Talk

Focusing on three things "not to neglect"
An interview with Professor Yoshitaka Kimura and Professor Nobuo Yaegashi

Up until now, ultrasound (echo) has been the method for checking the condition of a fetus between twenty-four and thirty weeks of pregnancy. The main purpose of ultrasound, however, is to discern the formation of the fetus, and ultrasound is not able to monitor whether the functional development of the fetus is progressing normally. Professor Yoshitaka Kimura and Professor Nobuo Yaegashi have spent more than ten years developing a fetal electrocardiogram for functionally monitoring the condition of the fetus. Based on this work, Prof. Kimura and Prof. Yaegashi were awarded the 2016 Commendation for Science and Technology by the Minister of Education, Culture, Sports, Science and Technology "Development Category of the prizes for Science and Technology.) We heard about the history of the machine's development and its future prospects.

It was said that development of ultrasound [Prof. Kimura]: Do you know the medical condition that affects more than ten million people every year around the world? It's premature birth. Because premature babies are prone to perinatal death, it has become the leading cause of neonatal mortality. In addition, the condition leads to eye and ear disorders or cerebral palsy, the majority of premature newborns are said to suffer from higher brain dysfunction (social adjustment disorder) by the time they are five years old, and the worldwide increase of premature births has become a major social problem. However, not only is there no established method of preventing premature births, but at present, there are no means of monitoring during premature births. Management of premature birth has been left to the experience and discretion of individual doctors. We developed an electrocardiogram device for measuring fetal development, something that was said to be impossible, and we were the first to prove through clinical trials that it is possible to monitor the fetus from the twenty-fourth week of pregnancy through the baby's thirtieth week. At the moment, fetal electrocardiogram measurement is the world's only means of monitoring fetal health from the twenty-fourth week of pregnancy through the thirtieth week. Prof. Yaegashi: I think that the evaluation was an epochal point. The first was the development of a fetal electrocardiogram-measurement devices, which have created a new potential for fetal assessment. The second was that this device has clearly shown potential as a commodity for clinical use. The research and development team won this award is a good model of the so-called bridging study—bringing basic research into clinical practice. What was demonstrated here was not just mere development, but bringing the ideas that emerge from basic research to clinical trials so they can be useful in clinical practice as well.

Prof. Kimura: Framework is only advanced in laboratories, we do not know whether it is, in fact, useful. I believe that actually confirming whether the developed device is helpful—putting it to medical use in the field—is the biggest evaluation part.

Prof. Yaegashi: This is the first award of this kind that has been received in obstetrics and gynecology, not only at Tohoku University, but all over Japan. Until now, these kinds of research results have never come out of obstetrics and gynecology, not only in Japan but also quite original and at a high level. Furthermore, this achievement comes from Tohoku University. From the development of the initial idea to the final clinical trial, the work has been carried out consistently at Tohoku University. I am extremely grateful that this was recognized as great research.

Prof. Kimura: When I heard about receiving the award, I was so happy. "That's great." I think I was given a good opportunity to bring new medical instrument into the world. I am quite happy that this research and development was recognized, but the importance of the research begins by the device to medical use. The true test is when this machine goes out into the world and, whether it will be able to save a lot of children. I feel that the boost given by this field-oriented approach was a huge source of strength and allowed us to proceed this great project. I am inspired and feel I have to work even harder.

Universal thinking apparatus/measuring "sensors"

Prof. Kimura: The idea of the principle came to me when I was teaching my students. Trying to retrieve the signal from the noise doesn't work, so I thought, rather than the signal, the noise is extracted, what should be left is the signal. Since the noise is larger than the two, it is easy to measure accurately. It is a universal thinking apparatus.

Prof. Yaegashi: Professor Kimura is a Mathematics graduate from Tohoku University's Faculty of Science, and I think this fully demonstrates such mathematical thinking.

Prof. Kimura: The technology of computer algorithms that I studied during my time as a medical intern was rather useful in the development of this device. When I was working hard with little sleep, in order to break up the day, I had a trick. I would say to myself, "Memorize this algorithm phrase before going to bed," and that has accumulated over many decades to now being my great strength.

Prof. Kimura: I had the principle and model of the device ten years ago, but it was difficult work to improve it and bring it to a level where the device could be used in a clinical setting. Also, it was supremely difficult to use in the highly confidential setting of a gynecology clinic. There were numerous struggles, such as plans that didn't proceed as expected, a lot of trouble building the budget, not having manpower, and having to go it alone, but we got here, thanks to the cooperation of many people.

Prof. Yaegashi: To make a diagnosis with an echo, you need to use expensive equipment at the hospital. This is not possible in rural areas, though, because it only captures instantaneous images of the baby, in contrast, the system we are developing will enable us to monitor the baby for a long time of period, not just in the hospital, but when the mother is at home as well. In obstetrics and gynecology, each pregnant mother is unique, and there are many unforeseeable circumstances. This system will provide patients with an extra level of assurance. From the viewpoint of obstetrics and gynecology specialists, on the other hand, an enormous amount of data will be collected, making it possible to conduct big data analysis. Maybe that will reveal the differences in how individual obstetrics and gynecology specialists interpret the data and this a lot of children. This technology is essential for each geographical region. Another benefit is that finding similar ECG waveforms will help predict the health condition of the fetus. It will be possible to offer a new kind of service that combines medical equipment with data analysis.

The challenges for widespread use

Prof. Kimura: We will build a system so that the hand portable device can be more easily installed and measurements more easily taken. We are thinking of a system that incorporates as cloud server, so that anyone anywhere can carry out monitoring. The biggest challenge will be how to work with companies in joint development efforts. In the Japanese enterprise system, compared to those in foreign countries, venture companies do not grow easily or, sometimes, they do not grow at all. So, we are going to have to create a venture yourselves in order to supplement what the current system lacks. In today's globalized society, even if you succeed in developing an excellent device in Japan, the rest of the world will soon catch up with you. It is urgent that we set up a university-based venture company and promote the device all over the world.

Prof. Yaegashi: I agree. This is a tough challenge. When I went to the U.S., I saw people launch ventures quite easily and make many enterprise funds. Compared to that, the situation in Japan is unfavorable.

Seeking to Initiate the Renaissance in Perinatal Care

Prof. Yaegashi: In this research project, we have identified questions and needs in the clinical medicine field. There are still unexplored areas in the realms of obstetrics and gynecology, particularly in obstetrics. The womb of a pregnant woman is a black box, so to speak, and, at the moment, it is difficult to act directly on the fetus. While at a stage where seeing the shape of the fetus is barely possible using ultrasound. Since the fetus and placenta of humans are different from those of animals, effective animal experiments are difficult to perform. So, it is to be said that many frontiers still remain in the science of obstetrics and gynecology.

Prof. Kimura: "Don't neglect learning in research training, don't neglect to be kind to people." I say this on a daily basis, and as for what I myself can do, it's just those things. So, wherever I can do it, I will do it with integrity.

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The Commendation for Science and Technology by the Minister of Education, Culture, Sports, Science and Technology (Science Category)