Table 1 Overview on clinical trials on dendritic cell therapy; number of doses, antigen source mode of infusion and clinical outcomes

S no	Clinical trials/ number of patients treated	Dendritic cell therapy (No of DCs infused)	Conventional therapy	Antigen source	Clinical outcomes	Mode of infusion	Reference
A. Prostate cancer							
1	Phase I (12 Patients)	APC8015 (2)	Variable	Recombinant protein PA2024	Tolerated with minor side effects, compared to chemotherapy raised PAP specific immunity, decreased in level of PSA and PAP	Intravenous	[19]
2	Phase II (21 patients)	APC8015 (2)	Variable	Recombinant protein PA2024	Treatment were tolerated, Significant decreased in PSA level	Intravenous	[20]
3	Phase III (225 patients)	Sipuleucel- T	Variable	Recombinant protein PA2024	33% reduction in risk of death	Intravenous	[21]
4	5 Patients	5-10 X 10^6	Radiotherapy	-	Feasible and well tolerated, specific immunological response viz. increased apoptotic cells and parenchymal distribution of CD8+, PSA recurrence ranging from 15-62 months	Intratumoral	[22]
5	737 Patients	Sipuleucel-T	Variable	Recombinant protein PA2024	Data suggested antigen specific immune activation is a mechanisms by which Sipuleucel-T prolongs the overall survival	Intravenous	[23]
6	12	2.7 X 10^7	-	Recombinant proteins PSCA, CPP-PSCA	6 SD, 1 complete disappearance of lymphadenopathy despite of rising of PSA, median survival 13.4 months for all patients	Subcutaneous	[24]
7	127	Sipuleucel-T	-	Recombinant Protein Prostatic acid phosphatase	115 patients had progressive disease and survival for 36 months, survival advantage to asymptomatic HRPC patients	Intravenous	[25]
B. Renal cell carcinoma							
1	27 patients	Mean 8.7 X 10^6	Chemotherapy IL-2/IFN-α	Cultured RCC cells	2 CR, 1OR, 7 SD, 17 PR	Intravenous/Intradermal	[26]
2	20 patients	Variable	IL-2	MUC-1 and PADRE peptides	2 PR, 1 CR, 10 PD, 5 SD, 2 MR	Subcutaneous	[27]
3	10 patients	0.1-1X10^6	IL-2	Whole cell lysate	40% patients showed clinical outcomes 3 of which showed disease stabilization and one show partial response with reduction in tumor size	subcutaneous	[28]
4	3 patients	2-7 X10^7	-	Whole cell lysate	Induced T cell immunological response without toxicity	Intradermal	[29]
5	3 patients	3 doses 1: 1X10^7 2: 2.5X10^7 3: 5X10^7	Nephrectomy	Whole cell lysate	5 SD, 1 PR 3 PD Median survival 29 months	Subcutaneous	[30]
6	15 patients	Average 3.95X10^6	-	Whole cell lysate	7 PD, 7 SD and 1 PR Increased in rate of peripheral blood lymphocytes (PBLs)	Intranodally/subcuteneous	[31]

7	7	Variable	Interferon alpha	Whole cell lysate	5 SD, 2 PD Therapy is safe and has potential for prolonging time to progression in the patients	Intrader mally/Int ratumoral	[32]
C. Breast cancer							
1	Phase II 26 patients	$5X10^6$	-	Antigen peptides	8 SD, 11 PD, p53 specific immune response	subcutaneo us	[33]
2	7 patients	4 doses	-	Recombin ant proteins HER 2 ICD proteins	Well tolerated, significant immuneogencicty, 100% 4.5 years of survival rate	Intradermal Subcutaneo us	[34]
3	27 patients	$1\text{-}2X10^7$	-	Recombin ant proteins HER-2/neu	DC1 showed potent inducers of durable type 1 polarized immunity	Intranodal	[35]
4	18	Lapuleucel T Level 1 (2 X 108) Level 2 (1 X 109) Level 3 (5 X 109)	-	Recombin ant fusion proteins BA7072	Feasible, safe and tolerated treatment stimulated significant immune response	Intravenous ly	[36]
D. Lung cancer							
1	5	2 doses ($5X10^7$)	-	Recombina nt proteins	2 patients survive almost twice greater than twice as expected	Subcutan eous intraveno usly	[37]
2	16	$1X10^8$	Variable	Adenocarci noma cell line 1650	Well tolerated therapy and had biological activity in NSCLS patients	intraderm ally	[38]
3	Phase I 15	3 doses 1: $3X10^6$ 2: $6X10^6$ 3: $12X10^6$	Chemothera py	Whole tumor lysate	Increased interferon gamma production by CD-8 cells in 5 patients and MR	Intrader mally	[39]
4	8	1-6 doses $1X10^6$	chemotherap y	Tumor cell lysate	No grade II/II toxicity Increased in T cell response against tumor antigen, 5 PD, 1 tumor response and 2 SD	Intranoda l	[40]
5	14	$8.2X10^7$ $7.9X10^7$	Variable	Adenocarci noma Cell line 1650	Dc vaccines showed acceptable immunological response as per therapeutic standard	Intrader mal	[41]
E. Melanoma							
1	10 patients	$1X10^7$	rhIL-2	Whole cell lysate	1 SD, 7PD, 2 MR	Internoda l	[42]
2	17 patients	$1\text{-}4X10^6$	-	DC/tumor cell fusion	Feasible and well tolerated, antitumor response and disease stabilization in majority of the patients	subcutan eous	[43]
3	Phase III 55 patients	$4X10^6$	Comparison with available chemotherapy	Peptides	DC vaccination couldn't demonstrate more effective than DTIC chemotherapy	subcutan eous	[44]
4	Stage IV Melanoma 46 patients	$1X10^6$	-	DC/tumor fusion	3 CR, 3 PR dendritic cell therapy has potential as a therapy in limited number of patients	Intrader mally	[45]
5	16 patients	$1X10^7$	-	Peptides + tumor lysate	3 SD, 6 PD, 2 CR and 1 SD	Intrader mal	[46]
6	Phase I 12	$4.5X10^6$	Chemotherap y	Myeloma ID	2 patients with partial response at 25 to 29 months, serum free DC	Intraveno us	[47]

				proteins	vaccines induced ID specific immune response		
F. Pancreatic carcinoma							
1	12	2 doses: $3X10^5$ 6 doses:	Concomitant gemcitabine chemotherapy	Whole cell lysate	1 PR, 2 SD, median survival (10.5 months), Increased tumor reactive T cells, 5 patients survive more than 1 year	Intradermally	[48]
2	49	$1X10^7$	Chemotherapy	Variable WT1, MUC1, CA125, Her 2, lysate	Effectiveness of DC vaccination with standard chemotherapy were feasible 2 CR, 5 PR, 10 SD	Intradermally	[49]
3	10	$1X10^7$	Gemcitabine	WT1 peptides	Feasible and effective for inducing antitumor T cell response	Intradermally	[50]
4	11	$1X10^7$	Gemcitabine	WT1 peptides	Significant increase in Overall survival (OS) and progression free survival (PFS)	Intradermal	[51]
G. Brain tumor							
1	Glioblastoma Multiforme) Phase I 18	$2\text{-}5X10^7$	Radiotherapy Chemotherapy Surgery	Whole cell lysate	1,2,3 years survival rate 88.9%, 44.4%, 16.7% OS 31.9 months PFS 8.5 months	Subaxillary; subcutaneous region	[52]
2	Glioma Phase I/II 24 patients	$1\text{-}32X10^6$	-	Whole cell lysate	1 PR, 3 MR, 10 SD, Average survival 480 days	Intradermally/ Intranodal	[53]
3	Astrocytoma 13patients	$1X10^6$	Chemotherapy	Whole cell lysate	Safe, induces tumor response and favourable tumor response with adjuvant chemotherapy	Intradermal	[54]
H. Ovarian cancer							
1	Phase I	$5\text{-}10X10^6$	Ant angiogenesis therapy and metronomic cyclophosphamide	Oxidized lysate	Increased clinical efficacy with combination immunotherapy by therapeutic immunomodulation	Intranodal	[55]
2	56 patients	$1X10^7$	-	Synthetic peptides WT1, MUC1 and CA125	71% enrolled patients developed immunological response	Intradermal	[56]
3	10 patients	$4.13X10^7$	IL-2	Autologous tumor lysate	3 CR, 1 SD, 2 PR Increased NK activity, IFN-gamma secreting T cells, Immune Subcutaneous secretory cytokines secretion found after DC vaccinations	Subcutaneous	[57]
I. Leukaemia/lymphoma							
1	3	3 doses $5X10^6$	-	Tax peptides	Safe and feasible treatment 1 PR, 1 CR, 1 SD	Subcutaneous	[58]
2	14	$5\text{-}10X10^7$	Low dose of Rituximab and local radiotherapy	-	5 objective response, 2 CR	Irradiated lesion	[59]
3	35	Variable	Chemotherapy	Idiotope (ID) proteins	Induced T cell and humoral anti ID immune responses and tumor regression	Intravenous	[60]
4	10	$1X10^6$	-	Tumor	50% patients showed objective	Intranoda	[61]

				lysate	response. 1 CR, 2 PR and 2 PR for 10.5 months and other remaining 5 PD	l	
J. Gall-bladder cancer							
1	Case report	10 doses	-	Formalin preserved tissue	Safe and effective	Intravenous	[62]
K. Colorectal cancer							
1	10	1-1.5X10^6	-	CEA peptides	Increased CEA specific T cells in 7 (10) patients, 2 SD for 12 weeks and significant decrease in CFA level in 2 patients	Intranodal	[63]
2	3	1-3X10^7	-	WT1 peptides	Immunity acquired from DC vaccination persisted for 2 years with prolonged disease free survival and overall survival	Intradermal	[64]
3	100	1X10^7	CIK treatment	Whole cell lysate	62 % patients developed positive cell mediated cytotoxicity response. Effective and safe treatment observed by quality of life and OS of patients	Intravenous Intradermal	[65]
4	74	PANVAC-V PANVAC-F	Chemotherapy	-	Recurrence free survival for 2 years and median follow up 35.7 months	Subcutaneous Intradermal	[66]
L. Hepatocellular carcinoma							
1	5	4 X10^7	-	CTP fused human AFP, MAGE1 and GPC-3	Well tolerated in all patients and induced antitumor response	Subcutaneous	[67]
2	Phase II 39	1-6 doses; average received patients 3 doses	Variable	HepG2 cell line	PR + SD ≥3 months 28%, significant decline in serum AFP, release of IF-gamma reflects antitumor immune response	Intravenous	[68]
M. Multiple solid malignancies							
1	51	1X10^6 6 doses	chemotherapy	Whole cell lysate/paraff in block	Therapy is safe, increased CD4:CD8 values, TTP > 9 weeks, median overall survival 397 days	Intravenous	[69]
2	16	3X10^6 6 doses	Chemotherapy Radiotherapy Hormonal therapy	Allogenic cell line	Therapy is feasible, non toxic, reduction in PSA level in prostate, 2 (5) SD in RCC	Intradermal/Intranodal	[70]
3	21	3X10^5	-	Whole cell lysate	Vaccination were well tolerated; induced tumor specific cellular cytotoxicity	Intranodal	[71]
4	14	1 X10^6 1X10^7 1X10^8	-	Whole cell lysate	No grade III/IV toxicity Local accommodation of CD4/CD8 T cells found at vaccination sites, release of IFN-gamma indicated increased immunological response	Intradermal	[72]
5	10	5X10^7	IL-2	Whole tumor lysate	Well tolerated without side effect, significant induction of anti-tumor immunity such as IF-N gamma producing CD8+ cell population, IL-12 secretions	Subcutaneous	[73]
6	32	1X10^5 to 4X10^6	-	DC-cancer	Increase in Cd4 and CD8 T cells	-	[74]

				cell fusions	expressing IFN-gamma release, 2 patients (Breast cancer) disease regression, 5 patients (RCC) and 1 (Breast cancer) SD		
7	18	3 doses of lapuleucel T	-	Recombinant protein BA7072	Short term disease stabilization in 5 patients and long term disease stabilization in 2 patients	Intravenous	[75]
8	15	$>5X10^7$	Interferon alpha GM-CSF IL-2	Autologous tumor lysate	7 SD, 1 PR Strong cell mediated antitumor immune reaction	Intravenous	[76]
9	22	Variable	rhIL-2	Autologous tumor lysate	21 patients have elevated of serum ANA (antinuclear antibody). No patients showed symptoms of autoimmune disease	Subcutaneous	[77]
10	54	Average $18.8X10^7$	CIK treatment Chemotherapy	Tumor lysate	Potential effective approach in control of tumor growth for post operative patients	Subcutaneous Intravenous	[78]

CR: Complete Response; PR: Partial Response; OR: Objective Response; SD: Stable Disease; MR: Mixed Response