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## Experiences With and Knowledge of Genetics in Families Affected by Congenital Adrenal Hyperplasia: The Parent Perspective

Christine Maccia

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EXPERIENCES WITH AND KNOWLEDGE OF GENETICS IN FAMILIES AFFECTED BY  
CONGENITAL ADRENAL HYPERPLASIA: THE PARENT PERSPECTIVE

by

Christine Maccia

Bachelor of Science  
UNC Wilmington, 2015

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Submitted in Partial Fulfillment of the Requirements

For the Degree of Master of Science in

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Accepted by:

Janice Edwards, Director of Thesis

Emily Jordon, Reader

Jaqueline Leonard, Reader

Louisa Pyle, Reader

Cheryl L. Addy, Vice Provost and Dean of the Graduate School

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## ABSTRACT

**Purpose:** This project was conducted in order to assess how parents of a child affected by *CYP21A2*-related classic CAH experienced receiving genetic information, The goal was to determine their knowledge of the genetics of the condition and how that knowledge has affected different aspects of their lives such as emotional well-being.

**Methods:** Parents of a child with classic CAH diagnosed in the past 10 years were invited to participate in an online survey via an advertisement posted in the support group, Major Aspects of Growth in Children. Survey questions consisted of demographic information, experience with the diagnostic process, knowledge of genetics, and open-ended questions. At the conclusion of the online survey, participants were invited to provide their email address if they wished to participate in a follow up interview. The semi-structured interview allowed parents to expound on their experiences with receiving genetic information and the impact it had on different aspects of their life. **Results:**

Twenty-two parents completed the online survey and four completed follow-up interviews. Four major themes regarding the diagnostic process were identified: genetic counseling, distress and information overload at diagnosis, use of information to obtain knowledge, and online support. **Conclusion:** These results indicate involvement of a genetic counselor during the diagnostic process was lacking, however, when participants had received genetic counseling, understanding their test result and inheritance of CAH, as well as the empathy shown by the counselor were the most important benefits. They also suggest parent's experience a significant amount of distress regarding their child's

diagnosis and identifies resources find useful for information and support. Genetic counselors can provide targeted, directed, and appropriate psychosocial and genetics-focused care for families. Involvement of a genetic counselor in the diagnostic process for CAH may lead to increased understanding of the genetics of CAH and decreased distress during the diagnostic process. Genetic counselors should work with pediatric endocrinologists to ensure that newly diagnosed patients are referred to genetics.

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## LIST OF ABBREVIATIONS

17-OHP .....	17-hydroxyprogesterone
21-OH .....	21-hydroxylase
CAH .....	Congenital Adrenal Hyperplasia
CCC .....	Comprehensive Care Centers
ECS .....	Expanded Carrier Screening
MAGIC .....	Major Aspects of Growth in Children
NBS .....	Newborn Screening
NC-CAH .....	Non-classic Congenital Adrenal Hyperplasia
PTSS .....	Posttraumatic Stress Symptoms
SV-CAH .....	Simple-virilizing Congenital Adrenal Hyperplasia
SW-CAH .....	Salt-wasting Congenital Adrenal Hyperplasia

# CHAPTER 1

## BACKGROUND

### 1.1 Congenital Adrenal Hyperplasia

Congenital adrenal hyperplasia (CAH) is a family of disorders primarily affecting the adrenal glands with associated hormonal differences. Uniquely, this disorder is associated with secondary genital differences in affected 46, XX individuals. Rarely 46, XY individuals exhibit secondary genital differences. Congenital adrenal hyperplasia is due to pathogenic variants in the genes *CYP21A2*, *CYP11B1*, *CYP17A1*, *HSD3B2*, *POR*, *STAR*, and *CYP11A*, which primarily code for enzymes involved in steroid biosynthesis (Yau et al., 2019). Pathogenic variants in the *CYP21A2* gene account for approximately 90% of congenital adrenal hyperplasia cases. For the purpose of this paper, *CYP21A2*-related CAH is synonymous with CAH unless otherwise specified. The *CYP21A2* gene codes for the 21-hydroxylase (21-OH) enzyme responsible for converting 17-hydroxyprogesterone (17-OHP) to 11-deoxycortisol during the final step of cortisol production (Witchel, 2017). When 21-OH is not functioning, 17-OHP cannot be metabolized and therefore accumulates in the individual leading to increased concentrations of testosterone, progesterone, and 17-hydroxyprogesterone. In addition, cholesterol cannot be biosynthesized into its downstream products cortisol, a stress hormone, and aldosterone, a hormone responsible for regulating salt retention. Congenital adrenal hyperplasia is commonly separated out into classic and non-classic forms (NC-

CAH), with the classic form being further divided into salt-wasting (SW-CAH) and simple-virilizing (SV-CAH).

## 1.2 Classic CAH

Classic CAH is inherited in an autosomal recessive manner and involves impaired cortisol biosynthesis leading to the accumulation of steroid intermediates such as progesterone and 17-OHP and deficiency of products such as aldosterone from precursor cholesterol by the adrenal cortex. The classic form of CAH presents in the neonatal period for both 46, XX and 46, XY individuals, however 46, XX individuals are more likely to be recognized as having classic CAH in the neonatal period versus 46, XY individuals. In 46, XX individuals with classic CAH, atypical genitalia are commonly the first clinical sign whereas 46, XY individuals may present with an abnormally pigmented scrotum due to abnormal testosterone. In childhood both 46, XY and 46, XX individuals with classic CAH also may develop early signs of secondary sexual characteristics due to premature adrenarche. As stated above, one of the primary downstream products of the cholesterol metabolism pathway that is interrupted in CAH is adrenal androgens such as testosterone. This interruption leads to excess androgens resulting in virilization in all forms of CAH (Nimkarn et al., 2002). When these are the only features present in affected individuals, they are said to have simple-virilizing CAH. The salt-wasting form of CAH represents seventy percent of people with classic CAH and can result in death due to dehydration, arrhythmias, and metabolic acidosis if not identified quickly (Yau et al., 2019). The salt-wasting form of CAH is characterized by chronic hyponatremia, hyperkalemia, and metabolic acidosis as elevated aldosterone causes the body to be unable to retain enough sodium (Miller, 2019). The salt-wasting phenotype is only

associated with the most severe, but also most common, form of this disorder due to total lack of enzymatic function. Individuals with any form of CAH may have short stature later in life due to earlier accelerated bone age and decreased fertility or infertility. Additionally, 46, XY individuals are at risk for testicular adrenal rest tumors with a prevalence of up to 94% (Claahsen-van der Grinten et al., 2009).

### **1.3 Treatment for CAH**

Treatment for CAH consists of glucocorticoid and mineralocorticoid replacement therapy to reduce stimulation of the androgen pathway that leads to virilization. Hormone levels require consistent monitoring that is primarily followed by a patient's endocrinologist. In order to avoid salt crises, those with classic CAH are given 1-2 g sodium chloride and 0.1 to 0.2 mg of mineralocorticoids daily. The lowest dose of glucocorticoids and mineralocorticoids is given in order to maintain appropriate suppression of androgens and prevent salt-wasting, while maintaining appropriate weight and preserving maximum height potential. Aromatase inhibitors and growth hormone therapy can aid in achieving maximum height potential. In case of illness or salt crisis, immediate treatment should be sought and admission to a hospital may be required. (Kamoun et al., 2013)

Historically, surgery was routine for individuals with atypical genitalia to allow for proper function, reduce complications such as urinary tract infections, and allow for reproduction (Houk et al., 2007). However, in recent years genital surgery for individuals with any form of atypical genitalia has become controversial due to the need for multiple surgeries resulting in profound scarring and gender dysphoria (Houk et al., 2007). Long-

term outcomes for those with CAH, even with treatment, are generally mixed either due to continued hyperandrogenism or the effects of long-term glucocorticoid use such as osteoporosis, hypertension, and elevated cholesterol. Affected individuals are also at risk for brain abnormalities and cognitive delays due to hormonal imbalances and salt crises. With early treatment, fertility in both males and females is largely preserved (Kamoun et al., 2013; Yau et al., 2019), however, even with treatment individuals have increased cardiovascular and metabolic disorder risk factors such as obesity, insulin-resistance, and dyslipidemia.

## 1.4 Diagnosis

### 1.4.1 Diagnosis of an Affected Individual

Congenital adrenal hyperplasia can be diagnosed through biochemical or molecular testing. The biochemical test for CAH involves measuring levels of 17-OHP. Elevation of 17-OHP is biochemically diagnostic for CAH and is the basis for the newborn screening (NBS) protocol. Newborn screening for CAH involves an immunoassay that tests for 17-OHP from a dried blood spot sample on Guthrie paper. Molecular testing for CAH involves sequencing and deletion/duplication testing of the *CYP21A2* gene and/or other genes associated with CAH. Limitations to molecular testing for CAH revolve around pseudogene interference. The *CYP21A1P* gene is a nonfunctional pseudogene that shares 98% sequence homology with the *CYP21A2* gene (Lee, 2014). Special laboratory techniques must be employed when performing molecular testing for CAH to ensure the active *CYP21A2* gene is being sequenced and not the *CYP21A1P* pseudogene (Lee, 2014). Genetic testing for children who have a positive NBS for CAH, or who are otherwise suspected of being affected, is useful in helping to

predict the clinical course of the condition. About forty different pathogenic variants have been identified in the *CYP21A2* gene with 50% of those having a clear genotype-phenotype correlation (New et al., 2013). Compound heterozygosity, or the presence of two different pathogenic variants, one on each chromosome, may lead to the presence of a combination of SW-CAH, SV-CAH, and/or NC-CAH variants in the same individual. This is a point where genetic testing is crucial, as knowing specific pathogenic variants in an individual can further delineate the risk for adrenal crisis.

#### **1.4.2 Identification of Carriers**

If a child undergoes genetic testing and two pathogenic variants responsible for CAH are identified, carrier testing for the child's parents can be performed. Parents may wish to know their carrier status as this information is useful when considering family planning. Prenatal diagnosis via chorionic villus sampling or amniocentesis, both invasive procedures that obtain placental or fetal cells, respectively, can be used to test for the known pathogenic variants before birth. Recent technological advances have created a noninvasive testing method to identify the CAH status of a fetus by testing cell-free DNA as early as six weeks gestation, however this is not widely available (Yau et al., 2019). As cell-free DNA testing is considered screening, further diagnostic testing would be recommended for confirmation of a diagnosis. In addition, parents can now learn that they are at risk to have a child with CAH via expanded carrier screening (ECS). The goal of carrier screening is to identify asymptomatic individuals who have pathogenic variants associated with an array of genetic conditions in order to identify at-risk couples. Expanded carrier screening looks for a number of genetic diseases irrespective of ethnic background (Sparks, 2019). Congenital adrenal hyperplasia was

previously not on carrier screening panels due to difficulties the pseudogene presented; however technological advances have made it possible to do carrier screening for CAH that is now available through several laboratories.

### **1.5 Care for Children with CAH**

In 2010, guidelines for the care of individuals with CAH were published to establish comprehensive care centers (CCC) for individuals of all ages with CAH. As care for this population is often fragmented, CCC enables easy access to all providers involved in the individual's care. According to guidelines, the interdisciplinary team at each CCC should include pediatric/internal medicine endocrinologists, reproductive endocrinologists, pediatric urologists/surgeons, gynecologists, geneticists/genetic counselors, behavioral health professionals, nutritionists, social workers, pediatric endocrine teaching nurses, and nursing staff (Auchus et al., 2010). Affected individuals would be referred to the CCC by their primary care provider, community health clinic, or state NBS laboratory to establish care. At the initial visit a pediatric endocrinologist would discuss the diagnosis of CAH, review the medical needs of the individual, and what treatment entails and how it is administered. Delivery of introductory genetic counseling to explain basic genetic concepts as they relate to CAH should be done at the earliest stage possible. As the initial visit is often overwhelming for families and there is a vast amount of information being presented, formal counseling by a geneticist and/or a genetic counselor should be delivered at a subsequent visit (Auchus et al., 2010). According to the CARES Foundation, an organization that serves both families and individuals with CAH, there are four CCC in the United States: New York-Presbyterian/Weill Cornell Medical Center in New York City, Children's Hospital

Los Angeles/Cedars Sinai/USC in California, Cohen Children's Medical Center/Northwell Health in New York state, and Riley Hospital for Children/Indiana University Health in Indianapolis.

### **1.6 Informational Needs of Parents of Children with CAH**

Studies have shown that there is a need for early, high quality information during the diagnostic discussion of a chronic and genetic condition (DeWalt & Hink, 2009). A study by Boyse et al. in 2014 found shortcomings in the way a diagnosis of CAH was communicated to parents. The Boyse et al. study found that parents had a limited understanding of the medical jargon used by their endocrinologist and were overwhelmed with the information provided to them at one time. In 2016 Lundberg et al. conducted a study that defined the various types of information that parents need in order to care for their child with CAH. In the study, parents emphasized a need to know what CAH is, how to cope with the diagnosis, and how to talk to their children. Most parents reported that when their child was diagnosed, they grappled with the understanding of what CAH was. Parents also reported they only understood pieces of the information provided and highlighted a need for information to be provided in plain, nonmedical language in order to avoid confusion (Lundberg et al. 2016).

### **1.7 Impact of Knowledge on Psychological Well-Being**

As previous research has shown parent's dissatisfaction in interactions with physicians during their child's diagnosis, it is important to explore how these experiences and lack of knowledge has impacted parents' psyche (Starke & Moller, 2002). In 2013 Paterski et al. investigated posttraumatic stress symptoms (PTSS) in parents of children



with a disorder of sex development to assess levels of PTSS in these individuals as well as what factors contributed to parents experiencing PTSS. The researchers recruited parents from an endocrine clinic where a child was receiving treatment as well as a patient support network and asked participants to fill out the *Impact of Events Scale Revised* (IES-R) to measure self-reported posttraumatic stress. Parents were asked to focus on their experience upon disclosure of their child's diagnosis when making their ratings. Paterski et al. found that parents of a child with a disorder of sexual development experience considerable levels of PTSS as a function of cognitive confusion rather than emotional distress. These results are consistent with other studies that have shown that reducing the amount of confusing information being given to parents or giving tailored information on a diagnosis or prognosis in a way that parents can understand reduces the amount of stress parents experience (Kitamura, 2005).

### **1.8 Impact of Knowledge on Family Communication**

A study by Abad et al. in 2016 described how Filipino parents communicated information about a child's diagnosis of CAH to their siblings and parents. They found that while all parents communicated the diagnosis to their family members, they were more likely to share information on the health implications of the condition versus communicating genetic information. While parents shared genetic information about CAH, the scope of information shared was limited to inheritance pattern, the possibility that parents are carriers, and recurrence risks for future pregnancies. The study observed that even though information was shared with relatives, the information was focused on implications for the parents themselves and not how this information might affect their relatives. Specifically, they did not share genetic information to those who might benefit

from the information, such as siblings who could themselves be carriers of the condition. The authors hypothesized that because health information was communicated more in-depth than genetic information, families viewed this as more important to the family members than genetic information. The study also found that the parents had limited understanding of the genetics of CAH. For example, some families thought that all children born after a child with CAH also would have the condition. There also was a misconception that carrier status was limited to the parents of a child with CAH as some parents were unaware that their siblings also were at risk to be a carrier for the condition (Abad et al., 2016).

## **1.9 Rationale**

To our knowledge, there exists no literature that explores the experiences parents with a child affected by classic CAH have with receiving genetic information and how that experience affects their knowledge regarding the genetics of the condition.

Additionally, no study explores the emotions parents experience post-diagnosis and how genetic counseling and knowledge of genetics affects the lives of parents who have a child with classic CAH. As the genetics and treatment implications of the condition can be quite complicated, ensuring parental understanding of this information can be vital to help them cope with and manage their child's condition. In general, literature reports on the experience receiving a diagnosis for a chronic condition such as CAH, and the subsequent communication with family and subsequent psychological well-being, however no study addresses these factors with a specific focus on genetic information. It has been well documented that parents report dissatisfaction with the information provided to them at the time of diagnosis and that appropriate understanding of a child's

diagnosis can reduce the amount of stress experienced by individuals receiving the information (Kitamura, 2005; Starke & Moller, 2002). As only four CCC currently exist in the United States, families with CAH may not have access to all the health professionals that are recommended to be involved in their multidisciplinary care. Specifically, a genetics professional's involvement during the diagnostic process may be lacking. As genetic counselors are trained in both medical genetics and counseling to provide information and support to patients receiving a genetic diagnosis, their involvement during the diagnostic process could be crucial during a difficult time. Furthermore, gaining additional information on what is and is not helpful to families may help ensure targeted, directed and appropriate psychosocial and genetics-focused care for these families into the future.

### **1.10 Purpose**

This project was conducted in order to assess how parents of a child affected by *CYP21A2*-related classic CAH experienced receiving genetic information. We primarily aimed to determine the following objectives:

1. Describe how parents of a child with classic CAH experience receiving genetic information;
2. Determine which providers most commonly communicate genetic information to those affected by classic CAH;
3. Determine the knowledge that parents of an affected child have about genetics of classic CAH;

4. Determine how the genetic counseling experience and knowledge of genetics affects the lives of parents who have a child with classic CAH;

We hope to use this information to inform healthcare providers and genetic counselors on how to better address parent needs and improve patient-centered care for this unique population. As guidelines for the management of children with congenital adrenal hyperplasia are evolving and as CAH is now on ECS panels, this is an opportune time to assess parent knowledge of the genetics of classic CAH and their experience receiving genetic information in order provide contemporary care to this population. The CAH population will benefit from genetics professionals being knowledgeable about their experience with genetics in order to provide a prospective level of care that optimizes patient and parent outcomes.

### **1.11 Hypothesis**

We predict that within the classic CAH population, there are varied experiences receiving genetic information and variation in the knowledge parents have regarding the genetics of CAH. In families with a child affected by classic CAH, we hypothesize that the family's knowledge of the diagnosis and genetic components will have affected how they coped with the diagnosis and how confident they feel in their understanding of the genetics of CAH.

## CHAPTER 2

### Experiences with and Knowledge of Genetics in Families Affected by Congenital Adrenal Hyperplasia: The Parent Perspective<sup>1</sup>

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<sup>1</sup> Maccia, C., Edwards, J., Jordon, E., Leonard, J., Pyle, L. To be submitted to *Journal of Genetic Counseling*

## 2.1 Abstract

**Purpose:** This project was conducted in order to assess how parents of a child affected by *CYP21A2*-related classic CAH experienced receiving genetic information, The goal was to determine their knowledge of the genetics of the condition and how that knowledge has affected different aspects of their lives such as emotional well-being.

**Methods:** Parents of a child with classic CAH diagnosed in the past 10 years were invited to participate in an online survey via an advertisement posted in the support group, Major Aspects of Growth in Children. Survey questions consisted of demographic information, experience with the diagnostic process, knowledge of genetics, and open-ended questions. At the conclusion of the online survey, participants were invited to provide their email address if they wished to participate in a follow up interview. The semi-structured interview allowed parents to expound on their experiences with receiving genetic information and the impact it had on different aspects of their life. **Results:**

Twenty-two parents completed the online survey and four completed follow-up interviews. Four major themes regarding the diagnostic process were identified: genetic counseling, distress and information overload at diagnosis, use of information to obtain knowledge, and online support. **Conclusion:** These results indicate involvement of a genetic counselor during the diagnostic process was lacking, however, when participants had received genetic counseling, understanding their test result and inheritance of CAH, as well as the empathy shown by the counselor were the most important benefits. They also suggest parent's experience a significant amount of distress regarding their child's diagnosis and identifies resources find useful for information and support. Genetic counselors can provide targeted, directed, and appropriate psychosocial and genetics-

focused care for families. Involvement of a genetic counselor in the diagnostic process for CAH may lead to increased understanding of the genetics of CAH and decreased distress during the diagnostic process. Genetic counselors should work with pediatric endocrinologists to ensure that newly diagnosed parents are referred to genetics.

## 2.2 Introduction

Congenital adrenal hyperplasia (CAH) is a family of disorders primarily affecting the adrenal glands with associated hormonal and secondary genital differences in 46, XX individuals. Congenital adrenal hyperplasia is primarily due to pathogenic variants in the *CYP21A2* gene that codes for the 21-hydroxylase (21-OH) enzyme that is involved in cortisol production. Pathogenic variants in *CYP21A2* results in absent or decreased levels of 21-OH resulting in an accumulation of 17-hydroxyprogesterone (17-OHP), which then leads to increased concentrations downstream products. In addition, cholesterol cannot be biosynthesized into cortisol, a stress hormone, and aldosterone, a hormone responsible for regulating salt retention. Classic CAH is inherited in an autosomal recessive manner and presents in the neonatal period for both 46, XX and 46, XY individuals. Atypical genitalia or an abnormally pigmented scrotum due to increased concentrations of testosterone are commonly the first clinical sign of CAH. In childhood individuals with classic CAH also may develop early signs of secondary sexual characteristics due to premature adrenarche. When these are the only features present in affected individuals, they are said to have simple-virilizing CAH (SV-CAH). Salt-wasting CAH (SW-CAH) is characterized by chronic hyponatremia, hyperkalemia, and metabolic acidosis as elevated aldosterone causes the body to be unable to retain enough sodium (Miller, 2019). The salt-wasting phenotype is only associated with the most severe, but also most common,

form of this disorder due to total lack of enzymatic function. The salt-wasting form of CAH represents seventy percent of people with classic CAH and can result in death due to dehydration, arrhythmias, and metabolic acidosis if not identified quickly (Yau et al., 2019). All forms of CAH result in virilization due to excess androgen production. Additionally, individuals with any form of CAH may have short stature later in life due to earlier accelerated bone age and decreased fertility or infertility. Individuals who are 46, XY are also at risk for testicular adrenal rest tumors (Claahsen-van der Grinten et al., 2009).

Congenital adrenal hyperplasia can be diagnosed through biochemical or molecular testing. The biochemical test for CAH involves measuring levels of 17-OHP whereas molecular testing for CAH involves sequencing and deletion/duplication testing of the *CYP21A2* gene and/or other genes associated with CAH. About 40 different pathogenic variants have been identified in the *CYP21A2* gene with 50% of those having a clear genotype-phenotype correlation, however compound heterozygosity may lead to the presence of a combination of SW-CAH, SV-CAH, and/or NC-CAH variants in the same individual (New et al., 2013). This is a point where genetic testing is crucial, as knowing specific pathogenic variants in an individual can further delineate the risk for adrenal crisis and allows for carrier testing for the child's parents. Parents may wish to know their carrier status as this information is useful when considering family planning. In addition, carrier screening for CAH is available on expanded carrier screening panels.

Treatment for CAH consists of glucocorticoid and mineralocorticoid replacement therapy to reduce stimulation of the androgen pathway to prevent salt-wasting and reduce virilization. Historically, surgery was routine for individuals with atypical genitalia. In



recent years genital surgery for individuals with any form of atypical genitalia has become controversial due to the need for multiple surgeries resulting in profound scarring and gender dysphoria (Houk et al., 2007). In 2010, guidelines for the care of individuals with CAH were published to establish comprehensive care centers (CCC) for individuals of all ages with CAH to allow easy access to all providers involved in an affected individual's care. The interdisciplinary team at each CCC should include pediatric/internal medicine endocrinologists who would be responsible for delivering the diagnosis of CAH, reviewing the medical needs of the individual, and discussing treatment as well as delivering introductory genetic counseling. Additional members of the care team would include reproductive endocrinologists, pediatric urologists/ surgeons, gynecologists, geneticists/genetic counselors, behavioral health professionals, nutritionists, social workers, pediatric endocrine teaching nurses, and nursing staff. (Auchus et al., 2010)

Previous studies involving parents of children diagnosed with a chronic condition have shown that there is a need for early, high quality information during the diagnostic process (DeWalt & Hink, 2009). A study that looked specifically at parents who had children receiving a diagnosis of CAH found they had a limited understanding of the medical jargon used by their endocrinologist and were overwhelmed with the information provided to them at one time (Boyse et al. 2014; Lundberg et al, 2016). Additionally, a 2013 study by Paterski et al. found that parents of a child with a disorder of sex development experience considerable levels of post-traumatic stress symptoms (PTSS). Additionally, appropriate understanding of the genetics of CAH may impact the amount of genetics related information parents share with family members.

To our knowledge, there exists no literature that explores the experiences parents with a child affected by classic CAH have with receiving genetic information and how that experience affects their knowledge regarding the genetics of the condition. Additionally, no study explores the emotions they experience post-diagnosis and how the genetics experience and knowledge of genetics affects the lives of parents who have a child with classic CAH. As only four CCC currently exist in the United States, families with CAH may not have access to all health professionals that are recommended to be involved in their care. Specifically, involvement of a genetics professional during the diagnostic process may be lacking. Genetics professionals are individuals who can aid in the process of helping individuals understand and adapt to the medical, psychological, and familial implications of a genetic condition; therefore, their involvement during the diagnostic process can be crucial. Additionally, genetics professionals can provide targeted, directed and appropriate psychosocial and genetics-focused care for families that may lead to increased understanding of the genetics of CAH, reduced PTSS, and increased sharing of genetics related information to extended family members.

This project was conducted in order to assess how parents of a child affected by *CYP21A2*-related classic congenital adrenal hyperplasia experienced receiving genetic information and their knowledge of the genetics of congenital adrenal hyperplasia. We primarily aimed to describe how parents of a child with CAH experience receiving genetic information, and determine who most commonly communicates genetic information to those affected by congenital adrenal hyperplasia, the knowledge that parents who have an affected child have about genetics, and how the genetics experience and knowledge of genetics affects the lives of parents of an affected child. Results may

inform genetics professionals on how to best address parents' needs to improve patient-center care for this unique population.

## **2.3 Methods**

### **2.3.1 IRB approval.**

This study was approved by the Institutional Review Board, Office of Research Compliance, of the University of South Carolina, Columbia, SC in December, 2019.

### **2.3.2 Participants.**

Our study population included parents or primary caregivers of a child with classic CAH who was diagnosed between the years of 2010 to 2020. Parents of children diagnosed outside that time range were excluded. This timeframe was chosen to ensure more accurate recall of information surrounding the diagnostic process and to reflect a period in which parents received the relatively contemporary care. Inclusion criteria was being the primary caretaker for a child with a clinical or genetic diagnosis of classic CAH made in the past 10 years, being 18 years or older, and being able to speak, read, and write English. Exclusion criteria included having a child with nonclassic CAH, having a child who was diagnosed more than 10 years ago, being under the age of 18, and/or not being able to speak, read, or write in English. Participants were recruited from Major Aspects of Growth in Children (MAGIC), a support group for children with endocrine disorders including CAH, via an advertisement for participation posted by the Division Consultant. For the full advertisement please see Appendix A. For participants' demographic information, such as age, race/ethnicity, and educational background, see Table 2.1.

### **2.3.3 Online survey.**

Participants were invited to take an online survey hosted by Qualtrics<sup>XM</sup> Survey Software (Appendix B). The survey was posted to MAGIC's online forum and was open from December 12, 2019 through March 1, 2020. By opening the survey and answering one question, participants provided informed consent. Data collection during the survey was completed anonymously to protect participant privacy. The first two survey questions assessed eligibility for inclusion. The remainder of the survey consisted of twenty questions including five that assessed demographic information, six that explored the diagnostic process and knowledge of genetics, and three open-ended questions. Skip logic was used to direct parents whose child was diagnosed postnatally to a question where they could provide the child's age at diagnosis. Upon completion of the survey, participants were given the option to partake in a follow-up interview by providing their email address. Providing an email address served as consent to be contacted and interviewed.

### **2.3.4 Semi-structured interviews.**

Follow up semi-structured interviews were performed by the principal investigator to allow parents to expound on their experiences with receiving genetic information and the impact it had on different aspects of their life (Appendix C). Interviews were recorded by phone and transcribed by hand. Transcribed interviews were kept on a password protected computer and assigned a survey generated number to ensure privacy and protection.

### **2.3.5 Data management and analysis.**

To protect the confidentiality of the participants, any identifiers including email addresses were destroyed after completion of the survey. No identifying factors, such as participant or child's name, were recorded in the transcription so that participants' answers could not be linked back to their identity. Responses to multiple choice questions in the online survey were reported along with the frequency of the response. For the responses collected from open-ended question and interview questions, a grounded theory approach was used to analyze the qualitative data. There were no preset themes for the study's focus, so apparent themes from participants' responses were coded and reported based on their frequency.

## **2.4 Results**

A total of 35 responses were recorded from the online survey. A total of 13 were excluded, six were due to an incomplete survey and seven were excluded as they did not meet inclusion criteria. A total of 22 online survey data was included in the final analysis. Four participants completed follow-up interviews. The participants who completed the qualitative telephone interview are designated below as Participants 1, 4, 9, and 10. Characteristics of the affected child and method of diagnosis is summarized in Table 2.2. A qualitative analysis of the online survey and semi-structured interviews revealed 4 major themes regarding the diagnostic process.

### **2.4.1 Theme 1: Genetics and genetic counseling.**

A minority of online survey respondents reported having a genetic diagnosis for their child's CAH ( $N=5$  or 23%). Fourteen out of eighteen online survey participants reported never having spoken to a geneticist or genetic counselor (78%). Of the four who

have spoken to a genetics professional (22%), one reported having met with a geneticist, two reported having met with a genetic counselor, and one reported having met with both a geneticist and a genetic counselor. Of note, one participant reported being given a diagnosis of CAH by a geneticist; however, in a separate question, did not report meeting with either a geneticist or a genetic counselor. One participant mentioned “we have been trying to see a geneticist for about a year now,” (Participant 22).

The benefits of genetic testing were addressed by three of the four interview participants. For Participants 1 and 4, genetic testing helped them cope with their child’s diagnosis. Participant 4 stated, “it was comforting for me...it just helped us to say it’s confirmed...100%.” Participant 9 saw the benefit in relation to family planning: “especially for having more children...knowing that I was a carrier.” Participant 10 did not see the benefit in genetic testing for their family. They expressed that “the genetic aspect of this whole thing is not a big concern,” Participant 10. The benefits, or perceived benefits, of genetic counseling were brought up by three individuals who participated in the follow up interview. Participant 9 did not initially see it as beneficial, however did think it would have been “immensely helpful” in helping them understand the genetics of CAH. Participant 1 expressed that it would have helped them understand why their child’s result came back with one mutation and one variant of uncertain significance. “I received zero explanation of why, what it means for him, you know?” (Participant 1). In their interview, Participant 4 remarked they did not feel they were going to be referred to genetics and so they asked for that referral to confirm their child’s diagnosis. “Had I not asked for that [referral to genetics] I think they probably would’ve never referred me,”

(Participant 4). They also described that the empathy shown by the genetic counselor was helpful to them during the diagnostic process.

#### **2.4.2 Theme 2: Distress and information overload at diagnosis.**

Only two online survey participants reported having a good understanding of the genetics of CAH at the time of diagnosis, one of whom reported meeting with a genetic counselor. When asked to elaborate on their response, four out of thirteen online survey respondents reported being overwhelmed while receiving information about the diagnosis. “I felt so overwhelmed. It was a lot of information to process at once,” Participant 15. Of those four, three report not having met with a geneticist or genetic counselor and one reports having met with a genetic counselor. Another four out of thirteen online survey respondents expressed they currently do not have a good understanding of the genetics of CAH, even after some time has passed. As Participant 7 explains “we were not well informed at all when our daughter was diagnosed. It has only been in the last 6 months that we really feel like we’re starting to get it.” Despite reporting an inadequate understanding of the genetics of CAH at the time of diagnosis, participants in the online survey were able to accurately use the terms carrier, recessive, and *CYP21A2* gene to describe the genetics of CAH.

Three out of four interview participants reiterated that they were not confident in their understanding of the genetics of CAH after the diagnosis was given. One participant reported not having a good understanding at the time of diagnosis and so requested to see a genetic counselor. Participant 4 reports that they had “zero confidence in understanding the genetics of it...the pediatric endocrinologist...just kind of made light of it.” Words participants used to describe their feelings during the diagnosis disclosure process include

devastated, scary, traumatic, and in shock. Participant 1 explained “it was so awful...the worst day of my life...I’m driving my newborn baby to a pediatric ICU and, you know, they’re acting like he’s going to die.”

### **2.4.3 Theme 3: Use of resources to obtain knowledge.**

Independently seeking information was a theme addressed by four survey participants (29%). Participants cited online resources or support resources as common sources of information, specifically through Facebook groups or online support groups. Participant 6 explained “honestly the most information I received was from other parents of children with CAH through various groups... and doing research on my own.” Additionally, Participant 14 sought information from support groups saying “the CARES foundation and the Magic Foundation websites helped a lot with understanding.” Two online survey respondents mentioned the book *Congenital Adrenal Hyperplasia: A Parents’ Guide*. Only one participant reported receiving resources about CAH from their provider at the time of diagnosis.

Three participants reported in their follow-up interview that they acquired most of their knowledge about the genetics of CAH independently. “I did a lot of research on my own. I started researching professionals in CAH,” (Participant 4). Participant 1 went so far as to do a research paper on the genetics of CAH in their search for information. Participant 10 mentioned in their online survey and telephone interview the book *Congenital Adrenal Hyperplasia: A Parents’ Guide* as a resource that was helpful to them. It “is extremely helpful...covers a lot of different aspects...the whole gamut of the childhood experience,” (Participant 10). Like Participant 10, Participant 4 found



Congenital Adrenal Hyperplasia: A Parents' Guide to be extremely helpful. They also mentioned that their other family members found it useful as well.

#### **2.4.4 Theme 4: Online support groups.**

Online support groups were a valuable resource reported by participants (n=4, 29%). Three of these individuals said the motivation came from the desire to connect with other parents who have a child diagnosed with CAH. This was echoed by three out of four interview participants. Facebook, MAGIC, or the CARES Foundation were the most common avenues used to connect with other parents. Hearing from other parents provided a sense of support, community, and served as an additional source of information about CAH for these individuals. In their online survey, Participant 15 wrote “what really helped me was going online and joining a group chat on Facebook with parents of CAH children. I was able to learn a lot and be able to relate to a lot of parents.”

In person interactions were also reported to serve as a good way to get support and help reduce distress. Two individuals mentioned the importance of these connections in their interview. Both Participant 9 and Participant 1 also mentioned how meeting other parents of a child with CAH provided hope that their child could live a normal and healthy life. Participant 9 stated “finding a support group showed us that [our son] could live a normal life and do anything he wanted to do.” Participant 1 echoed that statement saying, “to see [that] someone with that exact same condition has grown up to be perfectly fine and healthy...was the best experience.”

## **2.5 Discussion**

This study explored how parents or caregivers of a child with congenital adrenal hyperplasia have experienced receiving genetic information in order to determine who most commonly communicates a diagnosis of CAH, the knowledge parents have regarding the genetics of CAH, and how their experience with and knowledge of genetics has impacted their lives. These results show that involvement of a geneticist or genetic counselor during the diagnostic process is lacking and that parents see the benefit in genetic counseling. It also suggests parents experience a significant amount of distress surrounding their child's CAH diagnosis. Lastly, it identifies resources that parents find useful in seeking additional information and support regarding CAH.

### **2.5.1 Communication with genetic professionals during the diagnostic process for CAH.**

Results from this study show that parents who have a child with CAH are frequently not meeting with a geneticist or genetic counselor. Geneticists and genetic counselors receive extensive and specialized training on how to deliver the diagnosis of a genetic condition in a way that individuals with varying degrees of medical literacy can understand. Therefore, it is important that genetic counselors are involved in the disclosure of a diagnosis of CAH. Published guidelines that state geneticists and genetic counselors should be part of the comprehensive care team for a child diagnosed with CAH support the assertion that parents of a child with CAH should be meet with these professionals (Auchus et al., 2010). Additionally, studies have shown that parents who have received genetic counseling for their child's genetic condition report having a more positive diagnostic experience (Waxler et al., 2013). Given that genetic counselors

address not only the genetic aspects of a condition, but the impact it has emotionally on individuals and family members, in order to promote psychosocial well-being a more positive experience in their presence is not unexpected.

Results from this study also show parents desire to meet with a genetic counselor regarding their child's CAH diagnosis. Parents in this study frequently brought up that meeting with a genetics professional would have helped them better understand the genetics of CAH. This is not surprising as one of the goals of pediatric genetic counseling is to help parents understand the genetics of their child's condition (Biesecker, 2001). Parents also mentioned that genetic testing and counseling helped them to cope with their child's diagnosis. This is consistent with previous research that found participants believed genetic testing to have psychological benefits such as having a peace of mind (McGowan et al., 2013). Pediatric genetic counseling also aims to facilitate client acceptance of and adaptation to their child's diagnosis (Biesecker, 2001). Indeed, one participant reported that genetic counseling helped her accept and cope with her child's CAH diagnosis. This could be due to genetic counselors' expert ability to deliver difficult news and provide empathetic counseling during an emotional time.

All participants in our study reported feelings of distress while receiving a diagnosis of CAH, consistent with previous research that have shown parents of a child with CAH often feel overwhelmed with the diagnostic process and experience high amounts of stress following a diagnosis (Boyse et al., 2013; Paterski et al., 2015). In our study, parents reported that being overwhelmed during the diagnostic process contributed to having an inadequate knowledge of the genetics of CAH at the time of diagnosis.

These feelings existed despite our population reporting demographic factors that are

indicative of higher health literacy, such as being Caucasian and having college education. Previous research has shown that emotional distress can negatively impact an individual's ability to process information (Gilligan & Bower, 1984). Genetic counselors have expertise in delivering complex information to a layperson as well as providing emotional and psychosocial support and counseling. This expert ability could positively impact parents' ability to receive and process the genetic information being given to them. Research by Burlison & Goldsmith in 1998 suggests that appropriate emotional support and counseling can alleviate intense emotional responses that can increase an individual's ability to receive information. Additionally, a study by Davies et al. in 2003 found that when parents' emotional reactions were addressed during the diagnosis disclosure parents felt they were better able to respond to the information being given to them. Taken together, these studies suggest that genetic counseling can decrease distress felt by parents during the diagnostic process and facilitate their understanding of the genetics of CAH.

### **2.5.2 Need for provision of resources at diagnosis.**

Participants in this study frequently brought up resources that were helpful to them during the diagnostic process. While one participant reported that they were given printed resources by their endocrinologist, most interview respondents said they gathered a majority of information about CAH independently. A 2011 study by Sheets et al. found that parents desire to be given both professional and patient-friendly resources during the diagnostic process. Furthermore, the 2010 guidelines addressing care for individuals with CAH state that written materials and references to reliable resources should be provided to patients following the delivery of the diagnosis (Auchus et al., 2010). Genetic

counselors are knowledgeable about up-to-date, patient friendly resources, as well as professional organizations that serve parents and individuals with genetic conditions and so are perfectly positioned to provide these to their patients. One study posited that resources and support provided by genetic counselors contributes to a positive diagnostic experience reported by parents whose child has a genetic condition (Waxler et al., 2013). Additionally, having printed resources to refer to following the diagnosis disclosure can increase the knowledge base parents have regarding their child's genetic condition. As information given during a distressing time might not be retained, parents may leave the clinic with an inadequate understanding of the condition, regardless of their health literacy. One participant specifically stated that having printed information to read is beneficial since the time during the delivery of the diagnosis is overwhelming. Additionally, providing alternate means of information transfer can help overcome the barrier that emotional distress has on the process of information uptake during the delivery of a genetic diagnosis (Dillard et al., 2008). It should be noted that while participants in our study reported having an inadequate knowledge of CAH at the time of diagnosis, they were also able to use appropriate terms to describe the genetics and inheritance of CAH in their online survey. This could be due to their independent research on the genetics of CAH, however this was not specifically assessed in the survey.

### **2.5.3 Parent-to-parent support.**

Studies have shown that parents seek the support of peers who also have a child with the same genetic condition (Bray et al., 2017; Mathiesen et al., 2012; Sheets et al., 2011). These benefits include learning from the experiences of others, a sense of

community, and the ability to support others (Bray et al., 2017). Consistent with these studies, several parents in our study also reported that having a parent support network was beneficial to them. Specifically, it gave them a separate source to gain information about CAH and provided them with the feeling that they weren't the only people to have a child with the condition. Additionally, in our study parents reported that meeting other parents and their child with CAH served to provide them sense of hope for their own child's future. As genetic counselors often have a working relationship with families who have a genetic diagnosis, they can provide newly diagnosed parents with connections to other families who have volunteered to connect with parent's whose child has the same condition.

#### **2.5.4 Practice implications.**

Overall, our results show that parents of a child with CAH are frequently not meeting with a genetic counselor. As endocrinologists are typically the first medical professional to disclose a diagnosis of CAH, it is fitting for them to be the first individuals to have a discussion of CAH, including the genetics of the condition, with parents. Guidelines support that endocrinologists should be providing introductory counseling to newly diagnosed families, however they also state parents should be referred to genetic counseling for a formal discussion of the genetics of CAH and additional counseling (Auchus et al., 2010). To ensure that parents are receiving comprehensive care as recommended by guidelines, genetic counselors can work with endocrinologists in their institutions to educate them on the benefits of a genetics referral such as improved knowledge of the genetics of CAH and increased psychological well-

being. Additionally, it will be important for endocrinologists be aware that parents often desire referrals to genetic counseling as it benefits many different aspects of their lives.

These study results also provide important knowledge for genetic counselors. Specifically, that parents of a child with CAH see the benefit in genetic counseling for a variety of reasons. Some parents need confirmation that CAH is the true diagnosis for their child, some desire the knowledge for reproductive purposes, and others have a genetic test result that they need explained to them. Additionally, parents believe genetic counseling will help them better understand CAH as a genetic condition. Genetic counselors should aim to determine what the parent specifically wants to discuss during the counseling session and how they see genetic counseling as most useful to them. This could easily be established during contracting, or the two-way communication process between the genetic counselor and their patient in which expectations and goals for the session are set (Accreditation Council for Genetic Counseling, 2015). By doing so, genetic counselors can provide targeted, empathic counseling to maximize benefits to parents. It is also important for genetic counselors to know that receiving a diagnosis is a distressing and overwhelming process for parents and has a significant impact on their psychosocial well-being. As genetic counselors have extensive training in how to provide emotional support and facilitate psychological well-being, they can address parents' emotions in order to alleviate distress. This alone is beneficial to parents, but it can also serve to increase uptake of information given during the session, leaving the parent with a better understanding of the genetics of their child's condition.

Both endocrinologists and genetic counselors benefit in knowing that parents of a child with CAH often seek resources to obtain additional information and gain support.

Both endocrinologists and genetic counselors should provide printed information regarding the clinical presentation and genetics of CAH to aid parents in their understanding of the condition outside the clinical setting. Additionally, endocrinologists and genetic counselors can serve as referrals to online support groups and can identify parents are willing to meet with newly diagnosed families.

## **2.6 Limitations and future research**

### **2.6.1 Limitations.**

The small sample size of twenty-two online survey respondents and four interview participants was a limitation of this study. This could be explained by the relative reluctance of this population to participate in research. In the medical community, CAH often falls under the umbrella term of disorder of sexual development. However, individuals impacted by CAH and advocacy organizations that serve the CAH population often claim that this term has a negative connotation. As the term is not felt to be applicable to individuals with CAH, this has resulted in participant refusal or reluctance to participate in research (Lee et al., 2016).

An additional limitation stems from participant recall about their child's diagnostic process. The time period when a parent received their child's diagnosis was chosen to ensure accurate recall; however, participants were not asked to specify the exact number of years it has been since they received the diagnosis. Parents whose child was diagnosed several years ago could have inadequate recall of the diagnostic process. For example, one participant reported receiving a diagnosis from a geneticist, then later



reported never having met with a one. Another explanation could be confusion about the specific role of the provider they had met with.

### **2.6.2 Future Research**

To overcome some of this study's limitations additional studies could be conducted in a similar format with a larger sample size. Additional studies could also be conducted for parents of a child that was recently diagnosed with CAH rather than those whose child was diagnosed in the previous 10 years.

This study identified that endocrinologists are the main medical professional to disclose a diagnosis of CAH and would therefore be the ones to refer a family to genetic counseling. Future research into endocrinologist views on genetic counseling for CAH could provide insight into specific reasons for referring or not referring a family for genetic counseling. Additionally, as participant views on the specific benefits of genetic counseling varied, research into what parents of a child with CAH desire most from their genetic counseling session could contribute to existing literature that has broadly described what individuals desire from their genetic counseling session.

### **2.7 Conclusion**

This study explored how parents of a child with CAH experienced receiving information on the genetics of the condition to define how the experience impacted different aspects of their life. Specific themes that were identified included genetic counseling, distress and information overload during diagnosis, search for information, and online support. Parents often reported not having met with a geneticist or genetic counselor. They also described the desire to see a genetic counselor and how that would

have benefitted their experience. Additionally, they described feelings of distress surrounding the diagnostic process and how that contributed to an inadequate understanding of the genetics of CAH. Parents also identified resources and additional support they desire after the receiving the diagnosis of CAH. These results indicate involvement of a genetic counselor during the diagnostic process is lacking. Genetic counselors can provide targeted, directed, and appropriate psychosocial and genetics-focused care for families that may have a positive impact on newly diagnosed parents. Specifically, involvement of a genetic counselor in the diagnostic process for CAH may lead to increased understanding of the genetics of CAH and decreased distress during the diagnostic process. Genetic counselors should work with pediatric endocrinologists to ensure that newly diagnosed parents are referred to genetics. Additionally, this study identifies specific sources of information and support groups that parents seek after receiving a diagnosis. Both genetic counselors and endocrinologists should be knowledgeable about these resources and support organizations so they can direct parents to them following the discussion of their child's diagnosis.

Table 2.1 Participant Demographic Information

Characteristic	Response	N
Participant Age (years)	18-23	0
	24-29	2
	30-35	5
	36-41	4
	42-47	4
	48-53	0
	53+	1
Educational background	Some high school	0
	High school graduate or GED	0
	Some college	5
	Associate degree	3
	Bachelor's degree	4
	Graduate degree or above	4
Marital Status	Married	12
	Not Married	4
Race/Ethnicity	Caucasian	14
	Black or African American	1
	Hispanic	2
	Asian	1
	Middle Eastern	0
	Native American	0
	Indian	0
	Other	1

Table 2.2 Characteristics of the Affected Child

<b>Characteristic</b>	<b>Response</b>	<b>N</b>
Current Age	0-11 months	4
	1-5 years	6
	5-9 years	4
	10-14 years	2
	15-17 years	0
	18+ years	0
Years since diagnosis	0-4	16
	5-10	6
Prenatal or postnatal diagnosis	Prenatal	2
	Postnatal	11
Type of Diagnosis	Clinical diagnosis	11
	Genetic diagnosis	5
	Unsure	2
Testing performed	Single gene testing	0
	Known mutation testing	1
	Biochemical testing	5
	Unsure	8
	Other	2

## CHAPTER 3

### CONCLUSIONS

This study explored how parents of a child with CAH experienced receiving information on the genetics of the condition to define how the experience impacted different aspects of their life. Specific themes that were identified included genetic counseling, distress and information overload during diagnosis, search for information, and online support. Parents often reported not having met with a geneticist or genetic counselor. They also described the desire to see a genetic counselor and how that would have benefitted their experience. Additionally, they described feelings of distress surrounding the diagnostic process and how that contributed to an inadequate understanding of the genetics of CAH. Parents also identified resources and additional support they desire after the receiving the diagnosis of CAH. These results indicate involvement of a genetic counselor during the diagnostic process is lacking. Genetic counselors can provide targeted, directed and appropriate psychosocial and genetics-focused care for families that may have a positive impact on newly diagnosed parents. Specifically, involvement of a genetic counselor in the diagnostic process for CAH may lead to increased understanding of the genetics of CAH and decreased distress during the diagnostic process. Genetic counselors should work with pediatric endocrinologists to ensure that newly diagnosed parents are referred to genetics. Additionally, this study identifies specific sources of information and support groups that parents seek after

receiving a diagnosis. Both genetic counselors and endocrinologists should be knowledgeable about these resources and support organizations so they can direct parents to them following the discussion of their child's diagnosis.

## REFERENCES

- Abad, P., Anonuevo, C., Daack-Hirsch, S., Abad, L., Padilla, C., & Laurino, M. (2017). Communication about congenital adrenal hyperplasia: perspectives of Filipino families. *Journal of Genetic Counseling*, 26(4), 763-775.  
<https://doi.org/10.1007/s10897-016-0043-x>
- Accreditation Council for Genetic Counseling. 2015. Practice based competencies for genetic counselors.  
[http://gceducation.org/Documents/ACGC%20Core%20Competencies%20Brochure\\_15\\_Web.pdf](http://gceducation.org/Documents/ACGC%20Core%20Competencies%20Brochure_15_Web.pdf). Accessed 16 April 2020.
- Auchus, R., Witchel, S., Leight, K., Aisenberg, J., Azziz, R., Bachega, T., ... Zuckerman, A. (2010). Guidelines for the development of comprehensive care centers for congenital adrenal hyperplasia: guidance from the CARES foundation initiative. *International Journal of Pediatric Endocrinology*, 2010(1), 1-17. doi:10.1186/1687-9856-2010-275213
- Biesecker, B. (2001). Goals of genetic counseling. *Clinical Genetics*, 60, 323-330.
- Boyse, K. L., Gardner, M., Marvicsin, D. J., & Sandberg, D. E. (2014). “It was an overwhelming thing”: parents’ needs after infant diagnosis with congenital adrenal

hyperplasia. *Journal of Pediatric Nursing*, 29(5), 436–441.

<https://doi.org/10.1016/j.pedn.2014.01.007>

Bray, L., Carter, B., Sanders, C., Blake, L., & Keegan, K. (2017). Parent-to-parent peer support for parents of children with a disability: a mixed method study. *Patient Education and Counseling*, 100(8), 1537-1543.

<https://doi.org/10.1016/j.pec.2017.03.004>

Burleson, B.R. & Goldsmith, D.J. (1996). How the comforting process works: Alleviating emotional distress through conversationally induced reappraisals. In P.A. Anderson & L.K. Guerrero (Eds.), *Handbook of Communication and Emotion* (pp. 245-280). Academic Press.

Centers of Excellence. (2019, October 17). Retrieved from

<https://www.caresfoundation.org/what-we-do/comprehensive-care-centers/>

Chivers, C., Burns, J., & Dieros Collado, M. (2017). Disorders of sex development: mother's experiences of support. *Clinical Child Psychology and Psychiatry*, 22(4), 675-690. <https://doi.org/10.1177/1359104517719114>

Claahsen-van der Grinten, H. L., Hermus, A. R. M. M., & Otten, B. J. (2009). Testicular adrenal rest tumours in congenital adrenal hyperplasia. *International Journal of Pediatric Endocrinology*, 2009, 1-8. doi:10.1155/2009/624823

Davies, R., Davis, B., Sibert, J. (2003). Parents' stories of sensitive and insensitive care by paediatricians in the time leading up to and including diagnostic disclosure of a



life-limiting condition in their child. *Child: care, health, and development* 29(1), 77-82. <https://doi.org/10.1046/j.1365-2214.2003.00316.x>

Dewalt, D. A., & Hink, A. (2009). Health literacy and child health outcomes: a systematic review of the literature. *Journal of the American Academy of Pediatrics*, 124(Supplement 3). <https://doi.org/10.1542/peds.2009-1162B>

Dillard, J., Shen, L., Laxova, A., & Farrell, P. (2008). Potential threats to the effective communication of genetic risk information: the case of cystic fibrosis. *Health Communication*, 23(3), 234-244. <https://doi-org.pallas2.tcl.sc.edu/10.1080/10410230802055356>

Gilligan, S. G., & Bower, G. H. (1984). Cognitive consequences of emotional arousal. In D. E. Izard, J. Kagan, & R. B. Zajonc (Eds.), *Emotions, cognition and behavior* (pp. 547-488). New York: Cambridge University Press.

Houk, C. P., Hughes, I. A., Ahmed, F., & Lee, P. A. (2007). Consensus statement on management of intersex disorders. *Advances in Neonatal Care*, 7(1), 6.

Hsu, C. Y., & Rivkees, S. A. (2005). *Congenital adrenal hyperplasia: a parents guide*. Bloomington, IN: AuthorHouse.

Hughes, I. (1998). Congenital adrenal hyperplasia—a continuum of disorders. *The Lancet*, 352(9130), 752-754. [https://doi.org/10.1016/S0140-6736\(98\)22037-X](https://doi.org/10.1016/S0140-6736(98)22037-X)

- Kamoun, M., Feki, M., Sfar, M., & Abid, M. (2013). Congenital adrenal hyperplasia: Treatment and outcomes. *Indian Journal of Endocrinology and Metabolism*, *1*(Supplement 1), 14-17. doi:10.4103/2230-8210.119491
- Kitamura, T. (2005). Stress-reductive effects of information disclosure to medical and psychiatric patients. *Psychiatry and Clinical Neurosciences*, *59*(6), 627–633.  
<https://doi.org/10.1111/j.1440-1819.2005.01428.x>
- Lee, HH. (2014). Mutational analysis of CYP21A2 gene and CYP21A1P pseudogene: long-range PCR on genomic DNA. *Methods in Molecular Biology*, *1167*, 275-287.  
[https://doi.org/10.1007/978-1-4939-0835-6\\_19](https://doi.org/10.1007/978-1-4939-0835-6_19)
- Lee, P.A., Nordenstrom, A., Houk, C.P., Ahmed, S.F., Auchus, R., Baratz, A., ... Witchel, S. (2016). Global disorders of sex development update since 2006: perceptions, approach, and care. *Hormone Research in Paediatrics*, *85*, 158-180.  
<https://doi.org/10.1159/000442975>
- Lundberg, T., Lindstrom, A., Roen, K., & Hegarty, P. (2017). From knowing nothing to knowing what, how, and now: parents' experiences of caring for their children with congenital adrenal hyperplasia. *Journal of Pediatric Psychology*, *42*(5), 520-529.  
<https://doi.org/10.1093/jpepsy/jsw001>
- Mathiesen, A.M., Frost, C.J., Dent, K.M., & Feldkamp, M.L. (2012). Parental needs among children with birth defects: defining a parent-to-parent support network. *Journal of Genetic Counseling*, *21*, 862-872. doi:10.1007/s10897-012-9518-6

- McGowan, M.L., Glinka, A., Highland, J., Asaad, G., Sharp, R. (2013). Genetics patients' perspectives on clinical genomic testing. *Personalized Medicine*, 10(4), 339-347. <https://doi.org/10.2217/pme.13.32>
- Miller, W. (2019). Congenital adrenal hyperplasia: Time to Replace 17OHP with 21-Deoxycortisol. *Hormone Research in Paediatrics*, 91, 416-420. <https://doi.org/10.1159/000501396>
- New, M. I., Abraham, M., Gonzalez, B., Dumic, M., Razzaghy-Azar, M., Chitayat, D., ... & Yuen, T. (2013). Genotype–phenotype correlation in 1,507 families with congenital adrenal hyperplasia owing to 21-hydroxylase deficiency. *Proceedings of the National Academy of Sciences of the United States of America*, 110(7), 2611–2616. doi:10.1073/pnas.1300057110
- Nimkarn, S., Gangishetti, P., Yau, M., & New, M. (2002). 21-hydroxylase-deficient congenital adrenal hyperplasia. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/20301350>
- Paterski, V., Mastroyannopoulo, K., Wright, D., Zucker, K., & Hughes, I. (2013). Predictors of Posttraumatic Stress in Parents of Children Diagnosed with a Disorder of Sex Development. *Archives of Sexual Behavior*, 43(2), 369-375. doi: 10.1007/s10508-013-0196-8
- Sheets, K.B., Crissman, B.G., Feist, C.D., Sell, S.L., Johnson, L.R., Donahue, K.C., ...Brasington, C.K. (2011). Practice guidelines for communicating a prenatal or postnatal diagnosis of Down syndrome: recommendations of the National Society of

Genetic Counselors. *Journal of Genetic Counseling*, 20(5), 432-441.

<https://doi.org/10.1007/s10897-011-9375-8>

Sparks, T.N. (2019). Expanded carrier screening: counseling and considerations. *Human Genetics*. <https://doi-org.pallas2.tcl.sc.edu/10.1007/s00439-019-02080-y>

Starke, M., & Moller, A. (2002). Parent's needs for knowledge concerning the medical diagnosis of their children. *Journal of Child Health Care*, 6(4), 245-257.

<https://doi.org/10.1177/136749350200600402>

Waxler, J.L., Cherniske, E.M., Dieter, K., Herd, P., & Pober, B.R. Hearing from parents: the impact of receiving the diagnosis of Williams syndrome in their child. *American Journal of Medical Genetics*, 161(3), 534-541. [https://doi-](https://doi-org.pallas2.tcl.sc.edu/10.1002/ajmg.a.35789)

[org.pallas2.tcl.sc.edu/10.1002/ajmg.a.35789](https://doi-org.pallas2.tcl.sc.edu/10.1002/ajmg.a.35789)

Witchel, S. (2017). Congenital Adrenal Hyperplasia. *Journal of Pediatric and Adolescent Gynecology*, 30(5), 520-534. doi: 10.1016/j.jpag.2017.04.001

Yau, M., Gujral, J., New, M.I. (2019). Congenital Adrenal Hyperplasia: Diagnosis and Emergency Treatment. Retrieved from

<https://www.ncbi.nlm.nih.gov/books/NBK279085/>

## APPENDIX A

### ADVERTISEMENT FOR PARTICIPATION

Dear Parent or Caregiver,

You have been invited to participate in thesis research that aims to identify the experience you have had receiving genetic information regarding your child's diagnosis of congenital adrenal hyperplasia and your knowledge regarding the genetics of the condition. We hope to use the information gathered from the survey to inform healthcare providers on how to better address parent's needs to improve patient-centered care for the CAH population.

Below is a link to a survey where you will be asked questions regarding your experience receiving genetic information, your knowledge of the genetics of CAH, and some demographic information. You will also be asked several open-ended questions about your experience with CAH. At the end of the survey there will be an option to provide an email address if you are interested in participating in a voluntary follow-up interview.

The following are inclusion criteria for this study. Please consider participating if you:

- Have a child with a clinical or genetic diagnosis of CAH made in the past 10 years
- Are 18 years or older
- Can speak, read, and write English

If you meet the criteria, and are interested in participating, please follow the link below.

Please know that participation in this study is voluntary and all results will be de-identified for analysis and thesis submission.

Warm regards,

Christine Maccia

Graduate Student in Genetic Counseling

University of South Carolina School of Medicine

## APPENDIX B

### SURVEY FOR PARENTS OR CAREGIVERS OF A CHILD WITH CAH

Thank you for your interest in participating in my master's research project. Please review the study details below prior to completing this survey.

**PURPOSE AND BACKGROUND:** You are being asked to volunteer for a research study conducted by Christine Maccia, a graduate student in Genetic Counseling at the University of South Carolina. You are being asked to participate in this study because you are a parent or caregiver of a child with CAH and your child has been diagnosed in the past 10 years. The purpose of this study is to explore your experience with receiving genetic information and knowledge of genetics in congenital adrenal hyperplasia (CAH), and how that knowledge and experience has affected your family.

**PROCEDURES:** If you agree to participate in this study, you will be asked to answer several questions about your experience learning about CAH. The first portion of the survey will ask questions regarding your experience learning about the genetics of CAH, followed by brief demographic information. You will also be asked several open-ended questions about your experience with CAH. Answering one question in the survey will serve as consent to participate. At the end of the survey there is an option to provide your contact information to participate in a follow up interview where we hope you will tell us more about how your experience learning about CAH has affected your family. This is optional, but providing contact information will serve as consent to participate in the interview.

**DURATION:** Participation in the survey will take 10-15 minutes and if you volunteer, the interview will take 20-40 minutes.

**PAYMENT TO PARTICIPANTS:** We thank you for your time and participation in this survey. You will not be paid for participating in this study.

**VOLUNTARY PARTICIPATION:** Participation in this research study is voluntary. You are free not to participate, or to stop participation at any time, for any reason without negative consequences. You are not required to answer any question you do not wish to answer. Keep in mind that all survey responses are anonymous and no personal or identifying information will be collected or stored as part of the study. In the event that you withdraw from this study, the information you have already provided will be kept in a confidential manner.

If you feel that participating in this survey has brought up any questions that you would like to discuss with a genetic counselor, please contact your local genetic counselor or find one using <https://www.nsgc.org/page/find-a-genetic-counselor>. The Institutional Review Board (IRB) at the University of South Carolina has reviewed and approved this study. The IRB looks at research studies like these and makes sure research subject rights and welfare are protected. If you have questions about your rights or if you have a complaint, you can contact the IRB office at 803-777-7095.

If you have any questions, please contact Christine Maccia by phone (803-545-5775) or email ([christine.maccia@uscmed.sc.edu](mailto:christine.maccia@uscmed.sc.edu)).

By clicking "NEXT" you agree to participate in this survey.

Are you the parent or caregiver of a child with classic congenital adrenal hyperplasia?

- Yes



- No

How many years has it been since your child was first diagnosed?

- 0-4
- 5-10
- 11+

CAH can be diagnosed at different stages of life. Sometimes the diagnosis is made before birth, other times it is made after the child has been born. When was your child first diagnosed with CAH?

- Before birth (prenatal)
- After birth (postnatal)

Display This Question:

If: CAH can be diagnosed at different stages of life. Sometimes the diagnosis is made before birth, other times it is made after the child has been born. When was your child first diagnosed with CAH? After birth (postnatal) is selected

How old was your child when diagnosed? Please specify months or years

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CAH can be diagnosed in many different ways. Some only have a clinical diagnosis while others have a genetic diagnosis. What testing provided your diagnosis?

- Clinical diagnosis
- Genetic diagnosis
- Unsure

Many different tests can be used to diagnose CAH. What testing provided your child's diagnosis?

- Single gene testing
- Known mutation testing
- Biochemical testing
- Unsure
- Other \_\_\_\_\_

There are different providers who explain a new diagnosis to a family or individual.

Which type of doctor gave you your child's diagnosis? Check all that apply.

- Endocrinologist
- Pediatrician
- Geneticist
- Family Practice
- Unsure
- Other \_\_\_\_\_

Have you met with a genetic counselor or geneticist regarding your child's diagnosis?

- Genetic counselor
- Geneticist
- Both
- No
- Unsure

Please explain in your own words, your understanding about the genetics of CAH in general and how it relates to your child.

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Have you explained your child's diagnosis to any extended family members?

- Yes
- No

At the time of diagnosis, did you feel you had a good understanding of the genetic aspect of CAH (i.e. inheritance pattern, recurrence risk, gene involved?)

- Yes
- No

Please elaborate on your answer above.

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What information was most helpful to you when receiving a diagnosis of CAH?

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Thank you for completing the survey! If you are interested in participating in a follow up interview that will allow you to expand on your experience with CAH, please provide your email. Christine Maccia will then contact you to schedule a follow up interview aimed at determining how your experience with receiving genetic information and your knowledge of genetics has influenced certain aspects of your life such as feelings of distress and communication with family members. Your experiences will help inform the genetic counseling community on your specific needs and how we can provide patient-centered care that addresses those needs. The interview will last 20-40 minutes.

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How old are you currently?

- 18-23
- 24-29
- 30-35
- 36-41
- 42-47
- 47-52
- 53+

How old is your child currently?

- 0-11 months

- 1-5 years
- 5-9 years
- 10-14 years
- 15-17 years
- 18+

What is your educational background?

- Some high school
- High school graduate or GED
- Some college
- Associates degree
- Bachelor's degree
- Graduate degree or above

What is your marital status?

- Married
- Not Married

What is your race/ethnicity? (Check all that apply)

- Caucasian
- Hispanic
- Black or African American
- Asian
- Middle Eastern
- Native American
- Indian

Other \_\_\_\_\_

## APPENDIX C

### INTERVIEW QUESTIONS

Hello, my name is Christine and I am a graduate student in genetic counseling at the University of South Carolina. Thank you for participating in my survey and for giving your time for a follow up interview. This is an opportunity for you to give some more in-depth answers regarding your survey answers and should last about 30 minutes. I do want to let you know that this call will be recorded and transcribed for research purposes, however all information will be de-identified upon transcription.

1. After the diagnosis was given, how confident did you feel in your understanding of the genetics of congenital adrenal hyperplasia as it relates to your child?
2. After the diagnosis, how much information about the genetics of congenital adrenal hyperplasia did you seek on your own? Why?
  - a. If they met with genetics: Did speaking with a genetics professional help direct you to additional resources?
  - b. If yes: where these helpful, if no: would you have appreciated being given resources as part of the process?
3. Do (or did if saw genetics) you see benefits in knowing the specific genetic cause for your child's CAH? Why or why not?
4. How did your initial experience receiving a diagnosis of CAH impact you emotionally?

- a. (if saw genetics): Did having a genetic diagnosis help you cope with or better understand your child's diagnosis? Why or why not?
  - b. (if no genetics): How has your experience been with your/your child's diagnosis in the absence of genetic testing? Do you think having genetic testing would be helpful for your child? Why or why not?
5. We asked in the survey who provided you with your child's diagnosis.
  - a. You said that genetics was involved in the diagnostic process. Did you feel your needs were met by the genetics team, and how do you feel their presence was helpful, or how could it have been improved?
  - b. You said that genetics was not involved in the diagnostic process. Did you feel their presence would have been helpful or not for you, and why?
6. You said in your survey that you talked to your extended family about your child's diagnosis:
  - a. If saw genetics- Did you feel your experience speaking with a genetics professional helped you in having these discussions with your family, and why?
  - b. If did not see genetics- Do you feel that speaking with a genetic professional could have helped you in having these discussions with your family, and why?
7. In the survey when we asked about your experience receiving information on the genetics of CAH you said \_\_\_ (summary). Can you please elaborate on this further?



8. In the survey when we asked about what was most helpful to you during the diagnostic process you said \_\_\_\_ (summary). Can you please elaborate on this further?
9. What else would you like genetics professionals to know regarding care for families who have a child with CAH?