Increased prevalence of autism has paralleled the increased use of prenatal ultrasound. *Is this coincidence or connection?*

Autism was once a rare diagnosis. Today it is increasingly common, affecting 1 in 110 U.S. children, and 1 in 70 U.S. boys.

Prenatal ultrasound was once a rare medical practice, reserved for women with high-risk pregnancies. Today, prenatal ultrasound is routine for most pregnant women in developed countries. Often the first picture in the baby photo album is the grayish sonogram taken at 16 weeks.

Prenatal ultrasound is also performed outside the health care system by non-medical professionals. That first sonogram may come from a keepsake ultrasound boutique at a local shopping mall. These boutiques have mushroomed into a huge industry. In 2004 there were 250 boutique centers (4d-ultrasounds.com). By 2006, a single franchise operator, United Imaging Partners, had a network of 90 facilities just in the U.S. (Ostrom, 2006). Keepsake boutiques can be found in every state, including the six states[1] that have no standards, licensure, or regulatory provisions for radiologic personnel (ASRT, 2010).

In 2009, Connecticut became the first state to ban keepsake ultrasounds, limiting fetal ultrasounds "to those that are ordered by a licensed health care professional and are needed for a medical or diagnostic purpose." (State of Connecticut, 2009)

Ultrasound machines are also used in anti-choice "pregnancy crisis centers" to discourage adolescents and women with unintended pregnancies from having an abortion. Whether the sonographers in these facilities are trained and licensed is unknown. One Florida keepsake ultrasound boutique promotes its services to these organizations, claiming that a pregnant woman who "sees" her baby will be persuaded to maintain the pregnancy (Raucher, 2009).

Is today's prenatal ultrasound really safe? Is it even necessary in normal, low-risk pregnancy? Here is what some experts say:

[1] Alabama, Alaska, District of Columbia, Idaho, Missouri, North Carolina, South Dakota

Ultrasound affects the fetal brain:

"We conclude that ultrasound exposure in fetal life increases the risk of left-handedness in men, suggesting the prenatal ultrasound affects the fetal brain." (Kieler, et al, 2001)

"Ultrasound is not unsound, but safety is an issue...We do not know that modern ultrasound devices are safe…Ultrasound operators do not know how to use the real-time display of safety information on the screen…There is a possible link between experimental and epidemiological evidence on ultrasound and handedness." (Salvesen & Lees, 2009).

"Animal studies suggest that ultrasound may produce adverse effects in the neurological, immunological, hematological, developmental and genetic status of the exposed fetus." (Stratmeyer, 1982; Stratmeyer, et al, 2008)

In low-risk (uncomplicated) pregnancy, ultrasound does not benefit mother or baby and may cause harm:

"Based on existing evidence, routine Doppler ultrasound in low risk or unselected populations does not confer benefit on mother or baby. Future research should be powerful enough to address small changes in perinatal outcome, and should include evaluation of…long term outcomes such as neurodevelopment, and issues of safety." (Bricker & Neilson, 2000)

"Existing evidence does not provide conclusive evidence that the use of routine umbilical artery Doppler ultrasound, or combination of umbilical and uterine Doppler ultrasound in low-risk or unselected populations benefits either mother or baby. Future studies should be designed to address small changes in perinatal outcome, and should focus on potentially preventable deaths." (Alfirevic, et al, 2010).

"The particular sensitivity of the embryo to physical damage together with uncertainties of both risk and benefit suggest that caution should be applied to the scanning of early first trimester uncomplicated pregnancy." (Barnett, 2002).

Experts agree that there likely is no single cause of autism but rather a number of interacting factors that interfere with normal brain development, beginning around

the time of conception and continuing throughout early childhood. According to one expert, *"…there are many factors: Chemical factors, nutritional factors, microbiological factors, physical factors like radiation and ultrasound…I think multiple factors contribute, not just across the population, but within any one individual."* (Hertz-Picciotto, 2011)

Heat and Sound Effects

Ultrasound uses non-ionizing radiation to convert high-frequency sound waves reflected from internal tissues and organs into images that can be read by ultrasound experts. It can cause heating of tissues, particularly bone, as well as auditory effects. Because the fetal skull is much thinner and more vulnerable to hyperthermic injury than the skull of an adult, any increase in fetal temperature can interfere with normal brain development. According to Barnett (2001), "the rate of heating near bone is rapid, with approximately 75% of the maximum heating occurring within 30 seconds...for some exposure conditions, the thermal index (TI), as used in the FDA-approved output display standard, underestimates the extent of ultrasound-induced intracranial temperature increase."

Scientists at Yale (Ang, et al) found that exposure to pulsed ultrasound waves affects the movement of neurons in the brains of rodents. In mammals, including humans, neurons normally develop in one area of the brain and then migrate to the cerebral cortex. In this study, a small but significant number of neurons failed "to acquire their proper position" and remained scattered inappropriately in the cortex or in white matter.

Using a simulation model, researchers at the Mayo Clinic characterized the audible effect of a typical ultrasound scanner as equal to 100 dB, equal to the sound of a subway train entering a station. The scientists urged doctors to use caution when directing the ultrasound probe and avoid the fetal ear unless there is reason to suspect cranial or facial abnormalities. They wrote, "…contrary to common beliefs, ultrasound may not be considered a passive tool in fetal imaging." (Fatemi, et al, 2005).

More frequent, more intense exposure; less regulation

When prenatal ultrasound was introduced in the late 1970s, the medical community recommended that its use be limited to those women with high-risk pregnancies (diabetic women, those with multiple fetuses, very young or mid-life women with their first pregnancy) because the long-term effects of ultrasound were not known. Decades passed without evidence of visible physical birth defects in those children who had been exposed *in utero* to ultrasound, leading to an assumption that ultrasound was a safe technology.

Most of the clinical studies establishing the safety profile of prenatal ultrasound were based on use of machines prior to 1993, a watershed year in ultrasound technology and its regulation. In 1993, the Food and Drug Administration (FDA) increased the allowable output of ultrasound machines eight-fold. At the time of this increase, FDA failed to ensure that sonographers would be appropriately trained and credentialed to use the newer machines according to recommended international guidelines. Therefore, the belief that ultrasound is safe is based on research done when ultrasound was less frequently performed in each pregnancy and output of older machines was 8 times less intense than today's practice and equipment.

Only one study has compared children with autism spectrum disorders (ASD) with children without ASD born between 1995 and 1999. It showed that "antenatal ultrasound is unlikely to increase the risk of ASD, although studies examining ASD subgroups [girls] remain to be conducted." (Grether et al, 2009).

Ultrasound and autism more prevalent among higher socioeconomic groups

Several studies have shown increased prevalence of autism among better educated, more affluent communities (Durkin, et al, 2010; Van Meter, et al, 2010; Windham, et al, 2009; Maenner, et al, 2009; Fountain, et al, 2010). Women in these communities undoubtedly have health insurance and other resources to allow access to good nutrition, prenatal vitamins, and excellent prenatal care. They are also more likely to refrain from smoking and alcohol use during pregnancy. Why then are they more likely to have children with autism? One might argue that they may have more frequent ultrasound exposure, both medical and non-medical, than women with less education in less affluent communities.

Non-medical ultrasound the biggest risk?

The popularity of *non-medical* prenatal ultrasound is particularly alarming, given that this is a largely unregulated industry. If expectant parents knew the potential risk of these keepsake ultrasound exposures, they would certainly avoid them. The FDA (2004, 2008) warned about ultrasound videos and Doppler ultrasound heartbeat monitors used "for entertainment purposes."

Women who meet the criteria for uncomplicated, low-risk pregnancy should also know that years of research conclude that there is no benefit to mother or fetus and that there may be considerable risk (Alfirevic, et al, 2010; Bricker et al, 2000).

It is difficult to believe that most expectant parents are aware of the science showing potential risk of ultrasonography, particularly the FDA warnings of non-medical sonograms. If they were fully informed, they would not be so eager to have keepsake sonograms.

What most expectant parents wish for is a healthy baby, regardless of gender or appearance. If over-exposure to ultrasound poses any threat to that outcome, who would want it?

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