Nanotechnology for Cancer Treatment

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Situation

Cancer is a disease in which abnormal cells segregate without control and are able to attack other normal tissues [1]. Despite advancements in the medical field towards dealing with chronic illnesses, the current approach to treating and diagnosing cancer is of the least developing areas. Cancer, like any other infection, starts from a single cell which dies because of mutation i.e. change in DNA structure. In addition to infecting cells of a single site, malignant cancer imposes a significant threat on all tissues of the body due to its ability to spread by metastasis and affect more than its site of origin.

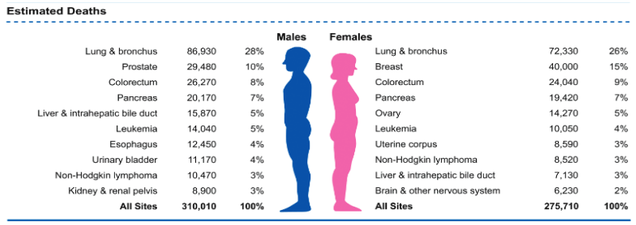

Figure 1: Estimated number of deaths (USA, 2014) [2]

Problems

- Lack of specificity: Nano-particles solely target cancer cells and can, hence, replace existing methods of cancer treatment [3].
- Toxicity: Nano-particles, like any agent being injected into the body, carry the risk of introducing toxins that can infect healthy tissues in the body. The ability of nano-particles to remain stable within the body without breaking down is one of the main challenges to ensure the administration of nanotechnology for cancer therapy [4].
- Cost: High costs associated with the bulk production of nanoparticles and the cost of hiring well skilled staff to operate the system make nanotechnology an expensive option [4].
- Quality control: There is a risk of inconsistency while manufacturing nanoparticles [4].

Solutions

- Improve specificity: Continual testing and research on nano-particles is a key solution [5].

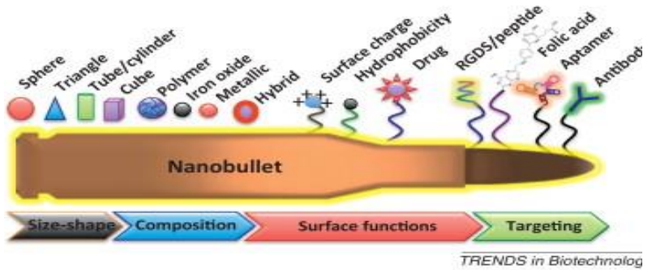

Figure 2: The ideal solution specifications [5]

- Reduce toxicity levels: Toxicological challenges including the stability of nanoparticles and the toxins that could be introduced into the body. This can, however, be resolved by careful designing of the particles and paying attention to their shape, surface area and potential to generate oxygen species, as mentioned by Xia et al. and cited in [4].

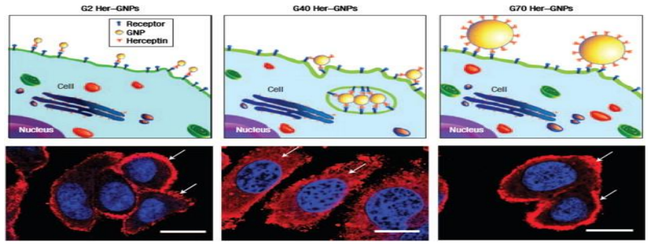

Figure 3: Shape, size, and surface area of nanoparticles in comparison to tumor cells [5]

- Minimize cost of manufacturing and treatment: The burden of high costs can be reduced by the collaboration of other corporations with the pharmaceutical industry. Chemotherapy, the current method of medication, is also expensive [4].
- Set a minimum quality standard: As regulatory authorities become more familiar with the production of nano-materials, the setting of an acceptable standard to their quality will become easier [4].

Evaluation

- Time consuming and costly animal testing is required to fulfill the safety requirements set by medical bodies [6].
- Designing process requires full knowledge of the use of nanoparticles to eliminate their toxicity [7].
- Cost is a potential constraint, however, this is the case with almost all new engineering projects.
- When authorities become more familiar with the use of nanotechnology to target caner, the quality control problem is will be solved [4].

Table 1: Proportions and frequencies of health service utilization use and accompanying costs (2012 US$) [8]

Variable	Proportion<comma> N (%)	Mean # (SD) per patient	Total # cohort	Mean cost in dollars ($) (SD) per patient	Total cost cohort ($)
Non-therapeutic investigations					
Total Cost			56367728.59		
Mean Cost (per patient)			60016.41		
Visits and hospitalizations					
Total Cost			4736752.58		
Mean Cost (per patient)			1872.62		
Treatment options					
Chemotherapy	1352 (40)	10.1 (7.44)	13716	2374.90 (1741)	3,210,868.20
Radiotherapy	944 (28)	--	944	6522.31 (--)	6,157,056.80
Blood transfusion	1391 (41)	3.1 (4.9)	4312	2429.74 (3836)	3,379,768.85
				Total cost (Cohort)	113,890,622
				Mean cost	33,956.66 (16,122)

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