

Modern Advancement in Diagnosis and Treatment of Clinical Cancer

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Abstract. Cancer is one of the leading causes of mortality worldwide with hundred types of cancer that affect humans. The most spreading cancer globally is breast, prostate, lung, stomach, and colorectal cancers and non-melanoma skin malignancies. Early detection of these transformations in the cell can improve the prognosis of cancer cases. Oncological screening and methods include ultrasound, MRI, digital mammography, CT scan, and magnetic resistance spectroscopy. Other techniques such as immunohistochemistry, RT-PCR, and micro-array are used for the diagnosis of cancer. Precision medicine is currently the subject of extensive research for the benefit of cancer therapy in the future. Chemotherapy, radiation therapy, immunotherapy, and hormone therapy are the most often administered treatments to patients. The greatest treatment for cancer is also a stem cell transplantation, but it must come after less effective treatments to prevent blood loss and restore the patient's health. The nanoparticles have been considered the best tumour-targeting vehicle. The recent nano-scale vehicles including polymeric nanoparticles, liposomes, nano-shells, and dendrimers have been used as conjugates.

Keywords: Oncological screening, micro-array, RT-PCR, immunotherapy, nanoparticles.

INTRODUCTION

Cancer begins when a cell breaks from the normal restraints due to uncontrolled growth and spread. Early premalignant stages of cancer have been identified as a result of research on the cytochemical and genetic levels of the disease's progression. These phases are characterised by precancerous changes in DNA sequence, gene expression, protein structure, and microscopic rearrangement.

Breast cancer is the term used to describe the uncontrolled growth and division of cells that start off in the breast tissue. The most prevalent kind of cancer in women is treatable in 70% to 80% of patients with the early-stage, non-metastatic illness. Breast cancer is a diverse disease; molecular characteristics may include activation of the hormone receptors (oestrogen and progesterone receptors),

activation of the human epidermal growth factor receptor 2 (HER2; encoded by ERBB2), and/or BRCA mutations. The likelihood of developing breast cancer can be increased by a number of risk factors, including sex, ageing, oestrogen, family history, gene mutations, and bad lifestyle choices.

Prostate cancer is a common cancer in men and causes death in men over 50 years. For early detection of prostate cancer, prostate-specific antigens (PSAs) have been used as markers.

In Western countries, lung cancer is the main cause of death. It causes when mutations or changes happen in the cells of the lungs which cause the cells to grow and spread in an abnormal and often very rapid way. The cause of lung cancer is due to smoking or secondhand smoke, any lung-related disease, radon exposure, personal history of lung cancer, age, and occupational health.

Stomach cancer or gastric cancer is developed from the inner lining of the stomach and may spread from the stomach to other parts of the body, mainly in the liver, lungs, bones, abdomen lining, and lymph nodes. This cancer is most common in men and the third leading cause of death after liver and lung cancer.

Colorectal cancer, also known as bowel cancer, is an abnormal growth of cells in the colon or the rectum, and this abnormal growth of cell may spread to other parts of the body. Symptoms include change in intestinal motility, blood in the stool, weight loss, and feeling tired all the time.

Non-melanoma cancer is the most common cancer in Western countries. The case of skin cancer has been increasing worldwide. Exposure to radiation, mainly UVB, is a major risk in different types of skin cancer. Similar to other cancers, early detection and diagnosis result in better treatment. Skin cancer usually looks like blemishes in starting. Non-melanoma cancer is not dangerous but with time it leads to ulcer and does not heal completely. It primarily appears as a dry scale or lump with slow growth that is pale or red in colour.

METHOD

India is a country of the population close to 1.3 billion; due to the continuously increasing population, it is challenging for healthcare planners to provide access to health care to everyone. The Indian federal government has made decisions to control non-communicable diseases like cancer.

In 2020 (Table 1), India's anticipated incidence of cancer patients was 679,421 (or 94.1 per 100,000 men) and 712,758 (or 103.6 per 100,000 women). One in 68 males was affected by lung cancer, one in 29 women by breast cancer, and one in nine Indians by cancer at some point in their life. In 2020, the five most prevalent cancers in men was lung, mouth, prostate, tongue, and stomach, accounting for 36% of all malignancies, while the five most prevalent cancers in women was breast, ovary, cervix uteri, corpus uteri, and lung. It accounts for 53% of all cancers (Table 1). In India, a woman dies from cervical cancer for every eight minutes, and a woman dies from breast cancer for every two minutes who are diagnosed with it. Approximately 3,17,928 deaths occurred in men and women due to tobacco use in 2018, and the related mortality in India was estimated as more than 3500 individuals per day. The risk of developing cancer before the age of 75 years in males is 9.81%, while it is 9.42% in females. The risk of death due to cancer before 75 years is 7.32% in males and 6.28% in females. Oral and lung cancer account for over 25% of death in males, whereas breast and oral cancer account for 25% in females. In 2018, the total death due to cancer was 7,78,821 in which a number of males were 4,13,519 and a number of females were 3,71,302.

For the diagnosis and screening of cancer, doctors use various detection methods. Ultrasound is the most common method for basic examination. In an ultrasound, there is the use of high-frequency sound waves that we cannot hear, and these sound waves echo off tissues in our body and create an image of areas inside our body. This image is called a sonogram. A device called a transducer, which is covered with warm gel, makes it easier to glide over the skin over the part of the body that is being examined. Magnetic resonance imaging (MRI) takes pictures of the body in slices with the help of magnet and radio waves. These slices are used to make detailed images of the internal body to differentiate between healthy and unhealthy tissues. The MRI machine makes loud extreme noises and rhythmic beats. Sometimes, a dye called a contrast agent is injected into the vein before or during MRI to show a brighter image of tumours. Digital mammography gives a high-resolution image due to the low image noise. The most crucial characteristics of this test are low noise levels because picture noise tends to obscure minor calcification, making it challenging to detect it. Digital mammography detectors can be categorised as scanning systems, computed radiography, or flat-panel full-field capture devices. Amorphous silicon or amorphous selenium is used as the substrate for flat-panel detectors. CT scan uses X-ray machines linked to a computer to take a series of images of body organs from different angles, and with these images, it creates a 3-D image of the internal body. Sometimes, in this examination, dyes are used to highlight certain areas. A non-invasive view of the body's metabolic activities is provided by magnetic resonance spectroscopy (MRS). With new advancements in body MRS, clinical MRS can get functional information along with anatomical information after a standard MRI by using high magnetic field strengths on body fluids, cell extracts, and tissue samples. In addition to this, immunohistochemistry test is used to detect protein in or on cells (markers). A high concentration of markers indicates the chances of cancer. RT-PCR is a technique used to detect cancer by amplifying suspected genes. Microarray is a new tool in a lab but it can also improve the accuracy of the result by suggesting novel tumour-specific markers for detection.

For the treatment of cancer, many therapies are used but the most common one is chemotherapy. The first use of chemotherapy was in the 1940s with nitrogen mustards and antifolate drugs. Patients usually receive chemotherapy alongside other treatments like surgery and radiotherapy. It is impossible to provide a success rate for chemotherapy alone (Tables 2 and 3).

Depending on their abilities (Table 4), stem cells have been used in cancer treatment. Hematologic diseases such as leukaemia, multiple myeloma, and lymphomas can now be effectively treated by HSC transplantation. Despite being successful in both preclinical and clinical models, stem cell treatment still faces significant obstacles. In order

Table 1. Projected incidence of cancer statistics is India, 2020.

Site	Male			Female			Both Sexes		
	Patients	CR	Cum Risk	Patients	CR	Cum Risk	Patients	CR	Cum Risk
All sites	679,421	94.1	1 in 9	712,758	103.6	1 in 9	1,392,179	98.7	1 in 9
Oral cavity and pharynx	139,018	19.2	1 in 41	49,951	7.3	1 in 112	188,969	13.4	1 in 60
Tongue	39,902	5.5	1 in 147	13,870	2.0	1 in 401	53,772	3.8	1 in 215
Mouth	57,380	7.9	1 in 103	22,483	3.3	1 in 241	79,863	5.7	1 in 144
Pharynx	3,029	0.4	1 in 1,793	1,102	0.2	1 in 5,475	4,131	0.3	1 in 2,701
Other oral cavity	38,707	5.4	1 in 137	12,496	1.8	1 in 476	51,203	3.6	1 in 213
Digestive system	163,845	22.7	1 in 32	110,137	16.0	1 in 50	273,982	19.4	1 in 39
Esophagus	32,622	4.5	1 in 159	20,206	2.9	1 in 264	52,828	3.7	1 in 198
Stomach	32,713	4.5	1 in 160	17,430	2.5	1 in 319	50,143	3.6	1 in 213
Small intestine	2,155	0.3	1 in 2,492	1,451	0.2	1 in 3,901	3,606	0.3	1 in 3,044
Colon	20,572	2.8	1 in 260	15,685	2.3	1 in 348	36,257	2.6	1 in 298
Rectum	21,915	3.0	1 in 244	14,985	2.2	1 in 372	36,900	2.6	1 in 295
Anus, anal canal	2,897	0.4	1 in 1,865	2,028	0.3	1 in 2,682	4,925	0.3	1 in 2,200
Liver and intrahepatic bile duct	26,678	3.7	1 in 189	10,732	1.6	1 in 514	37,410	2.7	1 in 277
Gallbladder and other biliary	12,385	1.7	1 in 422	19,510	2.8	1 in 284	31,895	2.3	1 in 340
Pancreas	11,908	1.6	1 in 429	8,110	1.2	1 in 657	20,018	1.4	1 in 519
Respiratory system	103,552	14.3	1 in 48	32,480	4.7	1 in 165	136,032	9.6	1 in 74
Larynx	27,146	3.8	1 in 184	3,316	0.5	1 in 1,633	30,462	2.2	1 in 331
Lung and bronchus	71,788	9.9	1 in 68	26,490	3.9	1 in 201	98,278	7.0	1 in 101
Other respiratory organs	4,618	0.6	1 in 1,273	2,674	0.4	1 in 2,156	7,292	0.5	1 in 1,600
Bones and joints	8,115	1.1	1 in 1,013	5,840	0.8	1 in 1,370	13,955	1.0	1 in 1,162
Soft tissue	8,047	1.1	1 in 842	6,590	1.0	1 in 1,052	14,637	1.0	1 in 936
Skin (excluding basal and squamous)	11,203	1.6	1 in 510	8,962	1.3	1 in 640	20,165	1.4	1 in 568
Melanoma of the skin	3,003	0.4	1 in 1,904	2,364	0.3	1 in 2,281	5,367	0.4	1 in 2,075
Other nonepithelial skin	8,200	1.1	1 in 695	6,598	1.0	1 in 890	14,798	1.0	1 in 781
Breast	5,377	0.7	1 in 1,022	205,424	29.9	1 in 29	210,801	15.0	1 in 56
Genital system	51,994	7.2	1 in 105	155,630	22.6	1 in 36	207,624	14.7	1 in 54
Uterine cervix	—	—	—	75,209	10.9	1 in 75	75,209	10.9	1 in 75
Uterine corpus	—	—	—	26,514	3.9	1 in 190	26,514	3.9	1 in 190
Ovary	—	—	—	43,886	6.4	1 in 133	43,886	6.4	1 in 133
Vulva	—	—	—	2,138	0.3	1 in 2,459	2,138	0.3	1 in 2,459
Vagina and other genital, female	—	—	—	7,570	1.1	1 in 745	7,570	1.1	1 in 745
Placenta	—	—	—	313	0.0	1 in 30,912	313	0.0	1 in 30,912
Prostate	41,532	5.7	1 in 125	—	—	—	41,532	5.7	1 in 125
Testis	4,352	0.6	1 in 2,095	—	—	—	4,352	0.6	1 in 2,095
Penis and other genital, male	6,110	0.8	1 in 916	—	—	—	6,110	0.8	1 in 916
Urinary system	33,269	4.6	1 in 158	11,265	1.6	1 in 502	44,534	3.2	1 in 240
Urinary bladder	20,470	2.8	1 in 250	5,403	0.8	1 in 1,014	25,873	1.8	1 in 402
Kidney and renal pelvis	12,363	1.7	1 in 442	5,657	0.8	1 in 1,038	18,020	1.3	1 in 620
Ureter and other urinary organs	436	0.1	1 in 10,843	205	0.0	1 in 21,892	641	0.0	1 in 14,531
Eye and orbit	1,304	0.2	1 in 6,870	953	0.1	1 in 9,063	2,257	0.2	1 in 7,792
Brain and other nervous system	19,979	2.8	1 in 341	12,750	1.9	1 in 546	32,729	2.3	1 in 419
Endocrine system	9,263	1.3	1 in 709	26,665	3.9	1 in 279	35,928	2.5	1 in 402
Thyroid	8,570	1.2	1 in 759	26,095	3.8	1 in 285	34,665	2.5	1 in 416
Adrenal gland	693	0.1	1 in 10,797	570	0.1	1 in 14,053	1,263	0.1	1 in 12,209
Lymphoma	32,695	4.5	1 in 197	20,247	2.9	1 in 296	52,942	3.8	1 in 236
Hodgkin lymphoma	7,294	1.0	1 in 1,150	3,936	0.6	1 in 1,871	11,230	0.8	1 in 1,418
Non-Hodgkin lymphoma	25,344	3.5	1 in 238	16,263	2.4	1 in 352	41,607	3.0	1 in 284
Malig Imm Prol D	57	0.0	1 in 101,774	48	0.0	1 in 164,355	105	0.0	1 in 126,050
Multiple myeloma	10,725	1.5	1 in 465	7,756	1.1	1 in 646	18,481	1.3	1 in 541
Leukemia	32,481	4.5	1 in 239	21,132	3.1	1 in 353	53,613	3.8	1 in 284
Lymphoid leukemia	14,159	2.0	1 in 608	7,419	1.1	1 in 1,138	21,578	1.5	1 in 789
Myeloid leukemia	14,913	2.1	1 in 474	11,275	1.6	1 in 617	26,188	1.9	1 in 536
Leukemia uns	3,409	0.5	1 in 2,287	2,438	0.4	1 in 2,980	5,847	0.4	1 in 2,583
Other and unspecified primary sites	48,554	6.7	1 in 114	36,976	5.4	1 in 153	85,530	6.1	1 in 131

Abbreviations: CR, crude rate; cum risk, cumulative risk of developing cancer at 0–74 years of age; Malig Imm Prol D, malignant immunoproliferative diseases; Uns, unspecified.

Table 2. Percentage of females with breast cancer who are under treatment involving chemotherapy.

Treatment Choice	Breast Cancer Stage		
	Stages 1 & 2	Stage 3	Stage 4
BCS plus chemo	2%	2%	2%
BCS plus radiotherapy and chemo	17%	15%	2%
Mastectomy plus chemo	12%	13%	7%
Mastectomy plus radiotherapy and chemo	6%	48%	7%
Radiotherapy and/or chemo without surgery	1%	4%	48%
Total	38%	82%	66%

Table 3. Percentage of patients who undergoes treatment involving chemotherapy.

Treatment Choice	Colon Cancer Stage		
	Stages 1 & 2	Stage 3	Stage 4
Colectomy and chemo	10%	67%	40%
Chemo alone	Less than 1%	Less than 1%	26%
Total	Approximately 11%	Approximately 68%	66%

Table 4. Information about the types of treatment that patients with non-small-cell cancer receives.

Treatment Choice	N-SC Lung Cancer Stage	
	Early Stage (1 & 2)	Late Stage (3 & 4)
Surgery plus chemo and/or radiotherapy	16%	7%
Chemo alone	1%	18%
Chemo plus radiotherapy without surgery	6%	35%
Total	24%	60%

to select an appropriate method for engineering stem cells, additional research would be conducted to shed light on the signalling of stem cells on tumour growth and metastasis in particular situations.

As nanoparticles can significantly contribute to the delivery of a particular drug, nanotechnology has been explored and used for the treatment of cancer. Nanoparticle-based drug delivery offers distinct benefits over conventional drug delivery, including increased stability and biocompatibility as well as precision targeting.

The negative effects of chemotherapy can be reduced by using nanoparticles in cancer treatment and diagnosis. Through molecular imaging, cancer can be detected. Liposomes are the most widely used delivery mechanisms. When compared to conventional approaches, these delivery agents allow for the detection and treatment of every type of cancer with less harm to healthy conditions.

These nano-carriers typically need to have a few basic properties, such as (1) stability in the vascular system (blood) until they reach their target, TME; (2) ability to

evade reticuloendothelial system (RES) clearance; (3) ability to evade mononuclear phagocyte system (MPS); (4) ability to accumulate in TME via tumour vasculature; (5) ability to penetrate at high pressure into the tumour fluid; and (6).

Nanoparticles for Cancer Imaging. Quantum dots for optical imaging nanocrystals have special qualities that make them appropriate for optical imaging. These cadmium selenide, cadmium sulphide, or cadmium telluride nanocrystals are coated with an inert polymer to enable optical fluorescence imaging. Quantum dots (Qdots) are used to fluorescently designate living cells.

CONCLUSION

As one of the main causes of death in the world, cancer affects people in one hundred different ways. Breast cancer is the term used to describe the uncontrolled growth and division of cells that start off in the breast tissue. It is the most prevalent kind of cancer in women around the world, and early-stage, non-metastatic cases can be cured in 70% to 80% of patients. In Western countries, lung cancer is the main cause of death. Stomach cancer or gastric cancer is developed from the inner lining of the stomach and may spread from the stomach to other parts of the body, mainly in the liver, lungs, bones, abdomen lining, and lymph nodes. This cancer is most common in men and the third leading cause of death after liver and lung cancer. Colorectal cancer, also known as bowel cancer, is an abnormal growth of cell in the colon or the rectum, and this abnormal growth of cell may spread to other parts of the body. The risk of developing cancer before the age of 75 years is 9.81% in males, while it is 9.42% in females. In 2018, the total death due to cancer was 7,78,821 in which a number of males were 4,13,519 and a number of females were 3,71,302. For the treatment of cancer, many therapies are used but the most common one is chemotherapy. Nanoparticles in cancer therapy and diagnosis can reduce the side effects of chemotherapy.

REFERENCES

- [1] Pawan Kumar and RVS Pawaiya, *Advances in cancer diagnostics*, Braz J Vet Pathol; 2010, 3(2), 142–153.
- [2] Saini et al., *IJPSR*, 2020; Vol. 11(7):3121–3134.
- [3] <http://cancerindia.org.in/cancer-statistics/>
- [4] *JCO GLOB Oncol*. 2020 Jul; 6:1063–1075.
- [5] <https://www.medicalnewstoday.com/articles/326031>
- [6] Din-Toi Chu et al., *Recent progress of stem cell therapy in cancer treatment* (2020).
- [7] Karim et al., *Journal of pharmacy and pharmacology* 3:2015, 299–315.
- [8] Senthilrani, N. et al., *Nanotechnology in cancer diagnostics and treatment*; 2328–3491.