**Sickle Cell Anemia Disease**

**Sickle Cell Anemia Disease: Case Study**

Healthcare is a sector that necessitates for proper planning for an effective management and control of a disease. The management of a disease is not only achieved by the healthcare professionals but also with the help of the government and family members. The governmental regulations have been pivotal in the control and management of procedures or interventions of the treatment and management of diseases and conditions in the general public. The government of the United States, through The Food and Drug Administration (FDA) agency has been protecting and promoting the health of the United States population. The FDA introduced new regulations for introducing new pharmaceutical agents as its roles in the management of the diseases and the health of Americans. Thus, this case report provides an analysis of the reasons behind the introduction of the new guidelines on pharmaceutical agents, the economics of healthcare, and the role the family plays in healthcare decision making drawing focus on sickle cell anemia disease.

**Description of the Disease, Its Prevalence**

Sickle cell anemia is an inherited type of anemia, a condition whereby the patient lacks enough healthy red blood cells to perform their main duty. The main function of the red blood cells is to carry oxygen from the lungs to the body tissues. Nevertheless, when sickle cell anemia is inherited, the patient lacks enough of the red blood cells to carry oxygen to the other body parts. According to Nussbaum et al., (2015), sickle cell anemia can be categorized under the single gene defects which are mainly caused by individual mutant genes. The mutation is only found in a single chromosome of a pair, or that which has been coordinated with a typical allele on the homologous genetic material.

The general prevalence of the single gene disorder is 1 in every 500 to 1000 people. However, even though they are responsible for certain disease and deaths, the single gene disorders such as single cell anemia as a group has been studied and documented to affect 2% of the population in an entire life span. This is thus a significant disease group that may also necessitate for better management and intervention. Additionally, Nussbaum, McInnes, and Willard (2015), in their book, offer an analysis of evidence-based studies on the incidences of such single gene diseases and observes that, in a population of more than one million live births, 0.36% of them was reported to have serious single-gene disorder such as sickle cell anemia. Thus, laboratory testing for the single gene disorders, specifically for sickle cell anemia could help in managing the condition.

**Laboratory Testing and Prescription of Drugs for the Disease**

The laboratory test for sickle cell anemia is very important to ensure that patients get proper treatment to protect them from other diseases and symptoms. The possible lab test involves lab technician placing an elastic band around an individual’s upper part of the arm in order to have veins swell for easy removal of blood samples. In carrying out a lab test for sickle cell anemia on infants, the process necessitates for the use of the lancet tool to puncture a finger (Ashiru et al., 2017). The collected blood for testing sickle cell anemia is examined for an abnormal hemoglobin referred to as hemoglobin S. An alteration of one of the genes changes the behavior of hemoglobin. Mutated hemoglobin creates abnormal red blood cells with a sickle shape.  This is the feature that the lab test practitioner will be looking at during the laboratory testing.

When the doctor finds out that the patient has sickle cell disease, there are drugs that are prescribed. Drugs possibly used in the treatment and management of sickle cell anemia are like Droxia oral, Penicillin V potassium oral, and vitamin E acetate oral. The use of these drugs is, however, managed and controlled by the US Foods and Drugs Administration agency. New drug agents have also been managed and controlled through the adoption of new guidelines by the FDA in order to control the quality and safety of the new drugs in the market. According to the U.S Food and Drugs Administration website, the regulation and management of the new drugs has been the main duty of the New Drug Administration (NDA) department. The NDA is an application in which drug manufactures formally proposes to the FDA to approve a new agent so as to be released to the general public for use.

**FDA Guidelines, Economics of Healthcare, and Role of the Family**

Thus, the guidelines and reasons behind the FDA regulations for introducing new pharmaceutical agents is to protect the general public from harmful agents. The main reason for the FDA regulation on new agents is that, there may be certain risk factors and as such, the FDA will have to carry out an assessment of the benefits and the risks from a clinical study. The drugs that are newly presented to be used in the management and treatment of diseases may contain certain poisonous chemicals or agents in small amounts that may accumulate and become toxic after certain period of its use. Thus, with the help of the FDA guidelines, the population is shielded from certain poisonous and harmful drugs.

However, there is little incidences of drugs that are harmful to human health. Drugs such as those used in the treatment and management of sickle cell anemia have been approved by the FDA and are safe to use. The assessment process of drugs for their safety necessitates for thorough study that may also require enough capital. The FDA through its partners carry out research and studies, especially longitudinal studies aimed at making sure that the new drugs are well studied and tested for their effectiveness. This process is however crucial and costly.

The US affordable care act has been one of the most important sources of managed care. This has allowed for both the poor and the richest Americans to access affordable care. Even though the capitalist and socialist sides have been resisting on particular provisos of the Obama Care, it is one of the strategies that has enabled for better managed care (Myler, 2015). Patients with sickle cell anemia can now access healthcare services courtesy of Obama care. Grants from the nongovernmental organizations have also been an enabling factor for the scientific studies. This is because the sponsorships by the nongovernmental organizations have enabled scientific research in coming up with drugs for the management and treatment of diseases such as sickle cell anemia. Thus, money and grants has enabled for a better healthcare interventions and scientific studies aimed at bettering care.

The healthcare interventions without family members of the patents would never be successful. The government may regulate drugs to be used, doctors may test for a disease like in the case of sickle cell anemia, but the treatment can never be effective if the family members of the patient are not involved in decision making. Family members play a significant role in decision making. Information sharing in healthcare involves family members. Patients may want their diagnostic results to be shared to one of their family members they wish, and also allow them to make a decision on their behalf (Verkerk et al., 2015). In cases of ambulatory care, family members are crucial as they assist the nurses in decision making on the better intervention to take, in consideration to their environmental factors.

As a conclusive remark, the management and control of diseases such as sickle cell anemia involves more than one stakeholder. Sickle cell anemia has low prevalence in America. However, it is attributable, together with other single-gene diseases, to cause certain disease and mortalities. The sickle cell anemia can be tested in a laboratory, a process that is crucial for a better management and treatment of the disease earlier. There are drugs that can be used in the treatment of sickle cell anemia however, not all drugs can also be used anyhow without the approval of the US Food and Drug Administration. The US Food and Drug Administration controls the use and sell of the new drugs as it carries out an assessment before licensing their use in general public. Capitalism in healthcare has allowed for better acre for every United States citizen. Every citizen can access managed care regardless of their financial situation. Additionally, family members are also a major stakeholder that assist in decision making in healthcare, such as in the cases of ambulatory care and the decisions on the better intervention to be taken.

Sickle cell anemia remains the main form of sickle cell disease that is inherited from parents and passed on to their offspring. Owing to the limited treatment options with bone marrow transplant being the only curative measure, it is imperative therefore for there to be an in-depth understanding of this condition with the view of managing it properly (Adewoyin, 2015).  The rationale for such an understanding is to explore the best possible ways to manage the condition. The issue of sickle cell anemia equally raises the subject of clinical genetics (Nussbaum, McInnes & Willard, 2015). Ideally, this is essential in ensuring that hereditary diseases are not only given a correct diagnosis but that proper measures are pursued in order to manage the condition effectively. Further, a hereditary disease such as sickle cell anemia is a disease that is not only confined to a patient but equally their family members. Genetic counseling, therefore, becomes an essential part in informing the affected person or their family members regarding the comprehension of the likely cause of a disorder as well as the management options and the understanding of the heredity impacts on a disorder (Middleton, Hall & Patch, 2015). The process of counseling is likewise often an emotional one and which an individual and their family may not be well prepared for. Thus, given the non-curable nature of sickle cell anemia, it becomes very necessary that individual and their families are able to get the needed support to handle both the social and psychological issues attached to the sickle cell disorder (Yawn & John-Sowah, 2015). Some of the critical aspects include the undertaking of chromosomal analysis, the causes behind the disorder, how the disorder originates as well as the disorder’s gene mutation and if inherited or acquired in the given case study.

**Chromosomal Analysis**

Chromosomal analysis is an integral part of the procedures involved in clinical medicine. There is an indication of a chromosomal analysis in the given case study. In the case of sickle cell anemia, an analysis of the chromosomes primarily involves laboratory tests. There is, therefore, an indication of laboratory testing for purposes of examining and identifying the presence of abnormal hemoglobin. In a laboratory analysis, the alteration of any of the genes is detected in order to show that hemoglobin is not in its normal form. Basically, through a chromosomal analysis, the detection of either the presence or absence of sickle cell anemia is made possible. It was evident that the patient’s mother was homozygous for sickle cell gene and the father was a carrier of the disease.

**Causes of Sickle Cell Anemia**

The inheritance of abnormal hemoglobin primarily causes sickle cell anemia. The abnormal hemoglobin basically refers to oxygen that contains proteins within its red blood cells. The abnormal hemoglobin then distorts the red blood cells. As a result, the distorted red blood cells become very fragile thus becoming prone to some form of rapture. Once the red blood cells in one’s body reduce due to rapture, the person then becomes anemic. Essentially sickle cell anemia is a deficit in the red blood cells that are healthy enough to transport blood throughout the body. Further, the bone marrow is responsible for the manufacturing of red blood cells.  The biconcave shape which is, to some extent, unique provides aids in the provision of more storage capacity the oxygen-carrying molecules. Such a scenario then makes the cells capable of squeezing through even the tiniest of blood vessels within the body.  Nonetheless, as a cause of sickle cell, the red blood cells are damaged and not capable of squeezing through efficiently thus preventing efficient circulation of blood.  Equally, the disease is known to occur more among African Americans and Americans.

**How Sickle Cell Anemia Originates**

Persons that only inherit a gene from one parent is only capable of having a sickle cell trait.  Persons that only have a sickle cell trait generally exhibit good health. Essentially, sickle cell trait is not normally regarded as a condition. The complications attached to it are mostly mild and very rare. Only in rare cases are morbidity issues noted. Therefore, no symptoms are normally exhibited by persons with sickle cell trait. The sickle cell anemia disease is inherited as basically being an autosomal recessive condition.  By being autosomal, it implies that the gene involved is in no way associated with the sex chromosomes.

 Sickle cell disease can be inheritable. As such the disorder may be passed down from a carrier parent to their children irrespective of gender (Nussbaum, McInnes, & Willard, 2015). Inheriting a single sickle gene is however not capable of causing the sickle cell disorder. However, if two persons both carrying the sickle cell gene mate, there is a possibility of their offspring suffering from sickle cell anemia. There has two be two genes involved. Therefore, in the present case, the sickle cell anemia has its origin in single gene inheritance. A single gene is one of the three recognized categories of known genetic disorders.  In single gene inheritance, also known as Mendelian inheritance, a gene pair comprised of an allele from either parent, mother, and father is responsible for sickle cell anemia. By being Mendelian, it means occurrence is mostly in fixed proportions (Nussbaum, McInnes & Willard, 2015). The two parents are both not individually capable of leading to the inheritance of sickle cell anemia to their offspring. Instead each parent’s single gene with other parents’ genes.

**Gene Mutation in Sickle Cell Disorder**

The sickle cell disorder is attributed to the point mutation. This form of mutation causes the red blood cells in hemoglobin to be distorted and consequently have a sickle shape once deoxygenation has happened.  The blood cells after that take the shape of a sickle clog the blood capillaries thus preventing circulation.  Nevertheless, with regards to mutation, two genes have to be mutated in order for sickle cell anemia to exist. Mutations are generally not always detrimental, but there are instances that the coding of a mutation goes wrong. This is the case in the sickle cell mutation. Due to an error in the gene mutation, blood circulation is affected hence sickle cell anemia.

Evidently, the sickle cell disorder is a life-threatening condition which requires efficient management. A broad and efficient understanding is therefore necessary. The heredity nature of the condition also makes it more than just an individual issue but a family matter as well in order to explore the risk management factors regarding the disorder. Generally, the role of gene mutation in the origin of the sickle cell indicates that the genetic composition of parents is capable of determining the potential of inheritance of sickle cell anemia.  The aspect of genetics counseling, therefore, is an area whose further exploration would provide more answers towards managing the sickle cell disorder.

Equally, the advancement in research and technology within the health industry has brought to the core a number of aspects regarding genetic diseases and their management. For instance, while the focus has been placed on the influence that genetics have on policy issues, there are equal concerns on the role nutrition has in sickle cell anemia as well as nutritional assessment and counseling, and how these issues relate to aspects like treatment options in sickle cell anemia and their effectiveness. The sickle cell disease ideally entails a myriad of issues that require adequate addressing for the proper management of the disease.

**The Influence of Genetics in Policy Issues**

Policy making within the healthcare sector is very crucial if better health care is to be realized.  One of the issues that has become of interest is that of genetics and genomics. There has been a heightened increase in the role that genetics play in policy making and their overall impact. Unlike diseases that are easily detectable through their presenting symptoms, genetics in health care are largely based on the prediction. Genomic medicine is, therefore, one of the ways that illustrate how genetics have in the recent past affected health care policies (Sarata, 2015). Through reliance on one’s health risks, better policies are formulated in order to arrive at the most preferred health decisions. With the rise in genetic testing, for instance, there is more interest in formulating health policies that incorporate both diagnostic and predictive tests. The sickle disease, for instance, is one of the many genetic diseases that have currently impacted health policies owing to a history of discrimination of persons with sickle cell. Overall, unlike before there is more influence from genetics in the formulation of health policies.

**Nutritional Influences on the Cause of Sickle Cell Anemia**

There is a direct relationship between the sickle cell disease and nutrition. As a chronic illness, there have been numerous attempts to demystify the role that nutrition has in ensuring that a patient still achieves a healthy lifestyle. Even so, nutrition may equally be a trigger for the occurrence of the disease itself (Qi, 2009). One of the major causes of a sickle cell crisis is dehydration. Insufficient water levels in the body cause the red blood cells to thicken, and red blood cells of a sickle cell shape are likely to clump together and result in the hampering of blood circulation. Dehydration on the 47-year-old female will, therefore, hamper proper management of her condition.

On the other hand, deficiencies in of various micronutrients and calories have been associated with certain clinical aspects of the sickle cell disease. Persons living with sickle cell have therefore been noted to have a heightened need for both micronutrients such as minerals and vitamins as well as calories. Further, persons with the sickle cell disease have lower levels of various vitamins and minerals such as zinc and magnesium. These deficiencies, in turn, lower the antioxidants contained in blood. Having proper nutrition therefor is quite essential for a 47-year-old female with sickle cell anemia. The rationale for this is particularly for her vital health and the management of sickle cell disease by preventing frequent or severe crises (Adewoyin, 2015). Micronutrients will essentially help in the fight against any infections and the generation of new and healthy red blood cells.

**The process of Nutritional Assessment and Counseling in Sickle Cell**

Nutrition assessment in sickle cell refers to a critical and systematic evaluation of one’s nutrient intake as well as their lifestyle and medical history. Conversely, counseling entails a process of assisting the patient make conscious and informed decisions regarding the disease and how well it may be managed throughout their lifetime. Aspects of genetic counseling, in this case, cannot be undervalued (Nussbaum, McInnes & Willard, 2015). The nutritional assessment process involves the gathering of the relevant information pertaining to a person’s nutrient intake and after that interpreting the information. Interpretation is made for purposes of deciding how one’s nutrition could be a trigger or causal factor to sickle cell disease. The processes of nutritional assessment and counseling have an impact on the patient’s health, screening, diagnostics, selection of treatment as well as the monitoring of the treatment’s effectiveness.

Nutritional assessment and counseling are integral to the patient’s health. In view of the fact that sickle cell is not curable, there is a pressing need for the patient’s nutritional needs to be assessed in order to establish whether a patient’s nutrient intake may directly be affecting any complications associated with the disease. The 47-year female’s nutritional needs will be assessed in relation to the status of her condition. By conducting a nutritional assessment on her, it will be established whether her present status is attributable to her nutrient intake and how well she may be advised so as to avert a sickle crisis due to nutrient deficiencies.

Counseling is particularly important when selecting the preferred treatment for a person with sickle cell anemia. Treatment is not done in isolation of the patient. Such a consideration is important more so due to the emotional and psychological needs attached to the nature of the disease (Nussbaum, McInnes & Willard, 2015). As such, it becomes a necessary component to involve the patient in the treatment plan in order for them to understand the treatment options and available and why certain options will be preferable for their case. The counseling process will enable the patient to appreciate the role of treatment for their condition.

Both nutrition assessment and counseling play a major role in the effectiveness of the treatment for sickle cell anemia. For instance, diet will directly determine the occurrence of a sickle crisis or not. Consequently, for the treatment options to have their desired effectiveness, dietary requirements will need to be adhered to.

**Prevalence Rate of Sickle Cell Disease With Regards to Human Nutrition**

The prevalence of the sickle disease is among other contributory factors attributed to human nutrition albeit in some cases. Human nutrition is central to the disease because of the high tendencies that things such as micronutrient deficiencies have in triggering a sickle cell crisis.

Notably, the sickle cell disease remains among the many genetic disorders that have aroused continued interest within the healthcare sector. From the influence on policies issues to matters of nutritional assessment, the condition has gained enormous attention. Further, the condition not being curable has considerably attracted interest regarding the nutritional needs of a person living with it. The reason for such interest is pegged on the direct relationship that sickle cell management has with nutrition. As such, it is arguable that sickle cell disease is multifaceted with a number of components being integral for the proper management of the disease.

**Conclusion**

**Ethical Considerations for Sickle Cell Disease**

Although the treatment or management of any health condition gives rise to a number of ethical considerations, the sickle cell disorder is among the disorders that have over the years exhibited a considerable number of ethical concerns. Ethical considerations for this disease, therefore, range from autonomy, confidentiality, privacy, and respect. Autonomy, in this case, refers to the freedom of the sickle cell patient to make choices regarding the disorder’s treatment and management (Labore et al., 2017). It is one of the fundamental principles in healthcare ethics Even though health care providers are better positioned to understand the needs of a sickle cell patient; there are numerous choices that patients ought to be allowed to make such as choosing their care providers.

Just as is the case for every patient population, sickle cell disease patients need to be treated respectfully. However, in many of the instances, the care of sickle cell disease patients is often characterized by respect insufficiencies (Haywood, 2013).  Respect refers to the attitude of showing value to another person. It is demonstrated through behavior that expressed such attitude. By healthcare providers showing respect to a sickle cell patient, there is a more likelihood for trust to be created hence a good relationship between patient and caregiver. As such ethical consideration, health providers have an obligation to create a healthy relationship with the sickle cell patient for them to feel at ease and valued during patient and health professional interaction.

Prevention of stereotyping sickle cell patient is an important ethical consideration. Since the disorder is one that racially inclined, some of the patients have been prone to be subjected to stereotype tendencies because of their race (Haywood, 2013). As an ethical consideration, health care providers are to be keen on any factors that are likely to arouse stereotype acts. For example, each patient ought to be treated as an individual regardless of their racial background. It is nonetheless worth noting that amidst these ethical considerations are ethical dilemmas that health professionals attending to patients have to grapple with. It is therefore at times a choice of striking a balance.

Genetic testing is one of the aspects of sickle cell disease that have brought to the fore patient confidentiality. Confidentiality is a cornerstone of doctor-patient and violating it is outrightly unethical. Disclosing of information to the family of the patient ought to be evaluated on the basis of the interests and needs of a patient in relation to those of family members. There is nonetheless a dilemma when it comes to the patient’s entitlement to privacy and the right of the patient’s family to access information whose concealment would otherwise pose health risks to them (Witt, M. M., & Witt, M. P. (2016). Such a dilemma raises questions as to who is the subject of genetic testing and counseling.

**Improving Care and Health Outcomes through Genetics in relation to reduced costs of Usual Practices**

The application of genetics has the potential of significantly improving care and health outcomes. One of the reasons why such may be the case is that the health professionals are now more aware and conscious of the role that genetics play. Genetics relies on information regarding one’s genetic composition to improve their health. The heightened increase in this field has coincided with a similarly high interest in recognizing the need for improving health care. Adopting genetics into healthcare provision, therefore, has led to better health outcomes. As opposed to the past years, information from genetic testing, for instance, has enabled health professionals to make an accurate diagnosis and prevent health problems early enough. Currently, there is sufficient evidence showing how genetics can contribute to improved care and health outcomes. With the inclusion of genetics in health care, there will be a higher prevalence of personalized medicine. Through personalized medicine, sickle cell patients, for instance, will able to receive treatment that is premised on the individual needs of a patient.

 The paramount goal of health caregivers in the treatment of sickle cell is to offer individualized treatment. Such treatment is based on information from a person’s genes. Sickle cell anemia is particularly linked to clinical heterogeneity that is somewhat unusual. An in-depth comprehension of the genetics behind the sickle cell disease, therefore, is critical to in informing personalized treatment. Misdiagnosis has for the longest time been among the reasons behind poor health care and unfavorable health outcomes. Consequently, with a more accurate diagnosis of genetic disorders, disease aggressiveness has been determined and after that direct treatment offered. Genetics have equally to a great extent in the reduction of costs in the usual practices. One of the reasons behind this is that the health professionals are now better placed to quickly arrive at an accurate diagnosis thus saving on the previously incurred costs.

**Changes in the Approach to Care when Evidence necessitating the Evaluation of Other Options is Presented**

Presentation of evidence suggesting that other options ought to be explored is often a sign that the existent approaches are not efficient or are inadequate. In the case of sickle cell disease, for instance, change in approach may be brought about by evidence indicating that the treatment option in a particular patient is ineffective. Evaluation of new evidence will include the consideration of how other options will improve the treatment given to a patient. Unlike other health conditions, the sickle cell disorder is one that presents a myriad of issues across different patient thus eliminating a uniform approach.

**Plan to Educate Health Professionals and Patients on the Sickle Cell Disorder**

Education of both patients and health professionals is very critical in ensuring that both sides are fully aware of the disorder and how well the disease can be managed. Educating colleagues in the health profession is particularly important because the health professionals handling a sickle case are central to the outcomes of managing the disease. In educating both patients and colleagues, I will employ a plan that not only takes into consideration all the associated factors. Educating patients will include informing them of how to prevent avoidable complications of the disorder and dealing with any resultant emergencies whenever they arise. Even though sickle cell anemia is not curable except in the case of a bone marrow transplant, being fully informed.

 It is imperative to note that the education of patients will entail informing them on nature of the sickle cell disorder and how the condition comes about. Such information will be specifically important in enabling the patients to realize that issues of blaming other family members, particularly parents, is not justifiable. A patient that is fully aware of how sickle cell disease goes on with his or her life in a normal way. More so, they are responsive to the support from their family members. Owing to the valuable nature of support that families offer, the health professionals are therefore unlikely to experience difficulty when handling patients.

Another component of the plan is to take the patients through the treatment options available for sickle cell and what treatment option may be preferable for a particular patient. The importance of this aspect of the plan is that patients are very central to the various issues regarding treatment options more so that of deciding on their care provider. Educating treatment options for sickle cell disorder will, therefore, be important in properly managing the patient’s disease. Though sickle cell patients have a common health condition, issues the sickle cell disease crisis may vary from patient to patient and therefore require an individual’s case to be handled independently. Educating an individual patient is part of the possible means to ensure each patient’s treatment needs are met.

The education of health care providers about sickle cell disease will entail making them informed on issues such as nutritional assessment, genetic testing, and counseling, nutritional assessment as well as treatment options. An education plan of this nature is helpful in ensuring that all the relevant factors are incorporated in management and treatment options (Yawn & John-Sowah, 2015). Genetic counseling and testing are critical stages that my colleagues will need to be very cautious off owing to the sensitive nature of a patient at these stages. Dealing with the patient’s emotions will require appreciating the fact that patients are very likely to have profound reactions to positive genetic test (Nussbaum, McInnes & Willard, 2015). Such an appreciation is necessary for my colleague healthcare providers to empathize with the patient and appropriately react to their emotions.

**References**

Adewoyin, A. (2015). Management of Sickle Cell Disease: A Review for Physician Education in Nigeria (Sub-Saharan Africa). *Anemia, 2015,* 1-21. doi: 10.1155/2015/791498

Ashiru, O. A., Ogbeche, R., Oladimeji, D. M., Iloabachie, E., & Osumah, O. (2017). Trophectoderm biopsy for preimplantation genetic testing (PGT) for sickle cell anemia: successful outcome in a developing country. *Fertility and Sterility*, *108*(3), e266.

Ballas, S. K. (2016). From individualized treatment of sickle cell pain to precision medicine: a 40-year journey. *Journal of Clinical Medicine Research, 8*(5), 357.

Development & Approval Process (Drugs). (2018). Retrieved from <https://www.fda.gov/Drugs/DevelopmentApprovalProcess/default.htm>

Haywood Jr, C. (2013). Disrespectful care in the treatment of sickle cell disease requires more than ethics consultation. *The American Journal of Bioethics, 13*(4), 12-14.

Labore, N., Mawn, B., Dixon, J., & Andemariam, B. (2017). Exploring transition to self-management within the culture of sickle cell disease. *Journal of Transcultural Nursing, 28*(1), 70-78.

Myler, L. (2015). Healthcare Innovation: Show Me The Grant Money. Retrieved from <https://www.forbes.com/sites/larrymyler/2015/09/24/healthcare-innovation-show-me-the-grant-money/#4739bca277be>

Nussbaum, R. L., McInnes, R. R., & Willard, H. F. (2015). *Thompson & Thompson Genetics in Medicine E-Book.* Elsevier Health Sciences.

Qi, L. (2009). Mendelian randomization in nutritional epidemiology. *Nutrition Reviews*, *67*(8), 439-450.

Ribeil, J. A., Hacein-Bey-Abina, S., Payen, E., Magnani, A., Semeraro, M., Magrin, E., ... & Bartolucci, P. (2017). Gene therapy in a patient with sickle cell disease. *New England Journal of Medicine, 376*(9), 848-855.

Sarata, A. K. (2015). *Genetic Testing: Background and Policy Issues*. Washington, DC: Congressional Research Service.

Verkerk, M. A., Lindemann, H., McLaughlin, J., Scully, J. L., Kihlbom, U., Nelson, J., & Chin, J. (2015). Where families and healthcare meet. *Journal of Medical Ethics*, *41*(2), 183-185.

Witt, M. M., & Witt, M. P. (2016). Privacy and confidentiality measures in genetic testing and counselling: arguing on genetic exceptionalism again?. *Journal of Applied Genetics*, *57*(4), 483-485.

Yawn, B. P., & John-Sowah, J. (2015). Management of sickle cell disease: recommendations from the 2014 expert panel report. *Am Fam Physician, 92*(12), 1069-1076.