

Nanotechnology in pain medicine: What is new?

Dear Editor,

In nanomedicine, nanoparticles are used for drug delivery at a target cell or organ. Nanocrystals, nanotubes, polymeric structures such as dendrimers, liposomes and solid lipid nanoparticles are used in practice. Nanotechnology has been successfully used in cardiology, degenerative diseases, diagnostics and cancer. The nanoparticles used earlier had issues like biocompatibility and dosing related problems leading to unwanted toxicity. The other issues with previous generation nanoparticles were carcinogenesis, hypersensitivity, oxidative stress due to liberation of reactive oxygen species, genotoxicity and immunogenicity. With the use of biomaterials, green materials, earth abundant materials and natural polymers not only the cost of nanoparticles has reduced significantly, the toxicity issues has also been addressed. Nanoparticles can access areas of body where earlier medications could not get concentrated.

Currently nanotechnology has found many indications for managing acute and chronic pain conditions. Nanotechnology has facilitated enhanced delivery of medications like analgesics, anti-inflammatory agents and local anaesthetics with optimal effect and lesser adverse events. Certain advantages of nanotechnology enhanced medications are that it facilitates targeted delivery system, better efficacy, lesser adverse effects, improvement in patient compliance and cost-benefit when used for long term use.

Liposomal bupivacaine is an extended-release local anaesthetic preparation which is prepared by embedding bupivacaine within liposome nanoparticles. Marketed as Exparel (Pacira Pharmaceuticals, Inc., Parsippany, NJ), liposomal bupivacaine is presented as vesicles of bupivacaine loaded in the aqueous chambers using DepoFoam® technology (Pacira Pharmaceuticals Inc, San Diego, CA). The safety of Exparel has been validated after its successful use in epidurals, abdominal wall blocks, peripheral nerve blocks and surgical incision sites.^[1]

Nanotechnology facilitated the development of first medication approved specifically for the treatment of breakthrough pain. Oral transmucosal fentanyl citrate (OTFC), marketed as Actiq® (Cephalon, UK)

has fentanyl as an active ingredient. The preparation is a unique oral transmucosal delivery system which utilizes microfabrication technology in order to release fentanyl for managing breakthrough pain in cancer patients.^[2] OTFC is currently available in 4 strengths: 200, 400, 800 and 1600 µg.

Low dose diclofenac loaded on submicron particle capsules has been successfully used for managing moderate pain experienced after elective surgeries.^[3] Due to the unique structure, low dose of nano-enhanced diclofenac, the side effects were significantly less but will better pain scores in the postoperative period. Ibuprofen and naproxen were also used embedded in nanofibres and instilled at surgical wound site.^[4]

Lalani *et al.* performed research on tramadol hydrochloride which were loaded with poly-lactic-co-glycolic acid nanoparticles and glycoproteins like transferrin and lactoferrin. The medication was tested on adult Wistar rats weighing 200-250 g. Authors found improved antinociceptive effects with this enhancement. It is not yet approved for use in humans.^[5]

Several medications for neuropathic pain like zoledronic acid, lamotrigine, nefopam have been modified using nanotechnology by researchers for optimal therapeutic effect. By making conformational changes using nanotechnology like liposomal encapsulation, surface engineered nanoparticles using ligands and nanospheres efficacy of these medications was improved.

To conclude, nanotechnology appears pathbreaking and is expected to benefit patients once it is approved for clinical use.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

Abhijit Nair, Poornachand Anne,

Kodisharapu P. Kumar, Srinivasa S. P. Mantha

Department of Anaesthesia, Basavatarakam Indo-American Cancer Hospital and Research Institute, Hyderabad, Telangana, India

Address for correspondence: Dr. Abhijit Nair,
Department of Anaesthesia, Ibra Hospital, Ibra-414,
Sultanate of Oman, Oman.
E-mail: abhijitnair95@gmail.com

References

1. Vyas KS, Rajendran S, Morrison SD, Shakir A, Mardini S, Lemaine V, *et al.* Systematic review of liposomal bupivacaine (Exparel) for postoperative analgesia. *Plast Reconstr Surg* 2016;138:748e-56e.
2. Mystakidou K, Katsouda E, Parpa E, Tsiatas ML, Vlahos L. Oral transmucosal fentanyl citrate for the treatment of breakthrough pain in cancer patients: An overview of its pharmacological and clinical characteristics. *Am J Hosp Palliat Care* 2005;22:228-32.
3. Gibofsky A, Silberstein S, Argoff C, Daniels S, Jensen S, Young CL. Lower-dose diclofenac submicron particle capsules provide early and sustained acute patient pain relief in a phase 3 study. *Postgrad Med* 2013;125:130-8.
4. Moradkhani MR, Karimi A, Negahdari B. Nanotechnology application for pain therapy. *Artif Cells Nanomed Biotechnol* 2018;46:368-73.
5. Lalani J, Rathi M, Lalan M, Misra A. Protein functionalized tramadol-loaded PLGA nanoparticles: Preparation, optimization, stability and pharmacodynamic studies. *Drug Dev Ind Pharm* 2013;39:854-64.

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

Access this article online	
Quick Response Code:	Website: https://journals.lww.com/joacp
	DOI: 10.4103/joacp.JOACP_158_20

How to cite this article: Nair A, Anne P, Kumar KP, Mantha SS. Nanotechnology in pain medicine: What is new? *J Anaesthesiol Clin Pharmacol* 2022;38:326-7.

Submitted: 06-Apr-2020 **Revised:** 01-Nov-2020 **Accepted:** 02-Nov-2020
Published: 15-Jun-2022

©2022 Journal of Anaesthesiology Clinical Pharmacology | Published by Wolters Kluwer - Medknow