encapsulation of Isoniazid, Pyrazinamide and Rifampicin in varied combinations in microemulsions and evaluated for its efficacy in in vitro release for treating MDR-TB [138]. Moreover, Ganoderma lucidum-derived polysaccharides (GLP) coated oil-based microemulsion has been developed and evaluated for stability of this nanocarrier in A549-bearing xenograft mice for targeted lung cancer therapy [139].

5.9. Carbon Nanotubes

Carbon nanotubes (CNs), an another nanocarrier system having tubular morphology mainly composed of carbon with diameter ranging from 4 to 100 nm. Moreover, their shape and size can be amended by changing the graphene molecules arrangement [140]. Basically, these CNs are not readily soluble in any aqueous or organic solvent. But major challenge associated with this nanocarrier system is its toxicity which demands for the solution. Progression in the technology has allowed us to chemically modify so that their biocompatibility can be enhanced, toxicity could be decreased and make it water-soluble nanocarrier system [141]. The large surface area of the CNs allows it load high amount of therapeutic agent. Additionally the unique electron emission, mechanical and optical properties makes it an effective nanocarrier system. Furthermore, this nanocarrier system has penetration power as it resembles with fine-needle and conjugation of functional groups on surface adds additional benefit of targeting the disease cell [142].

There have been studies that have used multiwalled CNs which augments the pulmonary eosinophilic inflammation and triggers the other responses by synthesizing cysteinyl leukotriene. These finding prompted to explore the pharmacological agents which can cease the leukotriene synthesis in asthmatic patients [143]. Still, the expedition is going among the researchers to load the drug for targeted delivery in COPD patients. Due to the blood circulation, the lower availability of anti-TB drug at targeted site has raised the concern for targeted delivery of drug. To resolve this issue, the researchers have developed isoniazid containing carbon nanotubes for effective delivery of therapeutic agent in bone TB [144]. Another study reported about paclitaxel-loaded single-walled CNs and result obtained from the study highlighted the potential of the nanocarrier system for treating lung cancer [145].

5.10. Quantum Dots

Recently, development in the field of nanotechnology has enabled us to fabricate the colloidal nanoparticles having the properties similar to atom and is known by the name "quantum dots (QDs)." These nanoparticles are unique as their surface modification improves both solubility and biocompatibility of these nanocarrier system [146]. It is considered to be effective fluorescent probe in contrast to other fluorophores (especially organic). High photo bleaching, wide absorption spectrum range and photo stability are few unique features of these QDs [147]. Mostly, QDs includes the elements from group II–IV (such as zinc sulfide, cadmium-selenide, and cadmium-telluride) to group III–V (such as indium arsenide, gallium arsenide and gallium nitride). QDs are composed of core and cap/shell-like structure which are further coated with polymer layer [148]. The cap/shell of the QDs serves as protective shield for core, as it contains metal complexes. These QDs are extensively are used for bioimaging, labeling, and targeting of biological molecules. In addition to these applications, now more avenues like drug delivery to target site are being explored for therapeutic purpose [149].

Still, the researchers have not considered quantum dots to be suitable nanocarrier system for targeted delivery in chronic respiratory disease [150]. The major concern for slow exploration is the heavy metal toxicity. But certain changes have been made and evaluated on the murine model. It is expected that in near future researchers will unveil the real potential of this nanocarrier and make them suitable for treating these chronic respiratory diseases [151].

Clinical studies of drug delivery system. Currently, various nanocarrier based drug delivery formulations are under pre-clinical and clinical trials for their approval by government agencies like European Medicines Agency (EMA), Europe and Food and Drug Administration (FDA), the United States [152, 153]. Moreover, different nanocarrier based formulations have already got the approval for treating lung cancer after their clinical trials. Doxil encapsulated in liposomes, known by the name "Abraxane" approved by FDA is commercially available in the market for treating cancer [154]. List of the nanocarrier based drug formulation in their clinical trials against these chronic respiratory diseases have been summarized in Table 1. Largely, most of the nanocarrier-based drug formulations are targeting the respiratory diseases such as COPD and lung cancer because of their high prevalence worldwide. But this also highlights that need for the development of nanocarrier based formulations for treating other respiratory diseases like asthma, TB and others [165]. As these formulations are effective and have improved the therapeutic potential of drugs, the