HOT TOPIC OF THE MONTH

Does nanomedicine have a delivery problem?

PERSPECTIVES

Analysis of nanoparticle delivery to tumours

Stefan Wilhelm, Anthony J. Tavares, Qin Dai, Seiichi Ohta, Julie Audet, Harold F. Dvorak and Warren C. W. Chan

Abstract | Targeting nanoparticles to malignant tissues for improved diagnosis and therapy is a popular concept. However, after surveying the literature from the past 10 years, only 0.7% (median) of the administered nanoparticle dose is found to be delivered to a solid tumour. This has negative consequences on the translation of nanotechnology for human use with respect to manufacturing, cost, toxicity, and imaging and therapeutic efficacy. In this article, we conduct a multivariate analysis on the compiled data to reveal the contributions of nanoparticle physicochemical

Delivery efficiency and consequences

How many nanoparticles accumulate in a tumour? Upon systemic administration, the mononuclear phagocytic system (MPS) and the renal clearance pathway compete with the tumour for nanoparticles. The MPS is a network of organs (most notably the liver and spleen) that contains phagocytic cells that take up nanoparticles, while the renal (kidney) system excretes nanoparticles smaller than 5.5 nm in hydrodynamic diameter[26–29]. Nanoparticles that escape the aforementioned biological barriers have the opportunity to interact with the tumour tissue. The percentage of administered nanoparticles that can achieve this is defined as the nanoparticle delivery efficiency[30].

To determine the current delivery

c&en
CHEMICAL & ENGINEERING NEWS

Home | Magazine | News | Departments | Collections | Blogs

Home > Volume 94 Issue 25 > Does nanomedicine have a delivery problem?

Volume 94 Issue 25 | pp. 16-19
Issue Date: June 20, 2016

26 26

Email Print

Does nanomedicine have a delivery problem?

Experts debate controversial paper that suggests delivery efficiencies for cancer nanomedicines are low and not improving

By *Michael Torrice*

Moderator: Santi Correa (Hammond Lab)

October 17, 2016

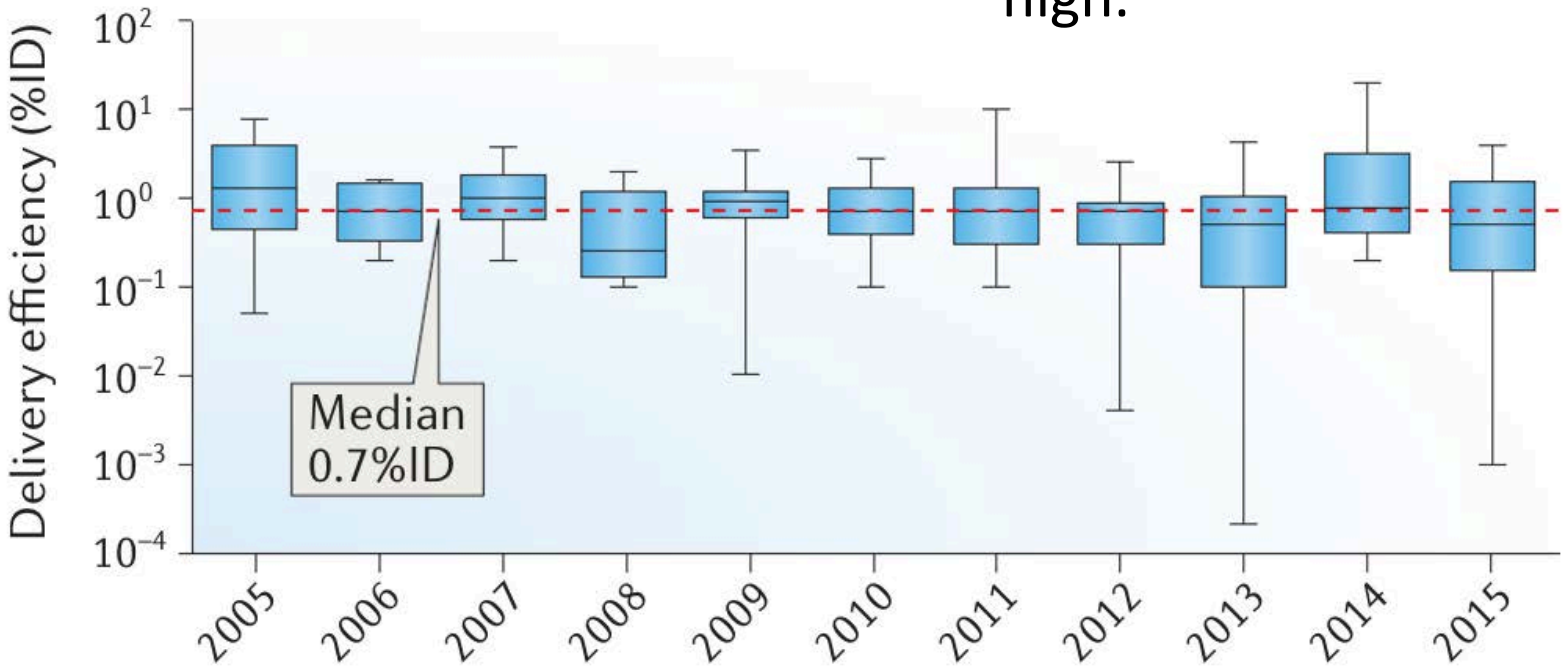
KOCH INSTITUTE for Integrative Cancer Research at MIT

MARBLE CENTER FOR CANCER NANOMEDICINE

Finding #1: Low Median Delivery Efficiency of NPs in solid tumors

- ~0.7% of an injected dose (ID) of nanoparticles ends up in a tumor.

- Required amount of NPs that need to be injected into humans would be high.



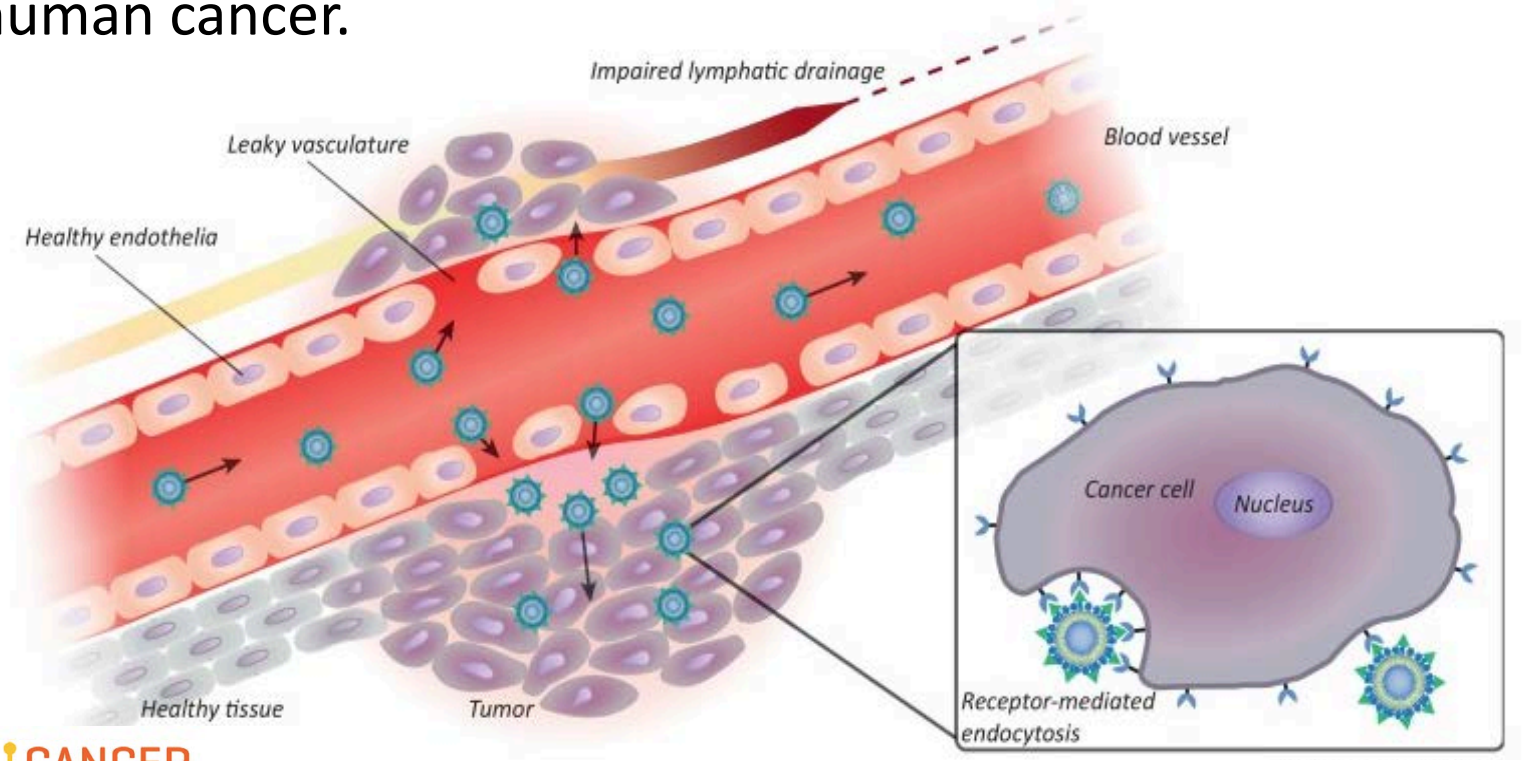
MARBLE CENTER FOR CANCER NANOMEDICINE

Wilhelm et al. *Nature Materials* (2016)

Finding #2: Additional clarity is needed on transport pathway of NPs

- Unclear how much of a role *enhanced permeability and retention* **(EPR)** plays in human cancer.

- Usefulness of certain animal models in making clinically relevant observations



MARBLE CENTER FOR CANCER NANOMEDICINE

Noble et al. *Trends in biotechnology* (2014)

Discussion Questions

- **Show of hands:** How many of you believe that the findings of this paper directly impact your research?

Discussion Questions

- Does the ‘nanoparticle in tumor’ parameter serve as a good surrogate for therapeutic index?

Discussion Questions

- Would the clinical success of NPs be any different if we could have achieved a tumor accumulation of say 7% vs. the estimated 0.7%?

Discussion Questions

- Is this low number the reason why tumor-targeted nanomedicines have not broadly entered the clinic?

Summary / Take-home

- Need additional evidence for NP transport mechanism to/in solid tumors, and avoid over-reliance on EPR. (How will the NP get past each biological barrier?)

- Consider the transport conditions imposed by different animal models and how to design your studies to most faithfully model the human condition.

- Think beyond targeting (and beyond numbers!), and focus on carrier-dependent drugs, combination therapies, protocols.