow a right to try to extend some of the use of our compassion if can do. When the FDA approves a drug, is approved for certain conditions or indications. These indications are noted on the label to be included within the drug. The FDA approves the language in the label, that is, the FDA approves every word written on the label. No matter what the drug's label says, a physician can legally prescribe the drug for any reason. This prescribing is known as off-label, meaning that they can prescribe the drug that is approved but it may not necessarily be for the indications. However, you may not be able to get insurance coverage for many things that are off-label drug prescriptions. If the product is considered to be a supplement instead of a drug, it does not need to be approved by the FDA. However, supplement manufacturers cannot claim that the supplements are intended to treat a disease or disorder. As a result rule or rule the result, supplements are not covered by third party payers such as insurance companies, although vitamins maybe covered in certain circumstances. Once the drug is approved for patients by the FDA, that drug can then essentially go into marketing. What it needs is to do that a NDC number to get reimbursed. There are usually about 20,000 of them that use about 11 digits and structure. The drug manufacturer begins to produce the drug based on an expected market size. This process may take some time. Ingredient availability may be a problem and cause delays, especially with these new and evolving biologic drugs.

vi. **Pharmaceutical Industry: Investigational New Drug / Phase 1 to Phase -** INDs, are the first stage in the process to go through the FDA. The FDA team approach to IND review involves a regulatory project manager, some sense of knowing what the chemistry, manufacturing, and control pieces are for the reviewer, pharmacology and toxicology reviewer, a clinical reviewer, and a statistical reviewer. In terms of looking at the submissions that go to the FDA for these INDs, it does vary from year to year. Peak about 55 or so in 1999, and then in 2012 also another peak around that same period. It depends upon what different agents are in the pipeline, what different components are going

through, but it's a pretty for robust pattern over the years. In terms of the regulatory timeline, there is a preclinical phase that starts off with the pre-pre-IND in terms of looking at different compounds and substances. The Pre-IND phase, and then finally when the IND is actually filed, this is when we're getting out of just discovery. In phase one, that is where the initial, if you will be a volunteer, where patients participate in phase two as a larger population. Phase three is where we get randomized clinical trials. At that point, and if there is approval, there is then the permission to then go to the market and then sell the drug, and then also, track what the impact of the pharmaceutical agent would be. In terms of regulations as governed by the Federal Register, the FDA's primary objective in reviewing an IND is to look at all this phases of investigation to assure the safety and rights of its subjects. The safety of the source materials, intermediates, and final product have to be taken into consideration, any viral or microbial contaminants have to be considered the manufacturing process, as well as product testing for identity, purity, and potency. All these things need to be revealed in the early stages of the development. For pre-clinical studies, the idea is that there's a scientific basis for conducting the clinical trial. There's a recommendation on initial safe dose and dose escalation in humans based on some early work, identification of potential target tissues or toxicity activity, any parameters to monitor clinically, and in patient eligibility criteria for proceeding with the studies. There is also the pre-clinical known as POC. POC in relevant animal models, this is bioactivity endpoints. Looking at the extent of functional correction, the durability effect of the agent, to determine effective dose and level range, it could be oral. Where does it have to go in that specification, and then collect safety data for animal models. For toxicology, the idea is to identify, characterize, and quantify that any potential local or systematic toxicities in relevant animal species. Finally, for clinical trials, some early phase considerations, what is the optimal dose and administration? What should be the starting dose and how should the dose escalate over a period of time? What's the route of administration? What's the schedule? Then, what would be that appropriate population for that early stage study? How are you going to stagger your dose escalation? This gives the initial set of information needed for an FDA, IND.

vii. **Pharmaceutical Industry: Global Regulatory & Harmonization -** More than 70 percent of the world's population are from APEM. Asia Pacific region includes the range of countries, India, the Philippines, South Korea, Taiwan, China, Hong Kong, Macau, all fall in that space as well. For different emerging regions that include Argentina, Brazil, Chile and Mexico. For the Middle East and North Africa they include Egypt, Pakistan, Saudi Arabia, and Turkey. Sub-Saharan Africa, includes South Africa and then in Eastern Europe, Russia. There are two different licensing models for drug regulatory assessment that countries can fall in to. The model of licensing system based upon submission of evidence, registration and reference countries, which can include the US and other places in Europe. Or the model of licensing system based upon a full assessment of new drug applications including biological products, is going to be much more intense. One thing that is trying to make this work better is to focus on what's known as a Global Harmonization Initiative, to really get to a point where the regulatory regimes that are introduced for new pharmaceutical agents can be much better standardized. The goal of IHC is to improve through harmonization, efficiency of development, registration of new medicinal products as much as possible bases on scientific consensus, and look for a commitment by regulatory parties to implement the harmonization recommendations. There are six official parties that are co-sponsors directly involved in this. So, from the sense of authority and research-based industry, we have the EU, Japan and the USA. Each of them has their different regulatory components involved. So, for example, the USA we talked about before, the EFTA, as well as the Pharmaceutical Research Manufacturers Association. Same idea comes into play here; we have both industry as well as regulatory agencies represented. The official observer for this activity, for harmonization, is the WHO as well as the European Free Trade Area, the EFTA, and from Canada, the Health Protection Branch. There's a CTD that has been developed for this harmonization idea. The idea is to find things that are acceptable for regulatory authorities within the

three regions. Also, this may not define the entire content but it gives some ideas about where the harmonization will be most effective. The objectives here are for industry to reduce the time and resources needed to compile applications, have an ease of preparation for electronic submissions. For regulatory authorities, facilitate reviews in a timelier basis, improved communication with the applicant and simplify exchange of information between the different Regulators. So, we think about this harmonization now, and in the future, there are new areas that need to be focused on as well besides just the initial phases to get say the difference of phase one, phase two, phase three and how they might relate using an FDA regimen to other countries.

viii. **Pharmaceutical Reimbursement: US Market -** There are two types of private insurance in the US that reimburse pharmaceuticals. There's group insurance and individual insurance. The group insurance is often offered by employers. Usually, this is the largest part of the insurance market, and across the entire United States, it's about 160 million people out of roughly 300 million people that have insurance in the United States get it through group insurance. These plans can either be fully insured or self-insured. The larger shares of them are going to be self-insured. With fully insured plan, the employer or union that offers to help insurance must pay a premium to an insurance company which has responsibility to pay all claims of the insured members. That's the minority of the cases. The majority or with the self-insured group plans, where the employer or union that offers the health insurance, is its own insurer and is responsible for paying all the claims of the insured members that have to submit them. Self-insured plan uses an insurance company to run the plan or PBM, but it basically is using its own cash reserves to pay for, essentially, honoring insurance policy. Individual insurance is typically purchased on your own. So, that's quite different. This would be more like when people talk about now the ACA, or the insurance exchanges that would be a marketplace, so, common to both types of private insurance is what's known as the PBM. This starts off by looking at consumers that are working through an insurance company to get some sort of health policy. The issue though, is that the insurance companies frequently find that it's too complex to manage all the pharmaceutical benefits, so they actually then work with essentially a PBM. That manager acts essentially as a middleman to negotiate with the manufacturers as a negotiated price, and then supply some of the benefit designs with the pharmacy. So, it's actually pretty advanced. When a new drug is approved, private insurance companies often must decide whether or not to cover it. Approved meaning by the FDA in terms of it going into market. Once a drug is approved, the manufacturer may meet with many insurance companies to discuss how the drug works and explain the costs and benefits of the drug, sometimes academic publications. Private insurance companies often follow Medicare's coverage decisions but do not have to do so and the off-label drugs aren't reimbursed. For example, some drugs are contraindicated for people with high blood pressure, so if you do not have high blood pressure and note to that in your appeal. The rules for appeals depend on whether or not your plan is fully insured or self-insured and whether you're a group plan or individual plans. Then, there could also be some state laws that could affect your appeal as well which are known as SPAPs or providing some drug coverage and offer discounted drugs for eligible residents in 35 states that had this design. It also depends on income and assets and resources as well as a lack of drug coverage, prefer if you're uninsured. Most SPAPs cover only seniors, but some cover those who are disabled and have other needs for assistance. Finally, some SPAPs types have a benefit cap, though there's a limit on how many drugs you can receive in that scenario. Some SPAPs have preferred drug lists, otherwise known as PDLs and cover only certain drugs. Other SPAPs have open formularies and generally cover almost any drug if you take it yourself. Most of it will not cover drugs that fall into a category of Medicare Part B drugs. They're drugs that a doctor usually must give you, and also these SPAPs have an appeal process similar to Medicaid appeal process. Medicaid, of course, is specific to the state.

ix. **Pharmaceutical Reimbursement: Public Insurance Market -** Medicare is a federal health insurance program for all US citizens and legal residents who have resided in this country, the US for a

continuous period of five years, who either are age 65 and older, or are aged 65 and disabled. There are many different parts to Medicare such as: Part A that pays for in-patient hospital treatment, Part B that pays for out-patient hospital services such as physician office visits and some medications, Part D the latest part, a new program. It's optional, but highly suggested, provides prescription drug coverage through private insurance plans to Medicare beneficiaries who enroll in a plan. Part D plans cover many but not all prescription drugs and in fact, by law, cannot cover certain categories of drugs. However, before Medicare pays for some new services or drugs under Part A or B for the first time, Medicare may require a new coverage determination. This could be done at a national level or regional level. Information about these national coverage, NDCs and Local Coverage Determinations is on the website at CMS. For Part B drugs, charges for any supplies should be included with the charge of the drug. Generally, you have to go through a provider in the plan's network to have Medicare Advantage plans cover that drug. If the drug is a Part B drug, Medicare Advantage plan must cover it. But in addition to that, Medicare Advantage plan must also provide Medicare prescription drug coverage Part D and can cover Part B drugs as D if it chooses. If the drug falls under Medicare Part D and you have Part D, the Part D may or may not be on the new drug and its formula. A plan's pharmacy and therapeutics, that's P&T, committee will decide if the plan will cover new drug or not. The P&T committee will look at the class of cause to which the drug belongs and determine whether it must cover this new drug.

x. **Pharmaceutical Reimbursement: Overseas US Market –** The overseas US market basically includes major purchases of drug and on the basis of that it provides relation between main Healthcare sectors. It further helps in making decisions for reimbursement status and price negotiation. US market also provides price regulation for Hospital drugs. Hence, the medico-economic evaluation will be systematized for drugs with a radical, significant or moderate ASMR1 and significant impact on Healthcare spending.

b) <u>Pharmaceutical market deployment and management :-</u>

i. **Defining a Market Space –** According to FDA, drug is an article intended for use in the diagnosis, cure, mitigation, treatment, or prevention of disease in man or woman and other animals. The common designations of what types of drugs that the FDA is concerned about is the prescription drugs that physicians will prescribe, actually in different countries sometimes those are prescribed by pharmacists without the physicians intervention. Expenditure growth is measured by multiplying price of drug with the quantity of drug. The five largest U.S. manufacturers are Merck, Pfizer, Bristol-Meyers, J & J and Eli Lilly. The wholesalers for these pharmaceuticals are generally intermediaries who supply retail pharmacies. Hospitals, doctors, and downstream organizations, they can provide product, patient, disease information, the other components. Hence, other actors / agents in pharma include insurers, employers, PBM, consumers and regulators.

ii. **Who are your Customers? -** The most obvious customers are the patients. They are going to be the users of the product, and then maybe not so obvious, but a very important customer in the pharmaceutical market are the actual providers and the other who are basically prescribing the technologies, the physicians as well as the pharmacists. They could be people with math anxiety, they could be communication convulsions, they can have problems with chemistry conniptions because they didn't do that well. They could have physics floundering, this one's kind of mean, wood shop apathy, and I think basic stupidity, that's just wrong, that's not nice at all. Hence it is important to understand

that the representative role is to provide value for the customer. Furthermore, it also include office based representatives and medical centre representative.

iii. **Who or what Influences your Customer? –** The key influence idea includes hope cure, enhancement, relief, household budget, advertising (television, magazines, and internet), physicians, alternative providers, science, and popular culture. Affordability is a major issue. The whole issue of public and private insurance, drugs, and people will self-pay. Theft is also a major issue too. If people really want to get a hold of drugs, they will steal them. Rebates are a way that drug companies and also insurance companies provide vehicles to make drugs more affordable.

iv. Early Competitors in Brand Space – According to WHO a branded (original) drug is an original drug for which the production and marketing are made possible for the innovator. In the discovery of drugs first of all we have to think about the biological targets, that's generally the discipline of biology. That's going to basically involve pharmacology as well as chemistry. But also toxicology is to understand what response is going to be to animals as well as humans and then finally, once we have those pieces the actual formulation of that, now that's an engineering task. Then finally, the manufacturer gets to an engineering task mainly chemical engineers to hold the pieces all together. So while physicians are core to the medical industry in general, there is a whole range of different disciplines that are engaged. So then, getting a drug to market, first of all we have to understand, what is our disease target? So we need to figure out what the possible drug candidates will be. When we know those pieces, the pre-clinical testing, that is the R&D stage, can be anywhere from 1-3 yrs. Some of those things are going to involve, ultimately humans but at first they're going to involve animal studies and then we're going to be involved in the toxicology area to find out any adverse drug reactions that need to be considered in this space. And from there we go into clinical R&D. That can be anywhere between 2-10 years, on average of 5 yrs. Phase 1, this is where we find healthy volunteers just to try out to see what the effects are going to be. With Phase 2 is where we actually get folks that have the condition and see how they respond to drugs to ameliorate their conditions. Basically marketing is core to make sure that the drug reps know to talk to the physicians and other folks what these products are actually doing, and to make sure that the consumers has awareness of it as well. So they know what the appropriate use for the drugs might be.

v. Global Space Competitors – The WHO defines a generic drug technically as a copy, that's a key word of an original drug, that's the brand of drug for which production and marketing are made possible by the expiry of the patent covering the innovator product. But regardless when they are produced, quality is the key. So four main aspects can be considered for generics in terms of whether or not you want to be using them both as a patient, but also prescribing them if a physician is involved. First of all, are they safe? Do we have evidence that they're safe? Is the quality as good as of corresponding brand? Is the doctor wise in switching from a branded to a generic drug? , are generics as effective as Innovator drugs, Are generics as effective as newer, medically innovated, more costly drugs? .Hence, FDA is indeed insuring a generic drug; it is indeed safe and effective. And that they're put through a multi-step process and you don't believe them, call the FDA.

vi. **Generic and OTC –** So there's a big distinction between prescription drugs and OTC drugs. For prescription drugs, these are available only by recommendation of an authorized health professional, such as a physician, and then there's non-prescription over-the-counter medications otherwise known as OTC drugs. Food is also being now used as a substitute for medication. In many cases, drugs tend to really be made up of different foods that are consumed for therapeutic value. The FDA is attempting to make more drugs available to the general public by switching some frequently used and safe prescription medications to OTC status. So more than one-third of the time, people who treat their routine health OTC medicines are basically trying to relieve symptomatic issues for their ailments, so runny nose, pain with aspirin, or any other sort of analgesics. OTC drugs must be labelled appropriately and they have to include what is the approved use of the product. They have to provide detailed instructions on safe and effective use and also caution and warning to those at greatest risk when taking the medication.

vii. Trends in Cancer Drugs – QALY just like you say graph that actually really shows you, if you have a medication and it's average, it's not really doing very much, this is what you're going to be getting back, this area of the recurred was your life, basically this is the quality of your life and then that going to give us time over years. And the thought is your quality will degrade over a period of time without any sort of major intervention. But, if you had a new drug or a new intervention, your quality is going to be extended out longer so that this new area under the curve basically designates what you're gaining as your quality adjusted life years. When NICE was put into place, they needed to put into a rationale for where they would call a cut point by saying.

viii. British Criteria for Cancer Drug Payment - The idea behind NICE is that it's a quasi-governmental organization that is funded by the UK government. That basically looks at whether or not, not just pharmacological procedures, but also procedures, devices, diagnostic technologies are appropriate for payment within the NHS of the British of the UK. In 2006, there was a new process introduced with NICE, otherwise known as STA. Now when we look at how NICE guidance actually works, there is the central goal of developing NICE guidance. But it actually falls into, basically, three different centres. The Centre for Public Health Excellence, which looks at different public health interventions, and such. The Centre for Technology Assessment, which does the proper technology appraisals, that's usually where most of the pharmaceutical and medical device components are going to fall. And then the Centre for Clinical Practice, which talks about the application of those technologies that are commonly used.

ix. U.S. Criteria for Cancer Drug Payment – So decision making in the US when it comes to cancer drugs is actually most pharmaceuticals can be fragmented. There could be the lack of a central decision-maker. There is the concern about what the political process might mean in terms of other issues. And the idea here is that, concern really, is the paradox is that the public sectors restricted in its use of cost effective analysis. Efficacy, meaning how effective is the regimen or agent, the safety, the quality, the consistency and affordability. So for the American Society Cancer Organization oncology criteria, this is another way of looking at it where you evaluate the toxicity or benefit of the technology on one hand. And then, across the different drug regimens looking at their clinical benefit, their toxicity, and cost. And ultimately making a determination about whether or not one is more valuable than the other given their cost's also a major factor, as well.

c) <u>The Medical Device Industry: Bench Science to Bedside:-</u>

i. **Medical Device Industry: Regulatory Basics –** The role of government here is essentially to focus on what is going to be determining a safe technology, and what can be put into the market. When you actually do a technology assessment in preparation of the regulatory aspect you are gathering, analyzing information to figure out what the performance of a technology is. Once that technology regulatory stage is passed, you need to make sure that your information is actually, collect and so that if you ever have to go back you can actually make sure that it's not initially lost and an understanding of this whole process for development and the reimbursements necessary to prevent any mistakes really from occurring, so we just go into market as quickly as you can. The medical devices are different in FDA process. In this case, what you have to go is for either the PMAs, or Pre-market notifications known as 510(k)s by the statute that their associated with. Medical device is basically an instrument, apparatus, implement, machine, contrivance, in vitro reagent, is component part or accessory which is recognized by the United States, if it has Pharma associated with it, it is intended for use of a specific disease or condition, or mitigation or prevention of disease, and the key thing is that it is not dependent upon being metabolized for the achievement of its primary intended purposes. So, different medical device classes, we have class one, the most basic one that's out there because it's really just for band aids, tongue depressors, any things we need momentarily in the body but generally pretty safe, it's low risk. In the subject pre-market approval, then we get to class two, these are usually things that are cleared the 5 10 k process. These pose either a low or a moderate risk, and then we finally get to class 3, PMA, these have higher risk. They're breakthrough products, and they have a much more expensive application process. Marginal criteria when people ask me and they have new ideas, and technologies is that are you leaving it in the person. So here's our person, there, there, and they're smiling.30% of all devices are Class I, 60% fall in Class II, the dominant one, and 10% for the extraordinary and new technologies in Class III. And then all these devices are subject to general controls marketing, proper labelling and monitoring performance and then there's radiation emitting laser pointers facing additional controls to minimize radiation risk.

ii. **Device Failure –** In this module they have compared two technology including balloon dilation of sinuses and negative pressure wound therapy. Healthcare reform presents new reimbursement opportunities but it also provides a lot of challenges as well, particularly as institutions have to take on more financial risk to pay for these technologies. So, points to take away from this. What do payers, that is, public and private insurance, say about coverage? Are the clinical and cost-effective evidence critical? Critical in the sense that it actually being critically done well, so you know it's actually going to work. How's it going to be paid? What's the procedure code or code combination that's required? Is there a payment advantage or disadvantage to providers? Sometimes hospitals can pay a lot more than physicians, and that could be an advantage if physician's filling hospital codes. What are the best sites of care for pricing, marketing strategy, whether it is hospital outpatient, physician, nursing home or ASC.

iii. **Medical Device and Pharma Convergence –** The FDA generally is the first place that we stop to make the distinction. Drugs are metabolized and devices are not. Size of the markets is quite large. Pharma is much bigger. Reimbursement policies are different, so devices are covered by Medicare. Prescription drug coverage is covered by Medicare Part D, but it's not directly paid for the same way that medical devices are and the consumer is different. For devices, marketing is much more

focused to hospitals and physicians. How are they similar? .That medical devices as opposed to drugs. Both are heavily subsidized by the government for research. Both require FDA approval to survive. Government reimbursement policy is a critical factor in their marketing strategy, both need to make a cost-saving (at best), or at least a cost focus argument for those seeking FDA and insurance reimbursement approval, particularly for insurance reimbursement approval. So is convergence coming between these two industries? It's the same regulators, in some cases they actually share staffs, and they soon have the same insurance revenues in the sense of private insurance revenues and risk-based insurance revenues. Medical devices are starting to look at those metabolizing threshold what's the drug route extend. And if drugs need devices for success then that could actually take it even further. And finally Pharma R&D pipeline has some issues but device enabled drugs and vice versa could provide a new product line. The limitations, though, is that this may encourage less innovation within possible, and there could be possible reduction of small firms enable to fund FDA trials. And another point is that new technologies can make all approaches extinct and capsize both technologies.

iv. **Reimbursement Coding -** So, coding systems are critical for reimbursement in the medical technology space particularly in the US. There are three different coding regimes to keep into consideration. One is the CPT four code regimes. Other is standard current procedural terminology. This is used to describe procedures for physicians, hospital outpatient and the laboratory. Next is international classification of diseases version 10, also version 9, and the predecessor. This could be divided into two spaces, either procedure code, used to describe the impatient procedures for hospitals paid, or diagnosis code, describing the medical reasons for why the service is provided. And then finally HCPCS II a product code to describe different products, equipment services and some procedures usually HCPCS II will operationalize and Medicare some of the CPT or many of the CPT coding structures. So these codes are used on insurance claims forms that are today mostly electronic to link services providers to payment. They establish medical necessity in the sense that if a health plan is paying for it then it clearly is considered covered. They define payment rates. Another thing we can do too, looking at those diagnosis codes you can track diseases. It's really very powerful, in this case, for epidemiological research. So the correct use of codes is required by law in the United States. Medicare has a Correct Coding Initiative that lists codes that will not be reimbursed if listed together. This gets back to some fraud abuse provisions as well. ICD-10 is used to identify diagnosis or procedure. The diagnoses codes can be found on claims are five digits long so for example here we have a fracture of tibia and fibula. We have first that three digit component the 823 that identifies fracture of tibia and fibula. Then there's the subset diagnosis, meaning two here for shaft closed, there's usually a dot that separates them. And then the last one gives the additional detail, which is at the fibula alone.

v. **Payment to Healthcare Providers -** Coding systems drive payment for physicians and healthcare facilities. So there are lots of different places these things come into play. If you talk about the position market, position payments are based on the CPT4 codes regardless of location. If services are being done in the home setting, they get based on also these ideas of HCPCS codes. This could relate to any sort of home dialysis units, for example, Hospital outpatients, payments go to the hospital for outpatient procedures, based on CPT4 codes, and they can also be grouped in to these things known as APCs. For ICD-10 codes, this is a procedure code. Closed reduction of fracture with internal fixation, tibia and fibula, relates to a specific type of DRG code, there's another version of that. Open reduction of

fracture. If you're talking about the diagnosis codes, again ICD-10 here, this actually tells you what the diagnosis actually is as opposed to actually doing the surgical procedures, which is what ICD-10 does. There is a secondary diagnosis codes as well. There could be, some sort of a traumatic or non-traumatic component that affects what went into that as complications that would affect you're coding for 493. And then as a result, all these things come together and say your DRG is likely to be 493 based upon this procedure, this diagnosis code and then the fact that you'll be these additional and as a result your payments going to be $10,570.25. CMS is the only government entity to establish official payment policy for fee schedules where there's variability by geographic components and cost of living. It is that the core one, the Medicaid program also does this as well but usually they rely upon some of the determinations of the managed Medicare meaning that the states have outsourced Medicaid to the private insurers. The reimbursement triad is at work in action. The physician or provider submits a claim, the basic goes in for coding, the payer checks to make sure that the things are actually covered or not. If they are covered, then it moves forward to payment. If they don't, you can go forward and it gets rejected.

vi. **Medical Device Industry: Reimbursement Strategy -** So begin early in the product development phase to figure out reimbursement. You can buy in from venture capital/executive management to figure out how that would actually take place. Commit to the various evidence developments to kind of get it to the next level. You want to make sure you have reimbursement assessments in place. Figure out your plan and timeline for implementation and develop a detailed health policy agenda. Figure out what CMS will do. Figure out what private insurers will do to make sure reimbursement can work. And when you think about the product development pipeline, we always caution this. As you go through feasibility technology and design and production and launch, reimbursement should be in there the entire time, as well as figuring out what you're going to do for your regulatory pathway. So a timeline obviously is going to be the key to figure this out. Figuring out how much money you want to spend for this, a lot of folks generally underspend for this.

vii. **U.S. Device Public Reimbursement** – So in the last set of the modules we discussed about the importance of having a reimbursement strategy. This gets more into details of exactly what your strategy is going to be talking about. So, let's start from the beginning. Let's say you're technology is approved in terms of the FDA and we need to get this thing paid for now, what are you going to do? This tends to be sometimes be more complicated than drugs. Drugs can work usually by the NDC and that's fine. Devices are used in many different settings. And the flow of payments involves many different risk takers, the hospitals in particular. So, how do hospitals get paid? That's probably the big seed, first, because that's really how the device manufacturers are going to get paid within the hospital billing structured. There are two classes of hospital procedures and treatment. There's the Inpatient side or there's also the Outpatient and the Ambulatory side. Medicare and most private payers treat them differently. They use different types of payments for different settings that are in play. In Medicare typically you're going to see things belong to what is known as Part A for inpatient and then Part B for physician and other services. We'll talk about more about Part A much more in a second. It is important to recognize that these settings, which medical technology will be used as the reimbursement strategy, will be different and that the procedure coding systems will thus be different as well. So in Medicare Part A, this is the inpatient services for hospitals. Hospitals get a fixed payment from Medicare for each

admission. The payment is determined by diagnosis. We talked about this related groups, otherwise known as DRGs. These DRG payments roughly increase in complexity and cost of the treatment. The ideas you're being paid for the whole length of stay. It could be two days. It could be ten days. But it's an average payment that's risk adjusted for that. Payment covers all hospital expenses, including, this is the key, the implanted or used devices. You might say, well, it's just tongue depressors and stuff like that, it doesn't really matter, and you're right. But it's an implantable cardiac defibrillator, otherwise known as ICD. Then that's the $30,000 unit cost that gets tacked on, and so it can be very expensive. So why should these DRG payments are of interest to device manufacturers? Well, it has to be factored in. DRGs, to get paid, the hospital submits a form that distinguishes diagnoses and procedures. These are based on ICD-9 and actually they're going to ICD-10. Sometimes ICD-9 is still used as a structure. So for example, these diagnosis codes in the ICD-9 parlance are 410.1 for AMI heart attack. And then heart transplant as a procedure code would be 37.51, usually that distinguishes four digits as opposed to five. Different codes, sets of codes are used for different diagnoses or procedure. And to make this all work these things go into groups that basically put the codes together as algorithms. You have to worry about putting in too many aggressive diagnosis codes because that could affect your reimbursement rate if you do that. Erroneously, that is due to up coding. That is otherwise considered fraud and not a really healthy idea if you want to stay in business. For outpatient services it's a little bit different. There's a different system that's put into place known as the APC system. APC and it's a prospective payment system now being developed or being deployed, I should say, for hospital patient services. You divide all your outpatient services into a payment schedule into 450 clinically relevant groups. Each one of these services are clinically similar and need comparable resources. So a hospital may furnish a number of services to a beneficiary that is a patient on the same day and receive an APC payment for each different service. The beneficiary is responsible for 20% of the cost. If they have actually something called MediGap, which is a policy that allows them to in effect top up their benefits, then it might be considerably cheaper. This is usually a technology pass-through cost, meaning that the beneficiary's responsible for paying some of the technology pieces if it's directly in play. Private health insurances actually do use these technologies as well. They use Medicare's Diagnoses coding requirements for example for their own purposes for their technologies for reimbursement. So it's important for both Medicare and private you have an idea of what's going on. And it's also key to understand why does this matter for device manufacturers? Simply that if they don't figure out a way to get their devices into the hospital services payment system, they're just not going to get paid. So then we'll turn to this whole process that actually, I get very excited about. Medicare claims processing. I'm not making this up. A lot of my research focuses on this. So, most insurance claims are processed electronically, not manually. They're submitted by the hospitals, and they get sent to CMS. That basically does claims processing. They will actually contract out of the CMS to other organizations to do their processing for them. They contract out to carriers to handle physician claims and fiscal intermediaries to handle hospital claims. Increasingly, these things have been put together into a structure called MACs, and they are basically handling, for the most part, these two pieces together. The carrier piece, historically, is part B. And the fiscal intermediary piece is part A. So and they're going to determine whether or not something will be paid or not. Medicare also issues coverage decisions. They decide whether they're going to cover it or not. Usually, the procedure is covered if certain conditions are met. The standard is reasonable and necessary. But, recent evidence suggests that what we're really looking at is a cost effectiveness criterion. Similar to what we talked about in the pharmaceutical components for the

cancer drugs. QALY are not explicitly used but they're certainly considered sometimes in a reimbursement strategy and there are discussions that occur both at the national and the regional level as well in terms of coverage decisions. We'll talk a little more about this later in our next components. This concludes this module on public reimbursement for medical devices.

viii. **U.S. Device Private Insurer Reimbursement –** Private insurance for providers in the medical device basis is similar to public. Generally when we're talking about the private insurance market, we're really focused on the employers, ultimately workers though, that pay for healthcare. And this is the self-insured market. This is, in terms of the U.S., what we have; say 330 million people, roughly about 160 million, the largest component of them, are going to get reimbursed through this self-insured vehicle. So for this market, rates are negotiated with the physicians themselves, by the insurance companies. Carve outs, meaning that the insurance company is giving a chunk of money to a specific specialist to focus on one particular service. Now insurers have a coverage committee that reviews evidence and decide what they're going to pay for. Ultimately, the decision would come down to the medical director of the plan, and with some of the guidance from what external sources would suggest.

ix. **Medical Device Reimbursement Outside U.S**. - Healthcare is primarily funded through mandatory health insurance system. There are additional contributions that come from employers and employees, basically mandatory employer mandate and most of the remaining costs have been covered by any complementary health insurers or patient co-payments that go into the design. So there are co-payments in the French system. It's not all complete coverage. Lots of different agencies are involved. The overall theme here is we're looking at health technology assessment. So different groups that come into place. First of all, whether the product is safe or not. Then the questions whether or not this is actually applications or not. And this is actually equivalent of something similar to what actually happen with a NICE in UK and then finally whether or not the technology is useful in the interest of public good and focus, and actually there's a medical device focus here as well as kind of key. And they also focus on non-drug products. So this actually, these two pieces overlap to actually give sort of overall health technology set very similar to our friends in the UK with a nice scheme. And then with that we go forward to actually the reimbursements. So first of all the Health Ministry determines if the device is going to be admitted to the reimbursement based on appraisal. You have to be approved to have your technology at least that's what CE marking would be. It's similar to the FDA. You then have to put together basically your technology dossier here. You need to have your economics component as well. All these things go in for appraisal and ultimately you find out whether or not your technology makes sense in terms of the economics as well as the capabilities. There's economic negotiation for what the price would be, relatively briefly. These two things then go through the Ministry of Health and if that works it get published in an official gazette, similar to what happens in the US when things get published in the US Federal Register.

d) <u>Medical Device Market Deployment & Management:-</u>

i. **Medical Device Industry: Market Space** – So, when thinking about the medical industry today, it's a pretty big industry. The major players in this arena Johnson and Johnson, GE Healthcare, Siemens Healthcare, Phillips, Baxter, Becton-Dickinson and many others. And while there is increasing

competition there is also lots of innovation, and but of course always remains regulatory issues as well. If we look at, the range of what's going on, in terms of different areas. We have, anything ranging from OBGYN, radiology, dental, ear, nose, and throat, to looking anesthesiology, gastro, plastic surgery, so basically it's, really a pretty diverse range across the whole team. So we think about what this world could look like in terms of service industry. The services market itself could do everything from product design and development. They could do regulatory consulting. They could do maintenance. They could do upgrades. They could do testing and certification and implement. On the application side of the market they can develop devices across all different regimes, class one, class two and the super-advanced class three. If we look at the services split, for product design and development, that's pretty much denominates what's there. If you look for regulatory consulting, that's 22%. Maintenance, 16%, implementation only 9% and upgrade and testing 13 and 11% respectively. Major players to get inside these are technologies you may not hear them all the time, but these are the firms that are really getting good at sort of doing these service innovations. So as the market evolves what you'll find is that there are increasing strategic alignments since, and partnerships between medical device manufacturers and outsourcing providers.

ii. **Medical Device Industry: Innovation Pipeline & Valuation** – So, a quick way to validate early medical technologies is to get the university resources behind you, particularly at a public university to see what's going on. And this might be meaning basically that revisits the original concepts of a public research university that has economic opportunity. With the combined talents of several super colleges of the university can provide the human intellectual talent to really develop. Not just leaders but also to develop the technologies and invent them at the same really get all the different parts of the university working together pretty seamlessly. And universities are very unique role to develop device innovators. They can independently examine new innovations whether they be service or technology, these can save and extend quality of life. Take a look at sustainability of technologies and services. They can cut avoidance of services and technologies. What's exciting also is that universities have access to unique human capital, open to scientific policy and management basis, legal expertise as well as how to really key actually. Universities have credible perspectives on meaningful trends in science. And there's an inventor as well as an investor perspective. So these folks from the Med school and engineering, investor perspective from the business school does give a verdict on both these types of clients.

iii. **Medical Device Industry: Global Partnerships** - So when we think about why we would want to focus on global, the idea is that everybody is thinking about health reform because there is lots of money going into medical industry and dollars. There's a lot more emphasis on value driven validation of these ideas. And there's also issue about having the right human capital to make these things work. And if you think about the fusion of actually having this fall to a university and with the medical industry makes a lot of sense. There's a big macroeconomic gamble we're taking with health reform. We're about to, as a society and worldwide put a ton of money, into this. And so we basically want to extend our functioning, to reduce our cost. But if we don't really get new innovations, that can truly apply to a global level, this U is going to be a big here. We live longer with little functional improvement, and much higher dollar.

iv. **Medical Device: Device Competitor Analysis** – When you think about what goes into a competitor analysis, there are some basic guidelines that we use. First of all, we look into whether analysis, the same or very similar intellectual property, that focused on the same disease, we're looking at the same technology action. So, looking at all of the different companies that are not the only ones that actually develop this, but this is essentially a range of the different firms that would be in the space, that could be doing something similar to that, different technology, and it's important to track where they are with their patents, and where they might be in terms of their probability and scalability to doing the work that they do. Another innovation that we've looked at the university, is this idea of a multiple degrees of freedom innovation tool so, and deals with. So, the idea is that, it will increase their range of motion, gives greater leverage, gives joystick-control for bending, and that gives also independent rotation bending of distal ends.

v. **Medical Device: Global Competitor Analysis –** So following up on the last lesson, we're just going to talk a little bit more about this idea of our Multi Degree of Freedom tool and how it can go global. So when we think about this tool, what we need to consider is that alternatives. There is traditional laparoscopic surgery, which is actually relatively too but when you do it, it requires multiple incisions basically, more than one port, two ports to come in. As opposed to SILS, which is becoming increasingly common is in China to reduce scarring and trauma. In terms of where this is, laparoscopic is still dominated by multi-port, just because it's easier to do versus 2% single port. And one of the reasons why people find this attractive is that if you think about it, what the multi-port is, it's like let's count them. One, two, three, so there are three different scars. And granted, these aren't huge scars, they're going to be basically Band-Aid scars of say, 1 or 2 inches. But the thought was that if he had had just one scar, wouldn't that be a better place to go? Now, we actually did this in terms of looking at the evaluation. There is a consider voice of the customer that you're basically operating maybe two different tools in this port. And you might prefer to have more ease of use with multi-port than single-port. The thought is, at least from the patient's perspective; this could be a superior technology. The single-port can pose challenges for surgeons. There's a lot less leverage to angle your instruments. There's a smaller range in that accessible space. It's difficult to visualize a scope near the instruments. So remember when you actually do these particular procedures, one of the things we're doing is some of the other ports that are open, or basically body areas that are open are really letting you view what's going on. And so they have this be in such close proximity why not get a clear image to what the nature of what's going on. And the tools have to be crossed; each hand operates opposite side of surgically. So this requires a fair bit of skill that may not have been really as critical in previous physical procedures. As we mentioned before it's a competitive space. We do think that this is unique and is different than what the Covidien tool could produce. And also even though there is this component over here It still does not quite have the same features and certainly would probably do better than the pre-bent tool we bought previously from Olympus.

vi. **The 510k: Friend or Foe?** - So, this is your friendly neighborhood FDA. So, this area, CDRH, tiny piece there this is essentially where mending techniques are done pre-market approval of different technologies go into this, post-market surveillance, the enforcement of whatever is done, in terms of what's approved for the FDA, and a prior research in terms of where the technology is actually going to be going. So, when we look about what goes into this space for the pre-market organizations usually

organized by medical specialties, say, cardiology, neurology, and such like that, and then would be looking at these technologies. There's also then the pre-market application or PMA. This is essentially where standalone full data reviews, where the design of clinical testing and safety effectiveness, includes any pre-approval inspection of the manufacture site, very intense. There's also then also the pre-market notification, otherwise known as the 510(k) process. The key thing, is that it is a comparison to a predicate technology, predicate being something that has been already introduced in the market before. It has also been usually previously marketed legally, and the idea is that, you can have an abbreviated review if you find that there's substantial equivalents back to this predicate. So, one of the concerns is that, potentially, the 510(k) process is getting a little more onerous because some of these technologies are not quite the same type of thing anymore. However, it can be one way to accelerate to get your product if you meet the appropriate criteria. We think about device classification. As we mentioned before, there are three risk class: class one being very simple like tongue depressors tech, class two being very easy to candidates for 510(k)s with some predicates, and then task three being the very advanced technologies, things that get implanted into you and get to stay for a very long time. So, when things look into this space, there's the risk of the product use and acceleration, how well it is understood and controlled, also how well a surgeon or a practitioner can use it. The risk rise is measured from one to three; low, moderate, high, and unknown risk. Initial classifications edge along next to six for all product types, then in the market buy panels of experts; pre amendment proposals. Procedures to have in place to move products up and down the risk classes as more as learned, and I'll work on my dictionary. So, when we think about what actually is the 510(k) process, first piece we have to think about, is what will go into this. It is an FDA's decision first of all to clear this product to go through the 510(k) process. You'd have to prove substantial equivalence, and as anyone will tell you, this is a term of art. What this means, is that it needs to have the same intended use as what you had in mind. So, what needs to be considered here is that it has to be as safe and as effective as the comparison technology, and can be also in sense of a different technology. If it's the same technology, obviously it won't be approved because it's equivalent to what was already there. So, when we think about the way 510(k) could work, one of the things we look into is the traditional. The first-time is marketed. Basically, the idea is that if it's a brand new market, FDA gets 90 days to review it, if it's an abbreviated review, that could be tested support equivalence on recognized standards and that can make it less than 90 days. A special review, is a single chance change to a marketed device, which could be like a tweet, can mean a software package or something else like that, and then there's already designed controls in place, meaning, that there aren't many major changes from how it would be implemented and used in a medical procedure, in which case it has a much smaller review, only 30 days. So, the question comes. I mentioned on the beginning 510(k) friend or foe, I'm a friendly person. Honestly, I think the 510(k) process is great to get market things to market quickly. It's easy to divide the market space based on some sort of precedent. The foe issue though, is that it made the application may not apply and you may have wasted valuable time, and increasingly, since there aren't as many predicate technologies as there used to be, one needs to be not overly optimistic that they can find a quick way through. So, people need to be cautious and that could make this process a foe. Then the other thing that's key too, is that the FDA's release standards is evolving, and so one could see that potentially, even something that would traditionally been a fiber 510(k) because of safety standards and some recall issues, people are more concerned now. That maybe it's been too loose a standard for a 510(k), into perhaps more clinical trials need to be done to look for safety.

vii. **Go to Market** – So, some ideas, as you're thinking about going to market, that really I think are quite essential. First of all, keep your innovation simple. The case method works. As long as you keep it simple, it works here as well, substituting innovation for it. So, one quote from Donald Coduto, for "Foundation design" is really like this a lot. "Some say the cup is half empty, while others say it is half full. However, in my opinion, both are wrong. The real problem is the cup is too big. Because you're trying to boil the ocean. Sometimes, all we need is a new perspective on an old problem". So, when you think about getting a product to market, one thing to keep in mind also is that, this is the typical growth cycle that you see. You can't start this life cycle course without an actual start. So, getting to market the first time in a first sale is really kind of key up there. So, as you're doing that, there are some elements of success that you should think about employing. You should focus on markets with problems, needs, and non-consumption, because there is there's nobody really in that space to begin with. Do not over-engineer or try to significantly change use patterns, just to make things easier. A lot of times people will do this, they'll look for great efficiencies. I think part of it is that, many-time engineers or their gut instinct is always to look for something more efficient in terms of time and process. That may be that engineer's perspective, it may actually work, it could have worked that way, but it may not always be, particularly, if it's talking about a major change of behavior to go to that space. Then, do not target markets with established sustaining competitors. It's great to have a really cool breakthrough technology, but you're going to have to hit it just right to really be the disruptive technology in the space. Unlike some of the world would say the.com world or things with it with really some of the more advanced business analytics, where you just need a really great ideas, some good arcoders, and you can kind of go to market and try to disrupt, and a different unique idea, there are a lot of actors involved in health care, from the physicians that use of technology to the manufacturers of the unique way that things are manufactured, and as a result, it's hard to go to bat against an existing competitor. What are the elements of success? Basically, look at your market appropriately; segment it out, which market's going to be most successful for you? Build a business model that can support the innovation and any subsequent disruption that you can achieve, and focus on team building. There are basically no founder, entrepreneur or innovator accomplishes success without very talented people. Sometimes it's the finance person that finds the money, sometimes it's the person who really is incredibly good at convincing other folks what this technology is, sometimes the inventor is not the best person to describe what is the unique aspect, or what that technology is. The key is that it takes a team to make this happen, and one or two person shows sometimes will not get you all the way there. Certainly, not for delivering the scope of economy.

viii. **Managing Market Share** - There's lots of things to look at here. First of all, a little bit history lessons. So, we'll look at some key innovations and the idea is that the rewards will come to those who make early stake in these monopolies. Getting first to market comes with significant risks. The more you progress up the device class, so for example going from class one to class three. Maintaining first-mover advantage is always a challenge and many first innovators loose share to bigger players. So, let's tackle that. This is a set of two slides. We're looking at first it's like some early first here. So, for example, here's the first X-rays developed by Roentgen which actually his name is used as far as the technology for measuring rads. Then there is the East Electrocardiograph developed by a Dutch physician, awarded the Nobel Peace Prize 1924, for his discovery. First modern respirator, later used

for essentially an iron lung machine. First cardiac catheterization in 1928. First metallic hip replacement surgery by US surgeon, Dr. Austin T. Moore. First kidney dialysis machine, Dutch born physician in 1945 and then when we look at, really the innovations coming in from hearts, the first artificial hip replacement, the first commercially available artificial heart valve invented by the United States team of engineers of Miles Edwards, that actually, that group still is in play today. Then we had the first successful external cardiac pacemaker developed by Paul Zoll. We had then the totally internal pacemaker, the actual Medtronic first mover or walk and sort of lies somewhere in between, basically it was external but battery-powered. We get to the CT scanners, those who came in place in 1970, get a Nobel Prize for medicine coming in place there. The FDA invents a little process that actually counts as innovation for regulating medical devices. This is partially admitted by rest of world now. The first PET scanner comes on line basically into the 1980s. The first MRI in 1977. The US team first cochlear implant for helping out folks with their hearing. First permanent artificial heart developed in 1982 and then writing process for all of European devices comes in placement in 1993. Major Medtronic and other company innovation, the first cardiac defibrillator where it basically restart your heart were developed by a Polish cardiologist and then mobile assisted surgery comes around that same point 1985. So, lots of existing technologies but necessarily the folks, we will also see these names essentially, these folks going on to become the CEO of their own company. Lot of times they'll sell their technology, license or technology or the team taking to the next level. Medical device firms offer customers different levels of service products at many different levels. We're going talk about four in particular. First of all, is the total high-end one, the premium differentiated. So, these products and services are differentiated by efficacy, that's how effective the technology is, their outcomes, care delivery, and supported by high types of selling and servicing models, usually by journal articles or other things supporting their claims. Because they're innovative and have proven benefits, they command pretty high prices. Then we get to premium undifferentiated. These are innovative but they're just incrementally so. These are products that are kind of like just next stage up. Research suggesting in these areas that category will suffer intense erosion in price and share. Many premium companies that profit from these products because of strong customer relations or brand image attractive to consumers are a great risk and could be a concern over a period of time. There's then the value chain. So, these are a set of features and goods and services tailored to meet the customer's expectation for good enough products and usually sell at much, much lower prices. Think of this as essentially the generic equivalent in the medical device space. The sales model for these offerings may involve online support, light-tight representatives, who call on clients and then we get to the basic level. Products do their job, offer minimal service, and compete purely on price, often used in settings where providers seek to supply a basic service than optimize outcomes. In McKinsey, the consulting firm estimation, this segment is growing faster than the premium segment and could ultimately lead to erosion long-term in the space. When you think about how to go to market, there are many options you have to calibrate. So, part of this is first of all, looking at whether we're talking about product type, operational support model, their sales model, what your clinical support model are and your brand name, and then how expensive do you want to be. Basically, with a range of options, so for product type, you can basically reduce your price on existing products, you can reposition end-of-life products, you can de-engineer them or you can build brand new technologies from scratch. You could look into high level support versus low level support. You can have a much more expensive, very premium sales model in terms of how you're going forward versus a lower channel. You could, for clinical support, actually have much more staff in the

field to go to market or in terms of branding, do you go brand new or do you use your existing brand are go in between heaving endorsed brand, lots of options. One last thought to sort of keep into consideration, when people think about getting leaner in their design doesn't necessarily mean that they're going to have less profit margin. So, here's an illustration of where we have a wound care product and what's actually happened here. If you look at the share or percent of their sales in terms of where things go, right now they're operating with a 25 percent margin but notice the firm made some changes and they're still operating with a 25 percent margin. Now, maybe the dollar amount is a little bit less, but look at how they actually achieve their cost savings. The largest share was cutting their sales force basically by going to a lean selling machine model. So, it was about 40 to 50 percent reduction in their sales force in terms of what they were doing. For other cost savings, they went to analyze for the product costs, that enabled them to do a little better and then they also reduce some of their operational costs going as well. But interestingly enough that actually accounts now for more of the value of what they're offering, but they still have a margin that's about the same as what they did before and operating a leaner platform. This concludes this module on going to market and a different technology and decisions and marketing and sales decisions you need to make as you construe your space.

ix. **Keeping the Product Fresh and Safe in the Long Run** – we are going to talk about different products and technologies, and particular, we're going to focus on illustration from General Electric, the Healthcare Infant Resuscitator. A very popular product, but also one that ran into some issues. So, what can really create a very bad day at the office is when you get essentially an FDA recall. So, keep in mind that the FDA in the US always keeps an eye out on the technology after it's been deployed, just getting approved for technologies insufficient, there's a periodic spot checks that are done. So just to give you a flavor, so this is the dates when different recalls have been issued for different technologies. So, you have to go into correct them and potentially on depending how serious it is, it could basically put you into major jeopardy and shut you down. So, the G-technology which was a really great technology basically imagine just to resuscitate infants is awesome, but GE ran into an issue, they had to recall a host of these for the past five years over serious error during the assembly process. So, that bad day from the FDA came on February 28th, 2014. Designated, every call is class one which does not mean there's like a tongue depressor, it's an easy class one device, it means it's a really major problem. FDA officials think the resuscitators could potentially seriously injure or kill infants because the oxygen air while in the fittings on the back panels were reversed during assembly, so that would be tragic. Specifically, the FDA goes forward to say that these recalled products may interfere with oxygen delivery resulting in inaccurate oxygen regulation in newborns, that's neonates, and may lead to low blood oxygen hypoxia or high blood oxygen hyperoxia. This may cause death in neonates particularly those who are critically ill, pre-term, and low-birth weight babies, they are also at increased risk for in terms of morbidity and mortality. So this recall involved a wide swath of these GE resuscitators, basically, anything manufactured between April, 2007 and October of 2013. Lessons learned from these things is to think about anything you can do to try to manage your risk, and this is a business, such you're trying to operate medical devices, but you need to keep certain things in mind to keep your risk down. One is try to minimize your cannibalization. So, an illustration of this might be that a company is taking a plain-products approach that is sure and meaning that you're using a reason, some other technologies. They must ensure they have a deep understanding of their premium

customers, and features they prefer and ensure that these needs are not met by its value offerings. So, in other words, don't necessarily make a product that's too undifferentiated, and catalyze some of the work that's already, it really makes your premium technology works best. If you defend against the competition, so to be able to keep it competitive advantage in value products premium, companies must reach scale quickly and show that they can achieve really high value products, and you have to remain flexible. So when you have a lean selling model, you may need to offer additional clinical support, more flexible inventory, sport key accounts if the need arises. Maybe more expensive, but if you lose that whole account, you could have your whole company go down, and that would be not a good idea. This is a screenshot from; actually one of my favorite movies probably predates some of the people who may have watched this. Depending on your age, these movies came out in 1982, The War Games from the John Anime Films. Basically, it's a computer hacker, hacks into the known computer system and launches a fake nuclear war is played by Matthew Broderick. A first Putlar's days off, this was before he had his big day off. So point of all this is that, let's talk about great movies from the 80s, but let me talk about the notion of war-gaming. So the whole idea is that you always prepare for what your worst-case scenarios might be, have people take different roles in terms of looking at this other situations. This is really the key for staying fresh, and your assessment of how they operated for your technologies. This could also help you evaluate risks and opportunities. So, for example, if someone in your company acts like they're going to play the FDA, and they really know where things are going to be, that can actually give a better sense of how to protect against adverse events. So, for instance, they could estimate the revenue flow from new product sales and the effect of cannibalization or increased competition on profits. Potentially, someone could basically role play a startup company or an engineer that breaks away from your company and talks about the technology they're going to take and figure out how to do that. All of this can be achieved through war gaming, and can help companies assess whether value products are likely to erode their brand and damage their premium categories, which will definitely affect their ability to innovate and to reinvest their profits into new ideas. Another part of staying fresh is that companies may choose to pilot new products and business models in one market to gain competitive advantage and insights over another. So, for example, Medtronic going into China to potentially promote brand new innovation in that space that's unique for the China market. They can have a situation where they may try to go into that market and then later go out for a much larger global roll-out once they find that they can actually capture a new technology. Even if they develop a value technology in emerging market, there could be an opportunity with coupled with a new sales market could be actually a premium technology depending on deployment. So, we have now reached the end of this entire module focused on pharmaceuticals and medical devices. It's been an honor to work with you throughout this process. It needs to say there's a lot more that can go into this area, and that's why I've tried to provide an opportunity for you to know the major features of the space, and the regulatory, the profitability components of it. How reimbursement gets done, how to worry about intellectual property, how to be strategic with your assessments and that will be helpful to you to understand this market. Even if you're not going to be doing work in the pharmaceutical medical device areas, it's important to understand that this is a tremendous amount of innovation in this space, and in many cases, some of the most expensive new innovations that could be game-changing are going to come from the space. So, a better understanding of it I think is really an exciting proposition. With that, we conclude this lesson and this module on Pharmaceutical and Medical Device Innovations.

Learning Methodology- The course consists of video lectures, quizzes, reading material and one peer review assignment for practice. The assignments and quizzes have some weightage in learning the course.

Key Learning from the course-

I. The Pharmaceutical Industry: Bench Science to Bedside –

In this module I learnt about how medical technology goes from ideas to treatments. First we will focus on the pharmaceutical industry. The take-away messages from this module are that there are many exciting ideas that never make it out of the lab. Furthermore, those ideas that do make it out require hundreds of millions of dollars per innovation. The skills gained from this module to enable a successful capstone is an appreciation of how technologies are innovated a midst a sea of regulation and intellectual property constraints. You will be better prepared to under the features of likely successful drug before it goes to market and competes to enhance and save lives.

II. **Pharmaceutical Market Deployment & Management –**

In this module I learnt about how the pharmaceutical industry takes a product that has cleared the bench and sells it in the market. Pharmaceutical marketing of a drug product is one of the most complex consumer behavior activities in practice today. Selling a new drug in a highly competitive global market space with a patent clock ticking is a constant tactical game played out on a long strategic clock that also runs into subsequent generic deployment. The take-away messages from this module are the pharmaceutical market requires strategic thinking that considers an array of contingencies. The market also must be nimble to adjust to different government policies that can create or break decades long product lines and therapeutic interventions. The skills gained from this module are an understanding of the competitive landscape analysis as well as threat assessment analysis required to complete the capstone medical innovation project.

III. **The Medical Device Industry: Bench Science to Bedside –**

In this module I learnt how medical device industry innovates and brings transformational products to market. The take-away messages from this module are that there are many exciting ideas that never make it off the cutting room floor of universities and research labs. Furthermore, those devices that do make it have to quite novel to compete in an increasingly crowded space. The skills gained from this module to enable a successful capstone is an appreciation of how medical devices are innovated a midst a sea of regulation and intellectual property constraints. You will be better prepared to under the features of likely successful medical device before it goes to market and competes to enhance and save lives.

IV. Medical Device Market Deployment & Management –

In this module I learnt about how the medical device industry takes a product that has cleared the bench and sells it in the market. Selling a new medical device in a highly competitive global market space with a patent clock ticking is a constant tactical game particularly in the crowed medical device Class 1 and Class 2 space. The take-away messages from this module are the medical device market requires constant innovation with product updates required at a far quicker rate than the pharmaceutical market. Manufacturers must also be nimble to adjust to different government reimbursement policies that put great financial risk or previously risk free core customers. The skills gained from this module are an understanding of the competitive landscape analysis as well as threat assessment analysis required to complete the capstone medical innovation project.

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