

APPLICATIONS OF LIPOSOMES IN CANCER Liposomes have been successfully used in cancer therapy. Another liposomal formulation Stimuvax is designed as anti-MUC1 cancer vaccine by Oncothyreon to treat non-small cell lung cancer and presently is in phase III clinical trial (Bradbury and Shepherd 2008; Fantini et al. 2011; Broglio et al. 2014). The thermo sensitive liposomal formulation of doxorubicin, called ThermoDox (Celsion) is under phase III clinical trial to treat the patients with primary hepatocellular carcinoma, in phase II for refractory chest wall breast cancer and colorectal liver metastasis (Poon and Borys 2011; Staruch et al. 2011). The Sopherion Therapeutics in the United States and Canada is conducting a pivotal phase III global registrational trial of Myocet in combination with Herceptin (trastuzumab) and Taxol (paclitaxel) for the treatment of highly aggressive HER2-positive metastatic breast cancer (Baselga et al. 2014). DaunoXome, the registered trademark of Galen, is the liposomal formulation of daunorubicin approved by the FDA for the treatment of AIDS related kaposi's sarcoma (Cooley et al. 2007; Petre and Dittmer 2007). The CPX-351 showed promising results in phase III clinical trial on the patients with secondary acute myeloid leukemia (AML) by improving the induction response over 40% (Riviere et al. 2011; Cortes et al. 2015). MM-398 is being evaluated in the clinical trials for its ability to treat various cancers, which are resistant to chemotherapy such as pancreatic, colorectal, lung and glioma (Ko et al. 2013; Roy et al. 2013; Saif 2014). LipoDox is the same liposomal formulation as Doxil in USA and made in India by Sun Pharma and in 2013, FDA approved the first generic version of Doxil, made by Sun Pharma (Berger et al. 2014; Chou et al. 2015). Doxil, a PEGylated liposomal formulation, is the first liposomal product that was approved by the FDA for the treatment of kaposi's sarcoma in AIDS patients (James et al. 1994; Barenholz 2012). In a study, it was observed that Doxil was also active against refractory ovarian cancer, and later approved by the FDA for the treatment of recurrent ovarian cancer also (Muggia 1997; Barenholz 2012). Doxil (US), or Caelyx (outside-US) is a PEGylated liposomal formulation encapsulating anticancer drug doxorubicin commercialized by Johnson & Johnson. Marqibo was approved in 2012 by the FDA for the treatment of acute lymphoblastic leukemia (Sarris et al. 2000; Rodriguez et al. 2009). Another liposomal formulation of Celator contains irinotecan Hcl and floxuridine and registered as CPX-1. A number of different liposomal formulations of anti-cancer agents have been shown to deliver the drug at the site of solid tumors with minimum toxicity as .(compared to free drug (Allen and Cullis 2013; Sutradhar and Lutful 2014