Sex in space: What does the future hold when space tourism catches on

The accident that brought the recent Virgin Galactic test flight to a tragic end reminds us that many technical questions still need to be answered before spaceflight can be deemed safe enough for tourists. Still, Sir Richard Branson, Virgin's owner, has vowed to move forward on his suborbital program, answering the questions, making the flights safe and, ultimately, routine.

At the same time, other space companies are also forging ahead with their own vehicles that will provide paying customers views of the Earth seen thus far only by space travelers, along with a few minutes of weightlessness. Built around suborbital flights, this early phase of space tourism, will not expose passengers to the spaceflight environment for long periods, but it will set the stage for eventual tourism in orbit and deeper into space, space hotels, and eventually off-Earth colonization. This means that at some point we as a society will need to have a down-to-Earth discussion about sex, pregnancy, and reproduction in not so down-to-Earth places. To this end, orbital space tourism, particularly space hotels, can serve as a test bed.

Spaceflight and the Initiation of pregnancy: The science

Evidence for normal post-spaceflight pregnancy dates back as early as 1963, when cosmonaut Valentina Tereshkova became the first woman in space. After spending nearly 71 hours in orbit age 26, Tereshkova returned to Earth. Five months later, she married another cosmonaut, Andrian Nikolayev, who had spent more than 94 hours in orbit. The next year, in 1964, Tereshkova gave birth to a healthy infant girl after a normal pregnancy.

What about actually getting pregnant in orbit? Traditionally, two issues are suggested as obstacles against fertilization of an ovum and implantation of the resulting blastocyst in the wall of the uterus. These two issues are space radiation and weightlessness, although other factors such as stress and disrupted circadian rhythms also may come into play.

On Earth, moderate to high doses of ionizing radiation, encountered in the context of cancer treatment are known to reduce fertility in both genders. In males, this is due to effects both on the quantity of sperm cells and the quality (for instance, how well they swim). In women, ionizing radiation is thought to harm ova before they are fertilized, but also to interfere with implantation, even should exposure occur subsequent to fertilization. Pregnancy requires healthy sperm and ova, successful implantation, and various developments subsequent to implantation. Thus, it has been suggested that there simply are too many steps in the process during which radiation can cause a potential pregnancy can go awry.

Studies of various species in spaceflight and under simulations and varying G forces on Earth have taught us that gravity plays an important role in gene expression and animal development. The blastocyst, the entity that must implant in the uterus, is the stage of embryo formation in which cells made from division of the fertilized ovum begin to specialize. As genesis of an embryo continues, cells continue taking on different and increasingly more specialized roles, depending on their location.

Various biological species studied in space flight appear to make use of Earth's gravitational field as a cue to positioning during early embryogenesis. Non-mammalian animal models studied in space studied in space to understand development have included *Drosophila melanogaster* (fruitflies), fertilized *Xenopus* eggs, and quail embryos. Additionally, various space experiments have been conducted on mammals, especially rats and mice. Although study results suggest that gravity affects different aspects of this development, it is possible for pregnancy, and even birth, to proceed under varying gravitational environments.

On the other hand, pregnancy rates may be different from those on Earth, but we're not really sure how different. To fertilize an egg, sperm must undergo a process called capacitation, which affects sperm motility and other properties. Researchers have looked at the effects of gravity on individual cells, including human spermatozoa, and results have been complex. For example, some evidence suggests that weightlessness may reduce the sperm count, yet there also is some evidence of increased sperm motility.

To be sure, the same studies also suggest that pregnancy is achieved and carried to term with more difficulty in weightlessness than in a 1 G environment. On Earth, however, in healthy women, only about a third of fertilized ova result in a birth; the rest either do not implant, or are aborted spontaneously during the early weeks of pregnancy, due to genetic defects. While radiation could play a role in the generation of some of these defects, mostly they arise simply because of the mechanisms by which the cells divide and reproduce their chromosomes. In the context of these natural defects, should increasing one's radiation exposure a little –and in low Earth orbit it really is only a little– have a major impact on the pregnancy rate? The answer is not clear, but studies involving cosmic radiation exposure in airline flight attendants suggest that the main risk of low dose space radiation could be a slight increase in the rate of spontaneous abortion.

Putting science into a space tourism context

When space tourism expands from suborbital to orbital voyages, initially tourists will be spending roughly seven to 14 days in space. Sperm can remain viable within a woman's fallopian tubes for up to about 72 hours before fertilizing an ovum; implantation then occurs about eight to nine days after fertilization. Consequently, a tourist may have sex the night before launch and become pregnant in orbit. Sex and fertilization can take place in orbit, with implantation happening on the ground. A potential mother might even have sex on Earth, be in space when fertilization occurs, then be on the ground again in time for implantation. Virtually any scenario is possible.

What about dangers? Might a pregnancy beginning in orbit produce birth defects due to unknowns related to the gravity issue? Generally, pregnancies with defects incurred very early are lethal to embryos, and thus do not progress. So for orbital tourism, probably the main concern will be an increased rate of early spontaneous abortion, a rate that is high anyway for humans, as noted above.

Moving deeper into space

As for the subsequent few weeks, when embryos are particularly vulnerable to events leading to birth defects, this is more of an issue for space, lunar, and Mars colonization. Located beyond the geomagnetosphere (the system of magnetic fields generated by liquid metal inducing electric currents deep in the planet), radiation levels around such colonies will be higher, but shielding will be better, and colonists will not be weightless. How much the .16g or .38g environments of the Moon and Mars, respectively, would help a fetus to develop normally is unknown, but the road to an answer will be paved by the first pregnancies initiated within space hotels.

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