Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR)

Request for a scientific opinion on

Nanosilver: safety, health and environmental effects and role in antimicrobial resistance

1. Background

Silver (Ag) nanomaterials ("nanosilver") are widely used today for their antibacterial activity. In medical care nanosilver has been used, for example, as an antibacterial agent in wound dressings (Wijnhoven et al. 2009) such as bandages to protect patients with severe burning against infections. It has also been used in catheters to prevent the formation of infectious biofilms (Rai et al. 2009, Silver 2006). It can be expected that, with prices of medical applications of nanosilver decreasing, their use will increase. Nanosilver has also been used in consumer products such as sports textiles, other textiles, washing powder and deodorants, where nanosilver should reduce undesired odours.

Recent review papers suggest that nanosilver may not be hazardous to humans and may result in low internal exposure (Nowack et al 2011, Ahamed et al 2010, Johnston et al 2009, Christensen et al 2010). However, data are insufficient to carry out a full risk assessment (Wijnhoven et al. 2009).

In addition, indirect adverse effects on human health may occur via an increasing resistance of micro-organisms against silver, including nanosilver and silver based compounds. This may limit the usefulness of nanosilver in medical devices and other medical applications (Landsdown et al 2007, McDonnell 1999, Khan et al 2011). Furthermore silver can be present in different forms (metallic – nanosized or not – and salts), and it is not clear how these different forms of silver influence its antimicrobial properties, a possible increase of antimicrobial resistance (AMR) and the healing process of e.g. burn wounds (Gravante et al 2009). Recent reviews and publications proposed to use a combination of nanosilver with usual antibiotics for the treatment of specific infectious diseases caused by resistant bacteria (Abeylath SC 2008, Pissuwan D 2010, Bolla JM 2011).

2. Terms of reference

The SCENIHR is asked to assess whether the use of nanosilver, in particular in medical care and in consumer products could result in additional risks compared to more traditional uses of silver. Furthermore, the SCENIHR is asked to assess whether the use of nanosilver to control bacterial growth could result in resistance of micro-organisms.

Specifically, the SCENIHR is asked to address the following questions:

1. What may be the implications of the widespread use of nanosilver for human health and the environment? Please consider direct as well as indirect effects occurring via the distribution into the environment (e.g. from use in appliances, discarding dental material, washing out from textiles, etc.). Does this change the existing assessments for silver in general?

2. Could the widespread use of nanosilver, in particular in medical care and in consumer products, increase the risk of selecting Ag resistant micro-organisms? Could the widespread use of nanosilver create cross-resistance in micro-organisms?

3. To what extent may the widespread use of nanosilver and the possible increase of resistant micro-organisms reduce the nanosilver's efficacy?

4. Are there any other safety, health and environmental effects of nanosilver?

In the assessment, the SCENIHR is asked to consider the following:

- Please consider the entire life-cycle of products containing nanosilver (manufacture, use, waste, etc).

- To this end, the SCENIHR shall document the mechanisms by which micro-organisms could develop resistance to silver, and detail the circumstances that favour resistance.

- While the focus of the mandate should be on nanosilver, please consider and distinguish as appropriate between the different forms of silver (e.g. salts – metallic – ion, wires, nanosized or not, etc) and identify the forms which exert the effects described in the questions above.

3. Deadline

Early 2013

4. Supporting documents

Abeylath S.C., Turos E., Drug delivery approaches to overcome bacterial resistance to beta-lactam antibiotics, Expert Opin. Drug Deliv., 2008 Sep, 5(9), 931-949.

Ahamed, M., Alsalhi, M.S., Siddiqui, M.K., Silver nanoparticle applications and human health, Clin. Chim. Acta, 2010, 411(23-24), 1841-1848.

Bolla J.M., Alibert-Franco S., Handzlik J., Chevalier J., Mahamoud A., Boyer G., Kieć-Kononowicz K., Pagès J.-M., Strategies for bypassing the membrane barrier in multidrug resistant Gram-negative bacteria, FEBS Lett., 2011 Jun 6, 585(11), 1682-1690.

Christensen, F.M., Johnston, H.J., Stone, V., Aitken, R.J., Hankin, S., Peters, S., Aschberger, K., Nano-silver - feasibility and challenges for human health risk assessment based on open literature, Nanotoxicology, 2010, 4(3), 284-295.

Gravante, G., Caruso, R., Sorge, R., Nicoli, F., Gentile, P., Cervelli, V., Nanocrystalline silver: a systematic review of randomized trials conducted on burned patients and an evidence-based assessment of potential advantages over older silver formulations, Ann. Plast. Surg., 2009, 63(2), 201-205.

Johnston, H. J., Hutchison, G., Christensen, F.M., Peters, S., Hankin, S., Stone, V., A review of the in vivo and in vitro toxicity of silver and gold particulates: particle attributes and biological mechanisms responsible for the observed toxicity, Crit. Rev. Toxicol., 2010, 40(4), 328-346.

Khan, S., Mukherjee, A., Chandrasekaran, N., Silver nanoparticles tolerant bacteria from sewage environment, J. Environ. Sci. (China), 2011, 23(2), 346-352.

Landsdown A., Williams, A., Bacterial resistance to silver in wound care and medical devices, J. Wound Care, 2007, 16(1), 15–19.

McDonnell, G. et al, Antiseptics and Disinfectants: Activity, Action, and Resistance, Clinical microbiology rev., 1999, 12, 147–179.

Nowack, B., Krug, H.F., Height, M., 120 Years of Nanosilver History: Implications for Policy Makers, Environmental Science & Technology, 2011, 45(4), 1177-1183.

Pissuwan D., Cortie C.H., Valenzuela S.M., Cortie M.B., Functionalised gold nanoparticles for controlling pathogenic bacteria, Trends Biotechnol., 2010 Apr., 28(4), 207-213.

Rai et al, Silver nanoparticles as a new generation of antimicrobials, Biotech. Adv., 2009, 27, 76-83.

Silver S. et al, Silver as biocides in burn and wound dressings and bacterial resistance to silver compounds, J. Ind. Microbiol. Biotechnol., 2006, 33, 627–634.

Wijnhoven S.W.P., Peijnenburg W.J.G.M., Herberts CA., Hagens W.I., Oomen A.G., Heugens E.H.W., Roszek B., Bisschops J., Gösens I., Van de Meent D,. Dekkers S., De Jong W.H., Van Zijverden M., Sips A.J.A.M., and Geertsma R.E., Nano-silver - A review

of available data and knowledge gaps in human and environmental risk assessment, Nanotoxicology, 2009, 3(2), 109-138.