Designer babies: You can screen for cystic fibrosis but intelligence is a ways off

Melinda developed breast cancer early in life, age 29. She tested positive for BRCA1, a gene that increases the risk of breast, ovarian and prostate cancers significantly. So, after her treatments and chemo, when she and her husband Matt were able to consider starting their own family, the decision weighed heavily upon them. Then they learned about pre-implantation genetic diagnosis or PGD.

Melinda and Matt used in vitro fertilization to conceive a dozen embryos. Then, in a genetics lab, one cell was taken from each embryo and analyzed for the BRCA1 mutation. Only the ones without the mutation were implanted into Melinda's uterus. They now have two healthy children who are both free of the cancer mutation.

But there are some big problems with the claim that these technologies will end disease. Eliminating disease is a tall order because most diseases are not controlled by a single gene. The segment, however, would give you a false impression based on correspondent Norah O'Donnell's interaction with Mark Hughes who runs a PGD lab:

> Norah O'Donnell: Let me do a rapid fire yes or no. Can you use PGD for Tay-Sachs?
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> Dr. Mark Hughes: Yes.
> O'Donnell: Muscular dystrophy?
> Hughes: Yes.
> O'Donnell: Sickle-cell anemia?
> Hughes: Yes.
> O'Donnell: Hemophilia?
> Hughes: Yes.
> O'Donnell: Huntington's disease?
> Hughes: It's one of the most common disorders we test for, yes.
> O'Donnell: Alzheimer's disease?
> Hughes: If it's a mutation in a particular gene that causes early onset, we can test for it, yes.
> O'Donnell: So you can test for Alzheimer's.
> Hughes: This is a small subset of a particular kind of Alzheimer's that attacks very early in life.
> O'Donnell: Colon cancer?
> Hughes: If we know which of the colon cancer genes, yes.
> O'Donnell: Breast cancer?
> Hughes: We do it regularly.

Reading that, you'd think it was possible to screen for nearly every disease, but that's simply not true. The diseases Hughes lists (and carefully so) are tied to known disease-causing mutations in one single gene. The idea that we could screen for schizophrenia, either type of diabetes, heart disease or high blood pressure is decades away. We simply don't know the identity of the thousands of mutations that cancause these illnesses or how they work.

The second part of the television segment focused on a company called GenePeeks, which we've covered before here at the GLP. This company takes a genetic analysis of both parents and creates about a thousand hypothetical children on a computer to look for any harmful mutations that might arise from the pairing. The company's founder has a child with an extremely rare genetic disease because both she and the sperm donor she used to conceive were unwittingly carriers. So, donor matching was the first target market for the company.

As consulting geneticist Lee Silver says in the Sixty Minutes segment, GenePeeks will expand beyond testing for disease in this population, and will likely include information about complex traits like height and eye color. The technology has the hypothetical potential to predict intelligence. But there are a lot of big problems involved from getting from here to there as geneticist and blogger Razib Kahn notes on his blog:

> If you have a trait whose genetics is distributed across thousands of loci then simulating the gentoypes is going to be a brute force affair. I trust computation to catch up to this problem, but then it is making predictions on the individual level. It is one thing to capture the heritable variation on the population scale, but predicting in an individual case is going to be harder. Then, once you have the prediction you have to screen an enormous number of genetic combinations. If you want more than one complex trait, and they are independent, then the problem becomes exponentially more difficult.

So the sheer math involved of first finding these thousands of genes in the population, then finding the variants in the individual, then making a good prediction about these traits for that individual, and further compounding over several traits might just be unfathomable. And, genetic editing techniques, where the genome of a embryo is tweaked to insert a desired gene or delete a harmful one may be more feasible in the next decade or two than ultra complex, high-throughput screenings like GenePeeks, Kahn says.

Kahn argues that for both of these reasons the plot of the 1997 movie Gattaca can never be realized. We will never make thousands of embryos just to discard them because they don't have the traits we like best. Instead, we'll take the ones we get, edit out the bad stuff and throw in a pair of blue eyes for good measure.

And this idea might be more palatable to the public. The comments section on the Sixty Minutes video is worth a read. The most ire is evoked by the idea of hypothetically screening for desirable traits, rather than selecting healthy embryos over those that carry mutations, despite one involving a computer simulation and the other viable embryos. When adding in the good comes along with editing out the bad, it will be interesting to see if people's perception of the ethics surrounding PGD and advanced pre-

conception screening change.

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Additional Resources:

- Richard Dawkins' moral policing aside, new era of fetal diagnostics underway, Genetic Literacy Project
- Personal genomics and gene editing revolutions beg for global regulatory rethink, Genetic Literacy Project
- Couples can protect children from devastating mutations with new IVF methods, Genetic Literacy Project