

Commentary

A New Grand Challenge for Nanotechnology: The Mom Project; Public Comments for NNI

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Abstract

Nanotechnology is increasingly moving from laboratories into commerce and has become “ubiquitous” in the global economy, according to the White House Office of Science and Technology Policy (OSTP) created by the US Congress to Advise the President of the United States about major issues in science. Bringing together the different strands of research for these agencies, OSTP created a new initiative in 2015 called the Grand Challenge, designed to confront an important problem nationally and globally and whose conquest will represent responsible and sustainable use of nanotechnology and also that captures the imagination of the general public in order to inspire next generation researchers under the auspices of the National Nanotechnology Initiative, (NNI). In 2015, OSTP announced the first Nanotechnology-Inspired Grand Challenge which would “create a new type of computer that can proactively interpret and learn from data, solve unfamiliar problems using what it has learned, and operate with the energy efficiency of the human brain”. Under the auspices of OSTP, NNI coordinates 20 USA federal agencies to foster nanotechnology research and lab to market commercialization. These federal programs have invested more than \$23 billion in support for characterization, modeling, and fabrication; and responsible transfer of nanotechnology-based products to public use. Therefore, when OSTP 2016 triennial strategy for NNI requested public comment by stakeholders, the Work Health and Survival Project (WHS) proposed a new Grand Challenge: “eliminating or reducing health disparities based on gender or sex, and especially those facets of the disparities that impact infant mortality and maternal mortality”. WHS commented that the 4 key Goals offered by OSTP within the NNI Mission fit exactly with the crying need for pulling together interdisciplinary nanotechnology and nanomedicines to eliminate gender based health disparities and reduce maternal mortality and infant mortality worldwide and locally, as already addressed by the European Union and the United Nations in UNICEF and UNAIDS. This article describes the OSTP Grand Challenge criteria and offers a case study of UNAIDS. This article concludes that reducing maternal mortality and infant mortality that has plagued humanity globally for millennia is consistent with all 4 Goals set forth for NNI Grand Challenge.

Keywords: National Nanotechnology Initiative; Maternal Mortality; Infant Mortality; President of the United States; Women’s Health; Health Disparities; Responsible and Sustainable Nanotechnology; UNAIDS

Ubiquitous Nano

Nanotechnology is increasingly moving from laboratories into

commerce and has become “ubiquitous” in the global economy, according to the White House Office of Science and Technology Policy (OSTP) created by the US Congress to Advise the President of the United States about major issues in science [1]. The Director of OSTP also serves as Assistant to the President for Science and Technology and manages the NSTC [2]. The Nanoscale Science, Engineering, and Technology (NSET) Subcommittee is the interagency body responsible for coordinating, planning, implementing, and reviewing the National Nanotechnology Initiative (NNI), a subcommittee of the Committee on Technology of the National Science and Technology Council. The National Nanotechnology Coordination Office (NNCO) provides technical and administrative support to the NSET Subcommittee and its working groups in the preparation of multi-agency planning, budget, and assessment documents related to the NNI.

NNI was established in 2001 under the auspices of OSTP, as a collaborative network for 20 agencies of the federal US government, spanning health [3] homeland security, space exploration, food and drug regulation, environmental protection, household and consumer goods, the Department of Commerce, the Department of Justice and branches of the government associated with military defence [4]. According to the 2016 Draft Strategy, these collaborations represent an investment of 23 billion dollars in nanotechnology research and lab to market efforts in commerce [5]. The official Draft for the OSTP 2016 triennial strategy for NNI requested public comment by stakeholders. In response, the Work Health and Survival Project (WHS), a stakeholder think tank proposed a new Grand Challenge: eliminating or reducing health disparities based on gender or sex, and especially those facets of the disparities that impact infant mortality and maternal mortality. WHS review of the draft strategy and its stakeholder comments concluded that the 4 key Goals offered by OSTP and the NNI Mission fit exactly with the crying need for pulling together interdisciplinary technology to apply nanotechnology

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and nanomedicines to meet a Grand Challenge that remains an important problem nationally and globally and whose co inquest will represent responsible and sustainable use of nanotechnology and that captures the imagination of the general public. Therefore, WHS proposed Grand Challenge to reduce maternal mortality and infant mortality that has plagued humanity for millennia.

The Mission of Governmental Development of Nanotechnology

OSTP of the Executive Office of the President of the United States was established by the National Science and Technology Policy, Organization, and Priorities Act of 1976. OSTP's responsibilities include advising the United States President in policy formulation and budget development on questions in which science and technology are important elements; articulating the President's science and technology policy and programs; and fostering strong partnerships among Federal, State, and local governments, and the scientific communities in industry and academia. NNI is credited with having tagged nanotechnology as a "revolution" [6] for industry and commerce, as articulated in the first NNI report in 2000 [7].

This notion that nanotechnology is a "revolution" has successfully echoed decades later in nanomedical literature ranging from clinical nanomedicine [8], to the popular press. "Technology is the fourth industrial revolution" embracing nanotechnology declared the delegates at the World Economic Forum in Davos, 2016 [9]. Echoing both the government voice and that of scientific research academia, Klaus Schwab, Founder and Executive Chairman of the WEF stated, "We feel we are not prepared sufficiently for this fourth industrial revolution which will come over us like a tsunami which will change whole systems", Under the 21st Century Nanotechnology Research and Development Act of 2003 [10], NNI agencies are required to develop an updated NNI Strategic Plan every three years. OSTP describes the NNI mission as "The vision of the NNI is a future in which the ability to understand and control matter at the nanoscale leads to a revolution in technology and industry that benefits society" [11].

Consistent with this mission, the draft for the 2016 update of the NNI Strategic Plan addresses how the NNI agencies will collaborate with each other and the broader nanotechnology community to expand the system while supporting discovery and innovation that will transfer of nanotechnology from lab to market. It is therefore not surprising that through the efforts of the NNI, nanotechnology has evolved from an area of fundamental research focused on understanding materials at the nanoscale towards commercialization, even if historically there has been little attention to outreach to the general public, integration of data across disciplines in order to understand nanotechnology across the life cycle of nanomaterials and nano-enabled products, and unaddressed issues of environmental safety and health.. As a result of NNI affiliated federal investments, nanotechnology has become ubiquitous in our daily lives and can be found in a wide variety of commercial products including healthcare products, cosmetics [12], consumer electronics, apparel, and automobiles. Sixteen

years after the advent of the NNI, basic research is building on the foundation of knowledge that has been developed in areas such as precision medicine and precision materials. Recognizing this evolution, the focus of the NNI has broadened in the 2016 Draft Strategy to embrace the evolving importance of previously unmet needs and therefore has initiated the Grand Challenge program to underscore the value of nanotechnology research and nano-enabled products to the general public and civil society.

Nanotechnology-Inspired Grand Challenges

In 2015, the White House OSTP announced the first Nanotechnology-Inspired Grand Challenge "to create a new type of computer that can proactively interpret and learn from data, solve unfamiliar problems using what it has learned, and operate with the energy efficiency of the human brain" [13].

The mandate for an Executive level Grand Challenge from the White House to the nanotechnology community promoted through the NNI must have "ambitious but achievable goals that harness nanoscience, nanotechnology, and innovation to solve important national or global problems and have the potential to capture the public's imagination". According to the draft strategy," NNI agencies will continue to explore grand challenges and other mechanisms to promote public-private collaborations that accelerate nanotechnology discovery, development, and deployment. Grand Challenges must inspire the private sector to enhance existing efforts to create new materials and use them in commerce." [14].

According to WHS stakeholder comments, eliminating or reducing health disparities based on gender or sex, and especially saving the lives of newborns and their moms, is exactly the Grand Challenge to solve an important global problem that will capture the public's imagination and inspire new researchers [15]. The rationale for the WHS proposal is clear. OSEP stated in the 2016 draft strategy that Grand Challenge programs should "leverage complementary activities in existing Federal initiatives in healthcare, information technology and advanced materials and manufacturing to extend the reach and broaden the impact of the NNI. ... engaging the general public and inspiring the next generation of scientists and engineers" [16]

- Goal 1: Advance a world-class nanotechnology research and development program.
- Goal 2: Foster the transfer of new technologies into products for commercial and public benefit.
- Goal 3: Develop and sustain educational resources, a skilled workforce, and a dynamic infrastructure and toolset to advance nanotechnology.
- Goal 4: Support responsible development of nanotechnology.

The vehicle to synthesize these goals into one coherent strategy is the "Grand Challenge" Program. The Grand Challenge program and the 4 goals for operationalizing the NNI Mission clearly strive to reach beyond investing in research in nanomaterials and nanotechnology-enabled devices to include activities in daily life that deploy nanotechnologies for the public benefit following these

criteria:

1.5. Utilize Nanotechnology-Inspired Grand Challenges to engage the broader community to solve problems of national and global importance.

1.5.1. Identify topics for potential grand challenges by engaging the broader community

3. Conduct biennial assessments of the progress and impact of each grand challenge and report the results.

A Grand Challenge to defeat disparities in health and reduce dramatically infant mortality and maternal illness or death during pregnancy and childbirth as proposed by WHS [17] takes into account and cuts across every one of these 4 Goals for NNI.

Nanotechnology-Enabled Tools Can Meet the Grand Challenge of Reducing Maternal Mortality, Infant Mortality and Health Disparities between Men and Women

According to the OSTP Report strategy 2016 draft for public comment: "A unique, established strength of the nanotechnology enterpriseliesinitsinterdisciplinarynature.Abroadnanotechnology R&D portfolio invests at the frontiers and intersections of many fields including biology, chemistry, computer science, ecology, engineering, geology, materials science, medicine, physics, and the social sciences. Recently, NNI agencies have been exploring efforts focused on research at the convergence of nanotechnology, biotechnology, information technology, and cognitive sciences that leverage knowledge and approaches in each of these areas to solve problems of national and societal importance" [18].

According to WHS, nanotechnology applications to nanomedicine and nano-enabled devices; sensors, new foods for better nutrition, a cleaner environment, [19] construction for sturdy housing and clothing that is almost immune from insects and rodents is no exception to this fine use of public funds for the greater public good [20]. Previously, WHS provided to IDA a presentation about nanotechnology applications that impact women's health, with a view to offering information that will be useful for OSTP. The 2013 lecture "Beauty Babies and Dieting: The Impact of Nanotechnology on Women's Health Disparities". in 2013 presented the potential policy ramifications of WHO findings about women's health disparities throughout the life cycle. as WHO had reported in 2009 [21]. The lecture noted that WHO had underscored the importance of health disparities between men and women at every stage of the life cycle in their major report in 2009. According to WHO, the difference in male versus female health outcomes using their indicators favored men as having better outcomes in every step of the life cycle [22]. The keystone WHO report, « Women and Health: Today's Evidence, Tomorrow's Agenda » WHO, Geneva Switzerland 2009 documented health disparities between men and women, and found that women's health lags behind their male cohorts at five key stages of the life cycle: 1. birth to 5 years, 2. adolescence (including implications of adolescent pregnancy) 3. Reproductive years 4. Post-reproductive years (menopause and greater risk for cancer among sex-based target organs) and 5. Advanced ageing (65-80 years). In an effort to understand the

system approaches that might reduce these disparities, WHO also examined the rôle of Constitutional law and local legislation ensuring the rights of women and children in light of their health outcomes, and subsequently formed the template for national laws in many nations, such as Nepal, Brazil, Malawi and Italy, discussed by WHO report Women and Children's Health: Evidence of Impact of Human Rights [23].

Progress despite recognition of this local and global problem has been slow. According to UNAIDS, 528,00 cases of cervical cancer appeared among women of reproductive age in 2012, and 268,000 died of the disease [24]. And, like sand along the riverbanks, nanomaterial exposure has been accruing in human bodies that use cosmetics daily. Whether for pleasure or as a requirement of their job [25], makeup is vital to women more often than men and throughout their lifetime. This strong but subtle exposure impacts women disproportionately compared to men, regardless of their age, ethnicity, demographics or their profession. Many personal care products are currently on the market and but remarkably little is known about chemical makeup and exposure hazards [26]. The lecture applied the WHO's respected findings as the point of reference to explore in detail policy implications of these findings within the context of nanomedicine and broader social applications of nanotechnology. Therefore, the lecture referred specifically to the three parameters that are unexplored regarding the root causes of health disparities between men' health status and women's health :

Beauty

Beauty refers to the disproportionate exposure among women compared to men for cosmetics and personal care products (PCPs) that have direct exposure to nano-enabled products, The potential for synergy between these products and other exposures to applications of nanotechnology in nanomedicine and commercial products remains unexplored. Therefore an implicit difference exists between men and women regarding direct nanoparticle exposure and therefore a possible impact regarding cumulative use that cannot be captured for retrospective study but that may confound our understanding of health outcomes: Eventually, it may become impossible to capture the data to guesstimate the actual exposures, unless some effort is made to use naninformatics to collect and analyse such exposure data..

Babies

Babies have the same female-dominated connotation, but this concern embraces the under discussed field of reproductive health at work, and the UN targets for reducing maternal mortality and infant mortality.

Dieting

Dieting is a reference to the European concern not to repeat their regulatory history regarding GMOs even though nanotechnology is a major concern for packaging, storing and transporting foods and for crops involving new uses of nanosensors for biosensors.

Implicit Impact on Newborn Health and Infant Mortality

An added value of the reasoning that supports this Grand Challenge

opens the door to exploring the transfer of nanoparticles along the trans placental superhighway, both as medicines in foetal therapies and from unintended or ambient exposures that may cross the placenta. As WHO has continued to note, the impact of women's health disparities is an obstacle for achieving health for all and a strong source of global disease burden [27]. Therefore, from the perspective of "Beauty Babies and Dieting: The Impact of Nanotechnology on Women's Health Disparities", there is a wonderful opportunity to apply nanotechnology in order to improve the quality of life and longevity of women compared to their male peers. Birth and pregnancy offer a natural place to start.

The European Union « Birth Day » Project to Reduce Mortality During Pregnancy and Childbirth

Unfortunately, nearly a decade after the path breaking WHO report, most of its observations remain true. According to the European Union website that calls for a new Horizon 2020 project called Birth Day, around the world, hundreds of thousands of women and babies die on the day of birth, and millions more are left with serious illness. Thanks to global efforts, since 1990 maternal deaths have dropped worldwide by 44%. Yet, deaths and serious health effects for both mothers and their new babies are still surprisingly high, especially given the amazing developments in nanomedicine and nano-enabled technologies. Quoting WHO estimates that 303 000 women died in 2015 from preventable causes related to pregnancy and childbirth European Union Research and Innovation program horizon 2020 has taken the lead to tackle the global problem of maternal mortality and infant mortality. Horizon 2020 cuts a path from UNICEF, 5.9 million children per year die before their 5th birthday, of which 2.65 million are newborn babies. It is widely agreed that many maternal deaths are due to preventable or treatable conditions (WHO factsheet as cited on EU Birth Day webpage). In response to this data, the EU "Together for the Next Generation: Research and Innovation for Maternal & Newborn Health" [28], Eva- Carin Banka Johnson, Innovation Project Manager, Future Homes, IKEA of Sweden addressed the global importance of this topic. Ms. Banka Johnson focused on the theme "think global – act global" [29]. In the context of explorative research, she highlighted the importance of taking the emotions people feel when confronted with a new design of a product or service into account, and how this may influence whether or not the uptake is successful.

Case Study: Practical Implications for UNAIDS as an Example of How Grand Challenge the Mom Project Can Bring Nano-Enabled Products to Health Systems

Nanotechnology has been applied since 2008 to promote microbicides in vaginal creams and other topical applications for HIV prevention in treatments and in condoms, according to experts in nano-enabled therapeutics in humans [30]. But, surprisingly many people are unaware of the decade long role that nanotechnology applications and nano-enabled medicines have played in the control of AIDS. Even the staff of UNAIDS, the international organization agency responsible for coordinating the global attack on the perennial HIV/AIDS problem were unable to cite a specific nanotechnology application to prevent or control

HIV/AIDS during informal conversations in October 2016. Yet, 8 out of 10 pregnant women living with HIV received antiretroviral medicines to prevent mother to child transmission of HIV. Yet there were 170,000 new infections among children in 2014, [31]. Additionally, the UNAIDS [32] document entitled, "We can prevent mothers from dying and babies from becoming infected with HIV" offers an outcome framework that explains "Why is this a Priority Area", and then sets for the blueprint of "What Needs to be Done?" with a call for "bold results". The framework mandates "integration and linkages" with treatment services, communities and scaled-up coverage within health systems. Therefore, UNAIDS provides an excellent example of how acceptance by NNI of the proposal for a Grand Challenge: The MOM Project could foster further innovation.

Social Implications of the Grand Challenge Proposed in the MOM Project

Nanomedicines revolution requires society to rethink ancient notions that are the building blocks of social constructs regarding the nature of disease and its treatment, and the prejudices encountered by people who suffer from illness, as it forces collective rethinking about early diagnosis and prophylaxis of diseases. Civil society eagerly anticipates improvements in health outcomes in the wake of nanotechnology applications and novel nanomedicines, but will this really happen? Do we have the social antecedents to produce improved health outcomes for women, or will we simply replicate deeply rooted problems, by thoughtlessly implementing policies that have not ferreted out embedded sexism?

The sheer economic importance of nanotechnology [33] will change several antiquated systems regarding industrial processes, scientific understanding and categorization of chemical informatics, and ultimately, the health care delivery systems that must use or correct the end products of these changes anyway. Recognizing that nanotechnology is already here in hundreds of consumer products: tennis balls, cars, refrigerators, cameras, cosmetics, the Committee noted that consumer products applying nanotechnology rising to 3 trillion US dollars in 2015 [34]. The question how to moderate potential health outcome differences based on cumulative doses is a trans disciplinary conundrum that can bring together nanotechnology and public health systems, while nonetheless supporting important economic development. Therefore, an unprecedented opportunity exists to benefit from both the nanotechnology revolution and the revolutionary social change that recognizes individual human potential under international laws preventing discrimination against people with disabilities at the same time [35].

Conclusion: The World Needs a Nanotechnology-Inspired Grand Challenge to Eliminate or Reduce Health Disparities Based on Gender or Sex and Reduce Maternal Mortality and Infant Mortality

Will empirically documented, gender-based health disparities between men and women be reproduced, OR improved, following the widespread use of nanotechnology?"

Saving lives of babies and their moms is an excellent vehicle for

engaging the general public who uses nanomedicines and nano-enabled products in daily life and a lofty goal that can attract students to the field in order to promote sustainability for both the society. As noted by WHS in its proposal for the Mom Project Grand Challenge, "Since nanotechnology is a revolution by every measure, we possess a once in a millennium opportunity to uproot embedded errors in our methods of creating and administering health care that concretizes or exacerbates health disparities. Or, We can use the new technology to eliminate or reduce those disparities and provide gender equity in health outcomes at last" [36]. It remains unknown but an intriguing legislative policy question, to what extent nanotechnology applications and the widespread use of nano-enabled medicines will either exacerbate or remove documented health disparities between men and women or across race and ethnicities.. Women's health disparities will become more difficult to grasp after nanotechnology takes hold because the extent of nanoparticle exposure in cosmetics, food, daily exposure to consumer products (such as automobile tires, paintings and coatings and refrigerators used in food transport). This potential cumulative effect will be more complex than any synergistic effect that epidemiology has attempted to measure before.

These concerns are exacerbated because the root causes of health disparities reflect larger social and cultural differences that have limited women's abilities in the past. Consequently many facets of women's unique needs have been long ignored in the health research context, especially when science relies on male models as a benchmark, and in reproductive health where the literature is fraught with emotional and politically charged ambivalence in every nation. Yet, every nation also has laws prohibiting discrimination against women and many have signed international treaties underscoring the mechanisms to address such inequality. Maternal mortality and infant mortality are not merely long standing challenges to public health, but they impact everyone in civil society, not merely the patients who survive weakly or the victims of poor delivery of care. Thus, it behooves NNI and civil society researchers, scientists, observers of the human condition in social sciences and lawyers, regulators and jurists charged with the obligation to protect the public health and in turn posterity to apply this once in a lifetime revolutionary leap in technology in order to create a unique opportunity to uproot embedded sexism and disparities in health outcomes and provide gender equity at every phase of the life cycle.

In conclusion, the Grand Challenge proposed by WHS is truly grand. Since, "NNI agencies have been exploring efforts focused on research at the convergence of nanotechnology, biotechnology, information technology, and cognitive sciences that leverage knowledge and approaches in each of these areas to solve problems of national and societal importance." (NNI 2016 Strategy, Draft for Public Comment p7) it is difficult to posit a global problem that is more apt to fitting these criteria. Infant mortality and maternal death or illness during pregnancy and childbirth have baffled humanity since life began, and probably touches a core value for

each religion or political faction that values the right to life. Civil society has been studying this challenge for centuries. Therefore we already have many of the outcome metrics and tools to measure and explore this problem. WHS believes that « We can do better. »

Because "the National Science and Technology Council (NSTC) is the principal means by which the Executive Branch coordinates science and technology policy by establishing clear national goals for Federal science and technology investments. " And " prepares research and development strategies that are coordinated across Federal agencies to form investment packages aimed at accomplishing multiple national goals." no one is better positioned to offer this Grand Challenge and then to implement a strategy that will address it [37].

Unlike any other Grand Challenge, eliminating or reducing health disparities based on gender or sex, with a particular interest in reducing maternal mortality and infant mortality is global, is an indisputably trans disciplinary, challenge that can capture the attention of the public who must understand the benefits of our new nanotechnologies in order to continue to support its research and development. NNI acceptance of Grand Challenge The Mom Project can address all four major goals and has the added value that it will "capture the public's imagination" more effectively than even the Nano-hero cartoon series that NNI agencies funded, designed by Spiderman creator, Stan Lee. Eliminating or reducing women's health disparities impacting infant mortality and maternal mortality during pregnancy is a truly Grand Challenge; one that will bring together a variety of disciplines to confront a long-standing global and national problem; and one that will reap benefits on behalf of billions of stakeholders, some perhaps unborn, using lab-to-market strategies to address this unmet crying need. Therefore, it is difficult to posit a global problem that is more apt to meeting the OSTP goals for NNI as operationalized in the Grand Challenge.

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References

1. Abbott L, Maynard A (2010) Exposure Assessment Approaches for Engineered Nanomaterials 30(11): 1634–1644.
 2. Artacoz L, Borrell C, Cortes I, Escriba Aguir V, Cascant L (2007) Occupational epidemiology and work related inequalities in health: a gender perspective for two complementary approaches to work and health research. *Journal of Epidemiology and Community Health* 31(2): ii39–ii45.
 3. Arunachalam KD, Annamalai SK, Hari S (2013) One-step green synthesis and characterization of leaf extract-mediated biocompatible silver and gold nanoparticles from *Memecylon umbellatum*. *International Journal of Nanomedicine* 8(1): 1307–1315.
 4. Bawa R (2008) “Nanoparticle Based Therapeutics in Humans” *Nanotechnology Law and Business* 5(2): 155
 5. Flavia Bustreo, Paul Hunt (2013) *Women’s and Children’s Health: Evidence of Impact of Human Rights* WHO Press Geneva Switzerland.
 6. Centers for Disease Control and Prevention (CDC) (2015)- NIOSH Publications and Products - Approaches to Safe Nanotechnology: Managing the Health and Safety Concerns Associated with Engineered Nanomaterials (2009-125).
 7. Centers for Disease Control and Prevention (CDC) (2010) *Reproductive Health and the Workplace*. Retrieved from National Institute for Occupational Safety and Health.
 8. Committee on the Environment, Agriculture and Local and Regional Affairs Commission de l’environnement, de l’agriculture et des questions territoriales” *Nanotechnology: Balancing Benefits and Risks to Public Health*” A Preliminary Survey for the Council of Europe Revised Draft Report Rapporteur: Mme Ilise Feitshans May 29 2012, final approval April 23, 2013.
 9. Dubey S, Lahtinen M, Sillanpaa M (2010) Green synthesis and characterizations of silver and gold nanoparticles using leaf extract of *Rosa rugosa*. *Colloids and Surfaces A: Physicochemical and Engineering Aspects* 364(1–3): 34–41.
 10. Eckelman MJ, Zimmerman JB, Anastas, PT (2008) *Toward Green Nano*. *Journal of Industrial Ecology* 12(3): 316–328.
- European Union “Birth Day Project” press release.
11. European Union Conference on Research and Innovation for Maternal & Newborn Health: Report Together for the Next Generation: Research and Innovation for Maternal & Newborn Health« European Union DG Research and Innovation December 2015.
 12. European Commission Labelling: competitiveness, consumer information and better regulation for the EU. 2006 Health & Consumer Protection Directorate-General.
 13. Executive Office of the President of the United States, Press release announcing the BRAIN Project Grand Challenge, 2015
 14. Executive Office of the President of the United States, Office of Science and Technology Policy, “National Nanotechnology Initiative Draft Strategy for Public Comment 2016”.
 15. Ilise Feitshans, Invited Presentation “Beauty, Babies And Dieting: The Impact Of Nanotechnology Law On Reproductive Health and Women’s Occupational Health Disparities” IDA background briefing for use by OSTP, Washington D C December 2013.
 16. Ilise L Feitshans, « Defining Nano » Presentation for the Council of Europe, Paris Sept 2011.
 17. Ilise Feitshans, *Law and Science of Nanotechnology: Perfect Together?* Available on DVD and on youtube <http://youtu.be/vEmorvYQJz8> « Lois et sciences des nanotechnologies: un ensemble parfait ? » Débat public sur des questions émergentes de notre époque Samedi 17 août Law and science of Nanotechnology: Perfect together ? A Public Discourse About the Emerging Issues of Our Times Musée d’histoire des sciences Parc La Perle du Lac Genève Suisse Nanotechnology: pour la protection des droits humains de la santé Nanotechnology : Science Protecting the Human Right to Health Avantages et risques de la Nanotechnologie: la position de l’Assemblée parlementaire du Conseil de l’Europe Benefits and Risks of Nanotechnology: The Parliamentary Assembly’s Position, Council of Europe, Tanja E.J. Kleinsorge, Cheffe du Secrétariat, Commission des questions sociales, de la santé et du développement durable, Assemblée parlementaire du Conseil de l’Europe, Strasbourg, France (Head of the Secretariat, Committee on Social Affairs, Health and Sustainable Development, Parliamentary Assembly of the Council of Europe), Sciences et société civile : est-ce que les gouvernements peuvent en faire plus ? The Role of Science in Our Society: Can’t Our Governments do MORE ? Mme Nicola Furey, Vice- President de Earth Focus Foundation, Moderator Dr. Nastassja Lewinski, Whitaker Fellow IST.
 18. Ilise Feitshans (2016) “Public Comment On The Draft Strategy 2016 For OSTP and NNI: A New Grand Challenge: The Mom Project Eliminating Or Reducing Womens Health Disparities Impacting Infant Mortality And Maternal Mortality During Pregnancy”, *The Work Health And Survival Project* Haddonfield NJ US.
 19. Flynn H (2014) *Nanotechnology Update: Corporations Up Their Spending as Revenues for Nano-enabled Products Increase* (State of the Market Report).
 20. Hankin S (n.d.) *Exposure assessment of nanomaterials*.
 21. John Howard, Guest Lecture at Safework, International Labour Organization Geneva Switzerland to ILO *Nanotechnology the Newest Slice of Global Economic Life* Nov 26 2008 at the invitation of the Coordinator ILO Encyclopaedia, of Occupational Health and Safety, Ilise feitshans . Archived by ILO.
 22. KA Jensen, Saber AT, Kristensen HV, Koponen IK, Liguori B, et al. (2013) *NanoSafer vs. 1.1 - Nanomaterial risk assessment* American College of Obstetricians and Gynecologists.
 23. Eva-Carin Banka Johnson, Innovation Project Manager, Future Homes, IKEA of Sweden Keynote Speech, European Union Conference on Research and Innovation for Maternal & Newborn Health “Together for the Next Generation: Research and Innovation for Maternal & Newborn Health” December 2015.
 24. Joint United Nations Program on HIV/AIDS (2015) *Progress Report on the Global Plan: Towards the elimination of new HIV infection Among Children and Keeping Their Mothers Alive* UNICEF, WHO and UNAIDS Geneva Switzerland .
 25. Varvara Karagkiozaki, Stergios Logothetidis (2015) Eds. “Horizons in Clinical Nanomedicine” Pan Stanford Publishing, Singapore
 26. Jane Onyanga Omara, USA Today Section B page 2 “Davos 2016 Examines 4th Industrial Revolution” January 18 2016
 27. George Loizou (2007) « Introduction to PBPK Modelling: A Tool for Biologically Based Chemical and Nanoparticle Risk Assessment, »citing NRC ed., *Toxicity Testing in the Twenty-First Century : A Vision and a Strategy* , National Resource Council Wash DC.
 28. UNAIDS *Country Ownership for a Sustainable AIDS response from principles to practice Discussion paper* July (2012).

29. UNAIDS, HPV, HIV and Cervical Cancer : Leveraging synergies to save women's lives UNAIDS Joint United Nations Programme on AIDS with WHO, UN Interagency Task Force on AIDS and The Global Coalition on Women and AIDS, Geneva Switzerland (2016).
30. United States Congress, 21st Century Nanotechnology Research and Development Act (15 U.S.C. §7501(c)(4), P.L: (108-153)
31. United States Environmental Protection Agency Office of Research and Development, Nanomaterial Research Strategy (EPA 620/K-09/011, U.S. Environmental Protection Agency, Washington, District of Columbia, 2009).
32. UNAIDS (2010) "We can prevent mothers from dying and babies from becoming infected with HIV" Joint United Nations Programme on HIV/AIDS (UNAIDS) Geneva Switzerland.
33. United States Food and Drug Administration (2013) Nanotechnology Regulatory Science Research Plan (U.S. Food and Drug Administration, Washington.
34. Work Health and Survival Project " Stakeholder Comments Regarding the National Nanotechnology Initiative 2016 Draft Strategy for Public Comment, Proposal For A New Grand Challenge : The Mom Project, Eliminating Or Reducing Women's Health Disparities Impacting Infant Mortality And Maternal Mortality During Pregnancy" September 23 2016, filed on the US Government portal for public comments, also available on Researchgate.org
35. World Health Organization (WHO) (2011) Building Health and Equitable Workplaces for Women and Men: A Resource for Employers and Worker Representatives. Geneva: WHO Press.
36. World Health Organization (WHO) Women and Health: Today's Evidence, Tomorrow's Agenda » World Health Organization, Geneva Switzerland 2009 ISBN: 9789241563857
37. World Health Organization (2010) "World Report on Disability" World Health Organization, Geneva Switzerland.