

OHSU Patient is One in a Million

By Lisa Rhuman

Victoria and Terry Wiltermood make a 550 mile round trip trek from Medford to Portland every two weeks so that



*Sergio Fazio, M.D., Ph.D. with
Victoria and Terry Wiltermood*

Victoria can receive LDL apheresis treatment (cholesterol dialysis) for an extreme form of familial hypercholesterolemia (FH). FH is a genetic disorder that causes LDL cholesterol (the “bad cholesterol” carrier) to be very high [above 190 milligrams per deciliter (mg/dl), when the optimal level is below 100 mg/dl] because the liver is not able to clear it from the bloodstream. The most

common form of FH, with LDL averaging 200 mg/dl, occurs in one in every 250-500 people.

Victoria’s physician, Sergio Fazio, M.D., Ph.D., professor of medicine and director of the Center for Preventive Cardiology in the OHSU Knight Cardiovascular Institute, sees many patients with FH but states that Victoria is an outlier because without treatment her LDL can go above 500 mg/dl, an extreme level that is seen in about one in a million people. Among other projects, Dr. Fazio’s laboratory studies the responses of patients to LDL apheresis and the genetic causes of severe inherited hypercholesterolemia.

Victoria was 16 when she and her four siblings were diagnosed with this genetic disorder after her mother had a heart attack at age 36. Children of an affected parent have a 50 percent chance of inheriting the defect, but unfortunately in her family the genetic roulette worked against them and every one of the siblings inherited the defective gene. Dr. Fazio says that diagnosis at age 16 is actually late in life, as this should be caught during early childhood so that appropriate treatment (not necessarily drugs) can begin as early as age five. Because of OHSU’s long-standing interest in cutting-edge cholesterol research, our relationship with Victoria goes back to the late 80’s, when she enrolled in an early statin trial conducted by the late Roger Illingworth, M.D., Ph.D., professor of medicine and former

(continued on page 4)

Director’s Message

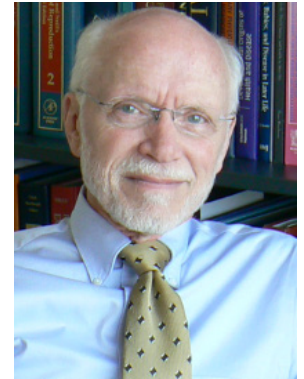
By Kent Thornburg, Ph.D.

If you have been wondering why one person lives to be 100 and the next person lives to be 66, you will be joining a host of cardiovascular scientists who are wondering the same thing. Genetic background has a powerful influence on lifespan. This has been shown with dramatic extensions of life by changing only a few genes in fruit flies and round worms. However, it does not explain rapid changes in lifespan in humans. In the last 100 years, average life span has risen from 50 years to 80 years in 2010. That is until 2016 when life expectancy declined for the first time in decades. Babies born today are not expected to live as long as did their parents. The decrease in life expectancy is based on the fact that chronic diseases like diabetes, hypertension and obesity have become commonplace around the globe. This fact cannot be blamed on changes in the genetic code passed from one generation to the next.

Cardiovascular scientists in the Knight Cardiovascular Institute are keen to understand what makes a person vulnerable for dying at a young age. Because we know that poor function of blood vessels is the root cause for most deaths, including heart attack, aneurism and stroke, it is about time to determine why blood vessels become vulnerable.

First you have to understand some basic biology. Every blood vessel in the body has a specialized flat cell that provides it with a smooth lining. The cells are called endothelial cells and the lining of cells is called the “endothelium.” These cells may look innocent and boring but they are the masters of how the blood vessel works. They can release substances that cause the vessel to increase its diameter by relaxing the muscle layer underneath or they can cause the vessel to constrict so much that no blood is allowed to pass. They can cause the wall of the vessel to grow thicker. They can prevent blood clots from forming on their surface or, on the other hand,

(continued on page 6)



Kent Thornburg, Ph.D.



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Standing on the Shoulders of Giants

by Lisa Rhuman

John A. Benson, Jr., M.D., Dean and Professor of Medicine, Emeritus, OHSU and President Emeritus, American Board of Internal Medicine has seen much change since he began his career in medicine. Benson grew up in Windsor, Connecticut and graduated from Harvard Medical School in 1946, months after World War II ended. He completed an internship at the University Hospitals of Cleveland before completing two years of active duty for the Navy Reserve. He went on to complete an internal medical residency and a gastroenterology fellowship, both at Brigham Hospital. In 1951 he moved to Massachusetts General Hospital for more training and practice. In 1959, he came to the University of Oregon Medical School (UOMS), now OHSU, as an associate professor and the first full-time head of the Division of Gastroenterology.



John A. Benson, Jr., M.D.

He came to Portland to start something new with strong backing from Howard Lewis, M.D., Chair of Medicine. Lewis encouraged him to become involved with the American Board of Internal Medicine (ABIM) early in his career. In 1969 he was elected to the Subspecialty Board on Gastroenterology and in 1969 to the parent Board. In 1975 he became the first president of the ABIM, a position he held for 16 years while maintaining a part-time appointment at UOMS. Sixteen seems to be a magic number for Benson as he also spent 16 years as the head of the Gastroenterology Division at OHSU. He loves teaching and appreciated that these two positions afforded him ample opportunity to mix teaching, clinical practice standard setting and administration. From 1991 to 1993, Benson became Interim Dean of the School of Medicine. He enthusiastically supported curriculum reform and the Heart Research Center (HRC), now the Center for Developmental Health, serving on the HRC Board of Governors from 1997-2003.

Now in his 90s, Benson continues to teach at OHSU in the interprofessional education program. This program brings students together from various health schools at OHSU to discuss topics relevant to all health care providers. The goal of the program is to prepare OHSU students to work together to improve patient care and community health. Benson is sold on this educational model that prepares graduates to collaborate in interprofessional teams.

The most profound changes in diagnosis and treatment of gastrointestinal disease that occurred during Benson's career were because of two advances: 1. Advanced imaging – fiberoptic endoscopy, computed tomography (CT) and magnetic resonance imaging (MRI) - provides detailed images that were not previously possible. Before these technologies, appendicitis patients were correctly diagnosed about 70 percent of the time. 2. Immunology – instead of basing diagnosis on experience and the usual behavior of a disease, immunological tests can now pinpoint the diagnosis with much more specificity.

Benson had his aortic valve replaced about four years ago and marvels that they can stop your heart and insert a valve without worrying about rejection. Advances in open heart surgery and valve design have benefited him directly.

Benson believes he owes his own longevity, in part, to genes. His mother's family lived into their 90s and his two siblings are still alive in their 90s. He also believes in living a healthy lifestyle and having an optimistic outlook on life. He stopped smoking 60 years ago and drinks very little alcohol. He watches fat and salt in his diet, not for therapy but for prevention. He says he's not much for moaning and groaning and instead embraces a "this too shall pass" attitude. Benson reflects on his parents' lives and their struggles during the Depression and realizes he has a lot to be thankful for. He also thinks a person needs interests beyond a profession – books, music, art, travel, conversations, politics even – in order to have a broader outlook.

Benson shares the following advice with young physician-scientists. Believe in good science. Take risks that are well thought out in terms of science. Listen to elders who have had experience in getting grants, in successful and failed experiments and in dealing with other scientists in their field. Learn from them and remember that in a sense you stood on the shoulders of giants and got where you did from their experience, advice and work. Don't be selfish – share your successes and failures. Benson feels fortunate to have worked with leaders in both Portland and Boston who made him aware that you have been helped by what the previous generation has taught you. No doubt, there are countless physicians and health care professionals today who feel fortunate to have learned from Benson.

*Benson believes
in living a healthy
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Stepping Across the Frontier

by Lisa Rhuman

Albert Starr, M.D., Executive Chairman, Knight Cardiovascular Institute, Distinguished Professor of Cardiovascular Medicine and Professor of Surgery, credits his parents for laying the foundation for a successful career. His father was a small businessman who taught him about finances and his mother was very ambitious for him. She made sure he was well educated and insisted he take piano lessons so that he could become a great surgeon.

Starr advanced through school rapidly, skipping grades and finished high school at age 16 and college at age 18. He went on to medical school and then an internship at Johns Hopkins. It was 1949, a seminal time in cardiac surgery, and he got to know Alfred Blaylock, who performed the first blue baby surgery; Denton Cooley, who was a pioneer in artificial valve implantation and who implanted the first artificial heart; and Dwight McGoon, who performed the first mitral valve repair.

Starr returned to Columbia where he worked with Frank Berry, M.D., physician in chief of the defense department. After a few months of training, the Korean War began and he was drafted into the medical corps. He asked to be assigned to a mobile army surgical hospital (MASH) in order to use his surgical skills. He performed over 1,000 surgeries in Korea and says that the movie, MASH, was a realistic portrayal of his experience. After two years, Starr returned to Columbia where Berry suggested he go into thoracic surgery, a field that was just beginning.

Starr was only 30 when asked to develop a surgical program in Portland, Ore. This was a great opportunity. He stopped by the Mayo and Cleveland Clinics on his way to learn from other surgeons. Soon after coming to Portland, he was approached by an engineer named Lowell Edwards. Edwards was an older man wearing a golf jacket and slacks and didn't look appropriate for the task but Starr soon learned the differences between Manhattan and Portland cultures; together he and Edwards built the first mechanical heart valve.

In addition to his parents, Starr credits his success to early opportunities and collaborations. He went into a new field, in an area (Portland) where there weren't older generations keeping their positions, and was able to move swiftly. He never turned down an opportunity.

There were so many advances in diagnosis and treatment during his career – it was the golden period of cardiac surgery. When he began, surgery was only developed for a few congenital heart defects, patient support

systems were primitive and there were only the stethoscope and basic x-rays.

The development of cardiac bypass surgery allowed surgeons to treat more prevalent forms of heart disease. Starr worked closely with Charles Dotter, M.D., the kingpin of interventional radiology.

He participated in most of the advances in cardiac surgery, including the trans arterial valve replacement. He collaborated with Alain Carpentier, M.D., Ph.D., Alain Cribier, M.D., and Thomas Fogarty, M.D., each of whom had new ideas for artificial valves and catheters that were developed with Edwards. Fogarty had been making catheters in his dorm room and the catheters he designed are still used today.

In the early 1970s, Starr's father died of coronary artery disease. That was a turning point for him. Knowing he had a family history of heart disease, he began an exercise program and went on a low-fat diet. In 1974, he had mild chest pain and an echocardiogram showed narrowing of the right coronary artery. He had bypass surgery then and a repeat surgery in 1980. He has been on cholesterol lowering drugs since they became available.

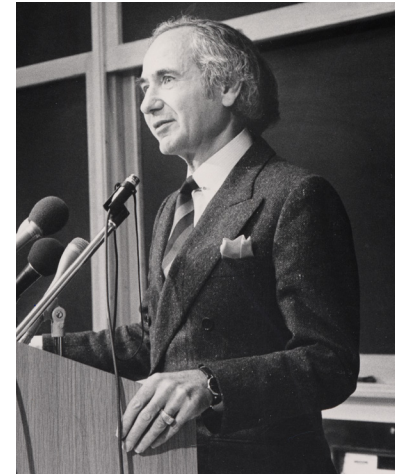
Starr offers the following advice on healthy aging:

1. Make use of all available preventive measures.

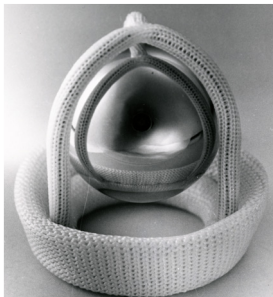
Early use of cholesterol drugs has been important to his longevity. 2. Manage stress. Starr makes rapid decisions so doesn't internalize stress. 3. Don't look back – you can't change the past. 4. Seize opportunities., stay engaged and always be involved in projects. 5. Keep your body in motion – exercise. 6. Stay slim - watch calories.

Starr's advice to young physician-scientists is simple, "if you want to get ahead, walk up to the frontier and step across." He explains that walking up to the frontier means learning everything there is to know about your chosen field, which will provide the confidence needed to amass new information and develop new inroads. He adds that academics is important but success comes from collaboration and innovation. Industry plays an important role. Think carefully and accept opportunities rapidly. His last piece of advice is to try to find the positive in situations, a practice that served him well in Korea and throughout his career.

*Photos courtesy of OHSU Historical Collections & Archives.



*Albert Starr, M.D.



*Starr-Edwards Heart Valve

OHSU Patient is One in a Million *(continued from page 1)*

Heart Research Center scientist who played a leading role in developing the LDL apheresis treatment.

Many people with high LDL cholesterol have no symptoms until the big one, such as a heart attack, occurs. However, Victoria did have visible signs that she didn't realize were related to FH – cholesterol deposits created a cloudy ring around her iris and small wart-like growths (xanthomas) on her knees. Because of her high blood LDL level, Victoria has had three heart attacks and a quadruple bypass surgery. She also has 27 coronary stents, small mesh tubes that open blocked arteries. She is lucky that her heart was not damaged, and thus she actually can enjoy life with minimal limitations.

A few years ago, when Victoria was averaging a new stent every three months, her Medford cardiologist told her that she wouldn't live more than a year without a more aggressive treatment to lower her LDL cholesterol level. Medications were not enough. She was referred to Dr. Fazio, who started her on LDL apheresis, a procedure that requires much commitment from the patient. Victoria is connected to a machine that continuously removes her blood to filter out the LDL cholesterol through a series of columns and then returns the cleansed blood through a different vein, leaving a waste bag full of cholesterol. This process, which takes about four hours and must be repeated every two weeks, drops her LDL down to as low as 30 mg/dl at the end of treatment. However, her LDL levels will slowly increase over the two weeks until the next procedure, and thus in addition to the apheresis treatment, she must self-inject a very strong medication (Praluent, a monoclonal antibody) to

Elevated LDL can cause endothelial dysfunction, even in the absence of other triggers such as smoking, high blood pressure or diabetes.

keep LDL in check between treatments. Elevated LDL can cause endothelial dysfunction, even in the absence of other triggers such as smoking, high blood pressure or diabetes.

Victoria's husband of 34 years, Terry, is fortunate to work for a family-oriented employer who provides a flexible schedule so that he can drive Victoria to OHSU every two weeks. He says the routine is "not for the weak of heart" and they are both grateful for this lifesaving treatment. Their lives center around the disorder and treatment. There are few places where they can live as this treatment is not widely available and only 500 patients in the U.S. are currently receiving it. Victoria worked for 18 years in the dental field and five years in a detox center but now finds it impossible to maintain employment with the time required for treatment, and was recently awarded disability status.

Victoria enjoys spending time with Abby, a Cavalier King Charles Spaniel who is more her shadow than her dog, and likes to garden, keeping her 60-year-old rose bushes flourishing.

She and Terry follow a low-fat diet and avoid fast food, although her high LDL is due to gene defects and not caused by diet.

Victoria and Terry feel very fortunate that this life-prolonging treatment is available, and she is particularly grateful that her daughter, who was tested at age two, did not inherit the defect. While most people would say, "why me?" Victoria says, "why not me?" and hopes that being part of Dr. Fazio's research studies will make life better for others and not only for her.

OHSU Develops Unique Heart Risk Assessment Tool

by Kate Natoli

Just as no two people share the same fingerprint, no two have the same risk of acquiring cardiovascular disease. Research at OHSU shows that much of this risk is established well before you are born, through genetics, the health of your mother and even the way that you developed in the womb.

In order to encourage patients to consider their family heart history, and to help unearth those risks based on the latest preventive and pregnancy cardiovascular research, experts at the OHSU Knight Cardiovascular Institute created a unique heart risk assessment that incorporates questions not commonly asked by cardiologists. This includes your birth weight, the height of your mother, and if you are a woman, whether you experienced condi-

tions like preeclampsia or gestational diabetes during a pregnancy. Co-led by Dr. Sergio Fazio, director of the Center for Preventive Cardiology, and Dr. Kent Thornburg, director of the Center for Developmental Health, a team of experts created an online tool that will assess the user's risk based on lifestyle, personal health history and family health history. The result is OHSU's Healthy Heart Family Tree, a personal heart health assessment based on a patient's family tree.

A major research group within the OHSU Knight Cardiovascular Institute, the Center for Developmental Health consists of more than sixty scientists who study a growing field of research known as the developmental

(continued on page 5)

Diabetes and Pregnancy

by Amy Valent

The placenta is the lifeline between a mother and her baby in the womb. It not only produces the hormones necessary to maintain a healthy pregnancy but is also responsible for the nutrients and oxygen that the baby needs to grow. Gestational diabetes affects one in ten pregnant women and is a condition where there is too much sugar in the blood. The American food culture and rising rates of obesity are contributing to the escalating rates of women being diagnosed with gestational diabetes over the last 10-15 years. It can cause problems for the baby such as growing abnormally large, low blood sugars or jaundice, conditions which require extra care after delivery, and higher risk for childhood obesity, high blood pressure and diabetes after birth. Women with gestational diabetes are at higher risk for needing a cesarean delivery, developing high blood pressure and preeclampsia, and have a 50 percent increased risk for developing type 2 diabetes in the five to 10 years after giving birth. Women who have diabetes before pregnancy are at increased risk for miscarriage and birth defects in addition to the problems seen with gestational diabetes.

Women with diabetes in pregnancy typically have heavier and thicker placentas. Beyond what the eye can see, there is an abnormal increase in blood vessels, evidence of stressed oxygen delivery and signs of inflammation in the placenta. These changes can be modified by strict control of a woman's blood sugars but not completely rectified, which suggests that other nutrients besides blood sugar can be harmful to the pregnancy. The placenta requires good maternal nutrients to provide for the needs of a healthy baby. Placentas from diabetic pregnancies have a lower capacity to produce energy. Sugars easily pass through the placenta to the baby. Transfer of fats and other essential nutrients through the placenta are altered in pregnancies complicated by diabetes. This is important because we know that nutrition and other environmental exposures in the womb program the baby for future health risks.

High quality food choices and exercise are not only key for treating diabetes in pregnancy but for all pregnant women who want to develop a healthy baby. Women should talk to their doctors about healthy nutrient-rich diets, lifestyle modifications, and exercise that helps the placenta function better, lowers pregnancy complications, and ultimately grows a healthy baby.



Amy Valent, D.O., Assistant Professor, Obstetrics & Gynecology

OHSU Develops Unique Heart Risk Assessment Tool *(continued from page 4)*

origins of health and disease (DOHaD) at OHSU. The center conducts cutting-edge research and explores ways to prevent chronic disease like heart disease, type 2 diabetes and obesity. The scientific foundation of the center is the 1989 Barker finding that birth weight is a crude marker for risk of death from ischemic heart disease.

Smaller full-term babies, those born at five pounds or less, have a three to five times higher risk of dying from heart disease as an adult than those born at eight to nine pounds. Risk begins to increase again in larger birth weight babies, those born at 10 pounds and above. Placental size, shape and function as well as the mothers' body type also indicate how a baby grew in the womb, and therefore play a role in the development of adult onset heart disease as well.

"While we have made incredible strides in treating heart disease so that fewer people die from it, we have done a poor job at preventing heart disease," said Kent

Thornburg, Ph.D., director of the Center for Developmental Health at the OHSU Knight Cardiovascular Institute. "The field of developmental origins shows us that to reduce rates of heart disease, we must focus on prevention much earlier than we once thought."

According to the American Heart Association, there are over 15,000 deaths due to heart disease annually in the U.S. in young women under the age of 55. One reason for this is due to conditions that can develop during pregnancy. Major changes happen to the body during pregnancy to which the heart and vascular system must adapt. Research shows that some conditions that may develop during pregnancy can signal future heart risk, such as gestational hypertension, gestational diabetes, and preeclampsia.

Experts at OHSU hope that the tool will encourage a more detailed discussion between patients and cardiologists about family history that allows for the most effective preventive and therapeutic strategies. The heart health assessment is available at www.ohsuheart.com/familytree.



Salmon with Herbs and Winter Vegetables in Pouches



Ferdinando Divina, OHSU Executive Chef, and Marlene Divina prepare salmon at the OHSU Knight Cardiovascular Institute Heart Protection Kitchen.

Makes 4 servings

Baking food in a parchment pouch or packet is a French technique known as “en papillote.” For this recipe, a salmon fillet and a sprig of fresh tarragon are baked on a bed of vegetables within each packet. As the packets bake, the delicate juices from the fish and vegetables mingle to create a mouthwatering flavor.

Ingredients

8 ounces broccoli spears, trimmed, diagonally sliced, cut into 2-inch pieces

1 large carrot, cut into matchstick-size strips

1 medium leek (white and light green parts only), halved lengthwise, each half cut lengthwise into 3/8-inch strips

4 salmon fillets or steaks (about 4 ounces each), about 1 inch thick, patted dry

¼ teaspoon salt

¼ teaspoon pepper

4 sprigs fresh tarragon, about 4 inches long

2 tablespoons sliced chives

2 teaspoons olive oil

Preheat the oven to 425° F. Cut eight

15-inch-long sheets of parchment paper or aluminum foil. Set aside.

Divide the broccoli, carrot, and leeks evenly in the center of four of the parchment sheets. Place one salmon fillet on each pile of vegetables. Sprinkle evenly with salt and pepper. Place a tarragon sprig on each piece of fish. Sprinkle evenly with chives and drizzle with oil. Place one of the remaining four sheets of parchment over the fish. Fold the edges toward the center. Holding the tops together, fold edges several times to seal securely. Repeat with the remaining packets, then transfer to a large rimmed baking sheet. (The packets can be made in advance. Cover and refrigerate until baking time.)

Bake for 8 minutes, then insert a thermometer into the center of the thickest piece of fish. When the temperature reaches 138 to 140° F, remove the packets from the oven. Using a fork or knife tip, carefully open a packet away from you (to prevent steam burns). If the fish isn’t cooked to your liking, reclose the open packet and bake all the packets for an additional 2 to 5 minutes until cooked through. Serve the fish and vegetables in the packets.

Note: For added convenience, use a 12-ounce package of broccoli slaw in lieu of the broccoli and carrot. Recipe developed by Ferdinando Divina and provided by the Knight Cardiovascular Institute.

Nutrition information (per serving): 206 calories, 9 grams total fat (2 grams saturated fat, 4 grams monounsaturated fat, 2 grams polyunsaturated fat, 0 grams trans fat), 61 mg cholesterol, 296 mg sodium, 525 mg potassium, 4 grams total carbohydrate, 2 grams fiber, 1 grams sugar (0 grams added sugar), 26 grams protein.

Knight Cardiovascular Institute dietician Tracy Severson says, “this simple, quick salmon recipe is a great way to get heart-healthy omega-3 fats and help meet the goal of having two servings of fish per week. Cruciferous vegetables such as broccoli contain anti-inflammatory antioxidants and cholesterol-lowering fiber. Baking them together in parchment paper keeps the fish moist and makes for easy clean-up!”

Director’s Message *(continued from page 1)*

they can allow cholesterol and fat to accumulate in the wall of the vessel that eventually leads to a clot (thrombus) that causes a heart attack or stroke. What we have realized lately is that endothelial cells have their own aging process. If a person’s endothelium ages too fast, they are more likely to die of a blood vessel cause.

Led by Sanjiv Kaul, M.D., CEO of the Knight Cardiovascular Institute, OHSU scientists are planning a full court press to understand the aging process in the endothelium. This is great news for scientists in the Center for Developmental Health/Heart Research Center because there is a clear relationship between how a person grows in early life and the function of their endothelium later in life. For example, people born at the low end of the birthweight scale are more likely to have what is called endothelial dysfunction, meaning that their endothelial cells are unable to dilate their arteries compared to people born larger. Such people are also more likely to die at a much younger age. Now we need to find out why people born small (or really large) have endothelial cells that age faster than normal.

I hope you enjoy reading this issue of the Heart Beat as you think about aging blood vessels. It is the next great frontier in curing heart and blood vessel disease.

YES! I support the mission of the Center for Developmental Health.

Enclosed is my gift of ___\$500 ___\$250 ___\$100 ___\$50 ___\$_____

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Checks should be made payable to OHSU Foundation and mailed to Center for Developmental Health, Oregon Health & Science University, 3030 S.W. Moody Avenue, Mail Code MDYMI, Portland OR 97201.

Online donations can be made at www.ohsu.edu/heart.

We appreciate the generosity of our thoughtful donors.
Below is a list of recent memorial & honorary donations:

In memory of Jean Behrends
Juanita Struble

In honor of Dr. Cheryl Maslen
Marilyn Maslen

In memory of Tom W. Morgan
Juanita Struble



In honor of Dr. Kent Thornburg
David and Kate Dickson

In honor of Dr. Kent Thornburg
Hallie Hackenberger

In honor of Dr. Kent Thornburg
Barbara and Arthur Palmer

Guardians of the Blood Vessels *(continued from page 8)*

Interestingly, from studying the adults who were developing in their mothers' wombs during famines, we know that babies, who developed in a poor in utero environment have a higher risk for heart attacks and strokes as adults. The poor environment includes both under nutrition, where calories are restricted, and over nutrition, where excessive calories are available to the developing baby. The babies' cardiovascular systems adapt to these poor nutritional environments in ways that put them at an increased risk for heart attacks and strokes as adults. The increased risks occur in people of both highly developed nations as well as in the developing world. In fact, some of the highest increases in risk factors for the adult disease occur in people who were undernourished during development and then ate a high fat, high carbohydrate Western diet as infants and children. This increased risk for cardiovascular disease, also known as accelerated cardiovascular aging, is likely due to the damage done to the endothelial cells of the blood vessels during development.

We are studying the damage that is done to endothelial cells during development and how that damage causes blood vessels to become diseased later in adulthood. If we want to prevent cardiovascular disease in adults, it is critical to understand how the environment in the womb harms endothelial cells for life.

We are studying how endothelial cells are modified for life by the mother's diet. One more step toward eliminating heart disease.

The Heart Beat

Please contact us by email at heart@ohsu.edu if you would prefer to receive this newsletter by email or if you would like information about lectures and events at the Center for Developmental Health.



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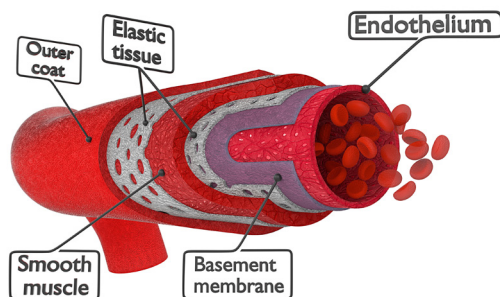


Guardians of the Blood Vessels

By Monica Hinds, Ph.D.

Endothelial cells are incredible cells that act as the guardians of all blood vessels. They make the lining of blood vessels. Thus these cells are in charge of the communication between the blood and tissue around the blood vessels. They protect against blood clotting and are amazing because they can cause blood vessels to expand when needed to increase blood, like during exercise. When there is a bacterial infection, the endothelial cell layer becomes leakier, allowing white blood cells to pass through the vessel wall to kill invading organisms. However, when damaged, their ability to regulate flow becomes defective.

Cardiovascular disease is a result of a damaged endothelial cell layer. Damaged endothelial cells allow blood to clot and blood vessels to contract when they shouldn't. Additionally, damaged endothelial cells become both leakier, allowing cholesterol to enter the vessel wall, and stickier to white blood cells. In that case, cells are more



likely to allow white blood cells to enter and build up in the blood vessel wall. The white blood cells and cholesterol which have passed through the endothelial cell lining then form a lump in the wall of the vessel, an atherosclerotic plaque. Thus damaged endothelial cells can cause severe reductions in blood flow, which leads to heart attacks and strokes. On the prevention side, endothelial cells are considered the first line of defense against these disease conditions in adults.



*Monica Hinds, Ph.D., Professor
of Biomedical Engineering*

(continued on page 7)