PHYSICAL ASSESSMENT OF CHILDREN WITH FASD: EVIDENCE-BASED PRACTICE

A PROJECT

By

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PHYSICAL ASSESSMENT OF CHILDREN WITH FETAL ALCOHOL SPECTRUM DISORDER: EVIDENCE-BASED PRACTICE

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By

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Abstract

Fetal Alcohol Spectrum Disorder (FASD) is the leading preventable cause of developmental delay worldwide. Early diagnosis and intervention are vital to the prevention of secondary disabilities for those with FASD. Current diagnostic guidelines fail to identify the many physical malformations associated with prenatal alcohol exposure and recommendations for diagnostic differentials vary between guidelines. A critical appraisal of the literature and review of current guidelines was conducted to create an evidence-based physical anomaly checklist and differential diagnostic table. The critical appraisal consisted of 27 articles and resulted in 85 physical anomalies associated with prenatal alcohol exposure. The review of current guidelines resulted in five guidelines and four supportive articles that identified 20 different genetic disorder differentials and four exposure related differentials. A Plan-Do-Study-Act (PDSA) quality improvement model was used to implement education on the reference tools and encourage practice implementation in a North American FASD diagnostic team. All providers directly participating in the diagnosis of FASDs must be aware of the many physical anomalies associated with prenatal alcohol exposure and should have a working knowledge of potential differential diagnoses. The physical anomaly checklist and differential diagnoses tables help to provide this information in a clinically practical way.

Physical Assessment of Children with Fetal Alcohol Spectrum Disorder

Though the harmful effects of alcohol exposure in utero have been alluded to since early Greek and Roman history, the classic triad of symptoms now associated with Fetal Alcohol Syndrome (FAS) was first described by Jones and Smith in 1973. FAS is characterized by three main attribute groups; facial dysmorphology, growth retardation, and central nervous system deficits (Murthy, Kudlur, George, & Mathew, 2009). Since these early studies, the effects of alcohol consumption during pregnancy have been extensively studied using animal models and case reports from human subjects. While FAS is considered the most severe presentation found in those with prenatal alcohol exposure, the teratogenic effects on the embryo and fetus are now known to exist on a continuum (Davis, Desrocher, & Moore, 2011). The severity of the effects of exposure to alcohol in pregnancy vary based on genetics, timing during the gestational period, the level of alcohol exposure, and the overall nutrition status of the mother (Warren, Hewitt, & Thomas, 2011). Symptoms range from subtle neurological and behavioral dysfunction to the most severe deficits found in FAS.

Fetal alcohol spectrum disorder (FASD) is the current term used to describe the range of symptoms that may result from prenatal alcohol exposure. While FASD is not a clinical diagnosis, it is used as an umbrella term to incorporate all possible outcomes of prenatal alcohol exposure. FAS, partial fetal alcohol syndrome, static encephalopathy, neurobehavioral disorder, and alcohol related birth defects (ARBDs) are all on the fetal alcohol spectrum (Davis et al., 2011). The presentation of these conditions varies from severe growth restriction, intellectual disability, and classic dysmorphic facial features to normal growth and intellectual ability. (Chudley et al., 2005). The complexity of the diagnosis requires an interdisciplinary team

approach to provide a comprehensive assessment and appropriate recommendations for intervention and follow-up (Murthy et al., 2009).

Background and Literature Review

Prevalence

FASD is the leading cause of developmental delay worldwide and foremost preventable cause of neurobehavioral impairment (Murthy et al., 2009; Davis et al., 2011). According to the Centers for Disease Control Prevention (CDC), the true prevalence of FASD is unknown in the United States. The estimated prevalence of full FAS is 0.2 to 1.5 per 1,000 live births in the United States (CDC, 2014). May et al. (2009) estimated the prevalence of FAS in mixed-racial and socioeconomic populations in the United States to be at least 2 to 7 per 1,000 with FASD rates as high as 2-5% of elementary school age children. May et al. (2009) further report that undiagnosed cases of FASD result in low prevalence estimates and promote school based assessments as a means of identifying true prevalence in the elementary population. In 2014 May et al. completed an updated study using in school screening of first graders in a Midwestern U.S. city and found significantly higher prevalence rates of FASD. Rates of FAS ranged from six to nine per 1000 children, PFAS from 11 to 17 per 1000 children, and other FASD 24 to 48 per 1000 children.

Prevalence in Alaska. The most recent data from the FAS Surveillance Project in Alaska found the prevalence of FAS to be 1.5 per 1,000 live births of children born from 1995-1999, or approximately 15 children each year in Alaska are born with FAS. The estimated number of children reported to the Alaska Birth defects Registry as being effected by prenatal alcohol exposure is 163 children per year or 16.3 per 1,000 live births (Alaska Department of Health and Human Services, 2012). Alaska has the highest rate of FAS in the nation among

states that track data on birth defects; as many as 180 children per year have been reported to the Alaska Birth Defects Registry as having a suspected fetal alcohol spectrum disorder (Alaska Department of Health and Human Services, 2010).

Economic Burden

The lifetime cost of caring for an individual with FAS was estimated at two million dollars in 2002. The annual cost of FAS alone was estimated at four billion U.S. dollars in 2004 (CDC, 2014). Thus, FAS and FASD represent a major public health concern in the United States. While the direct costs of FAS may be accounted for, it is difficult to assess the true impact of the disorder on the individual, family, and society (Murthy et al., 2009). Unemployment, mental health problems, criminal activity, inappropriate sexual behavior, and school disruption are all secondary disabilities that may result from FASD without intervention to minimize the impact of the disorder (Chudley et al., 2005).

Importance of Early Diagnosis

Early diagnosis is vital for improved developmental outcomes and prevention of future cases of FASD within the individual family. When early intervention occurs, parents may be counseled and receive information on prevention (Sanctis, Memo, Pichini, Tarani, & Vagnarelli, 2011). In addition to prevention, early diagnosis can benefit the child already affected by prenatal alcohol exposure. A study in 2004 examined the life histories of 415 individuals with known FAS and fetal alcohol effects (FAE) and found that the number one predictor of adverse life events was a lack of early diagnosis. The study found that the longer individuals went without a diagnosis, the greater the chance they had of having adverse life events. Both early diagnosis and a stable home environment were shown to be predictors of better outcomes and less adverse life events. The adverse life events that were studied included: inappropriate sexual

behavior, disrupted school experience, trouble with the law, confinement, and alcohol and drug problems (Streissguth, Booksein, Barr, Sampson, & O'Malley, 2004).

While early diagnosis is key to preventing secondary disabilities in children with prenatal alcohol exposure, to provide the best care to these children, the diagnosis must be accurate. When an accurate diagnosis is given FASD diagnostic teams recommend interventions that are patient and family specific. Once key deficits are identified by the interdisciplinary diagnostic team, the patient and family are given recommendations for therapies and follow-up care. According to Astley (2014) a survey of patients from the past twenty years that were given a diagnosis of an FASD using the 4-digit diagnostic code reported that the diagnosis opened doors to interventions and services they needed (Astley, 2014). Thus, while diagnosis and intervention seem to have a great benefit to the individual and their family; FASD diagnostic teams must ensure that FAS or other FASD remain a diagnosis of exclusion (Astley, 2004).

Diagnostic Challenges

FASD may be challenging to diagnose for several reasons. First obtaining a reliable history of prenatal alcohol use can be challenging; the birth mother may be reluctant to admit alcohol use during pregnancy. Furthermore, receiving an accurate account of the amount of alcohol consumption and timing during pregnancy may also be difficult or impossible to elicit. The pregnancy history may be unknown in cases of adoption and foster care which may result in difficulty determining a diagnosis and excluding other differentials. The apparent lack of the characteristic facial features associated with FAS may also lead to a misdiagnosis (Bertrand et al., 2004).

Providers also face the challenge of distinguishing FASD from other prenatal exposures and genetic disorders. The lack of consistent terminology has complicated the diagnostic process

since the characteristics of FAS were first described in 1973 (Warren, Hewitt, & Thomas, 2011). While there are guidelines for the diagnosis of FASD, many of the current guidelines do not adequately account for other genetic diseases (Hoyme et al., 2005). Hoyme and associates produced a clarification of the Institute of Medicine (IOM) guidelines for diagnosis and emphasized the importance of creating a guideline that would minimize the rates of false positives and false negatives and precisely define the diagnostic categories. While receiving a diagnosis is important for early intervention, the consequences of misdiagnosis are many and are often not highlighted in the literature. Misdiagnosis may lead to false stigmatization of the mother, inaccurate labeling and inappropriate treatment and referral, which may ultimately cause diagnostic studies to be terminated prematurely resulting in the true cause of the disability being overlooked (Hoyme et al., 2005). Furthermore, misdiagnosis results in inaccurate prevalence data and may ultimately lead to inadequate funding for social and health services to those with FASD (Chudley et al., 2005).

Current Diagnostic Guidelines

A preliminary examination of current guidelines highlights the inconstancies between guidelines and demonstrates the lack of specific physical assessment recommendations and differential diagnoses tables. The CDC guidelines, 4-digit diagnostic code, clarification of the IOM criteria, and the Canadian guidelines for diagnosis are explored in further detail. These guidelines demonstrate some of the current gaps in the diagnostic process and support the need for further research and review of the guidelines.

The CDC guidelines for diagnosis and referral. Bertrand et al. (2004) developed a guideline for diagnosis and referral of FAS as part of the CDC task force. This guideline utilizes four criteria for FAS: facial dysmorphia, growth problems, central nervous system abnormalities,

and maternal alcohol exposure. The individual must exhibit all three facial characteristics: smooth philtrum (University of Washington Lip-Philtrum Guide rank 4 or 5), thin vermillion border (University of Washington Lip-Philtrum Guide rank 4 or 5), and small palpebral fissures (at or below the 10th percentile).

Growth problems are defined as prenatal or postnatal height or weight or both below the 10th percentile (adjusted for age, sex, gestational age, and race). Central nervous system abnormalities are defined as structural (head circumference at or below the 10th percentile adjusted for age and sex, clinically significant brain abnormalities observed with imaging), neurologic (neurologic problems not associated with post-natal insult or fever), functional (performance substantially below expected for an individual's age, schooling or circumstances defined as global cognitive or intellectual deficits in multiple domains with performance below the 3rd percentile or two standard deviations below the mean for standardized testing), or (deficits below the 16th percentile/one standard deviation below the mean in at least three of the following areas: cognitive or development deficits, executive function deficits, motor function delays, problems with attention or hyperactivity, social skills, other sensory problems, language problems, or memory deficits). Maternal alcohol exposure may be confirmed directly by the mother or from a reliable adult source, or it may be classified as unknown prenatal exposure. The first three components are required for a diagnosis with maternal alcohol classified as confirmed or unknown (Bertrand et al., 2004).

The CDC guideline highlights several prenatal exposure syndromes and genetic disorders that share some of the clinical manifestations of FAS. A table provides a list of syndromes with similar features: Cornelia de Lange syndrome, Floating-harbor syndrome, Geleophysic dysplasia, Opitz syndrome, Toluene embryopathy, Miller-Dieker (Lissencephaly) syndrome, Fetal

Valproate syndrome, Campomelic dysplasia, DiGeorge sequence, Dubowitz syndrome, Duplication 10q sequence, Duplication 15q sequence, FG syndrome, Maternal phenylketonuria (PKU) fetal effects, Oculodentodigital syndrome, Trisomy 18 syndrome, and Velocardiofacial syndrome. A second table provides differentiating characteristics for the following genetic disorders: Aarskog syndrome, Williams syndrome, Noonan's syndrome, Dubowitz syndrome, Brachmann-DeLange syndrome, Toluene embryopathy, Fetal Hydantoin syndrome, Fetal Valproate syndrome, and Maternal PKU fetal effects (Bertrand et al., 2004).

Bertrand and associates (2004) provide guidance on differential diagnoses and mention ARBDs and ARNDs, but do not provide clear guidelines for these diagnoses because there was not agreement on diagnostic criteria. The CDC guideline does not provide any information on malformations associated with prenatal alcohol consumption. Though the guideline recommends that a thorough physical exam is conducted during the diagnostic process, a clear and concise recommendation for the physical exam is not defined.

The 4-digit diagnostic code 3rd edition. In 2004, the third edition of the 4-digit diagnostic code was released with updates based on recommendations of Canadian and U.S. guidelines. Like the CDC, Institute of Medicine (IOM), and Canadian guidelines the 4-digit diagnostic code recommends a multidisciplinary diagnostic team consisting of professionals from (medicine, psychology, speech-language pathology, occupational therapy, as well as other disciplines). However unlike other guidelines, the 4-digit diagnostic code outlines a diagnostic process that enables providers to classify the severity of the clinical manifestations of an FASD with a 4 point ranking system. A ranking of 4 is considered the most severe and a ranking of 1 is the complete absence of the clinical feature. The manifestations ranked according to symptoms include growth, facial phenotype, central nervous system (CNS) effects and alcohol exposure.

The facial phenotype is calculated with the use of computerized software that measures and quantifies facial features associated with FAS (Astley, 2004).

Growth deficiency is given a rank of 4 when there is severe growth restriction classified as height and weight less than the 3rd percentile. A Growth rank of 3 occurs when either the height or the weight is less than the 3rd percentile, and the other measure is greater than the 3rd percentile. A rank of 2 is considered mild when height or weight is greater than the 3rd percentile but less than or equal to the 10th percentile or when both height and weight are between the 3rd and 10th percentile. Growth is considered normal when both height and weight are greater than the 10th percentile.

The facial features associated with FAS (palpebral fissures, upper lip, and philtrum) are measured using facial photographic analysis software. A rank of 4 is a severe presentation and occurs when the palpebral fissure length is less than or equal to two standard deviations (SDs) below the norm and when the lip and philtrum is ranked at 4 or 5. A rank of 2 or 3 is given when a combination of severe and moderate measures are found and can be determined to be either 2 or 3 based on table of measurement combinations. A rank of 1 occurs when there is very little evidence of the facial features and a combination of close to normal or normal measurements are determined with the software.

The CNS ranking of 4 occurs when there are structural or neurological abnormalities and is termed static encephalopathy. Findings that confirm a rank of 4 include: occipital frontal circumference (OFC) two or more standard deviations below the norm and/or there are significant abnormalities in brain structure of presumed prenatal origin and/or hard neurological findings likely of prenatal origin. A CNS rank of 3 occurs when there is significant impairment in three or more domains of brain function (cognition, memory, motor, language, neurological

soft signs, etc.). A rank of 2 or mild dysfunction is given when there is evidence of delay or dysfunction but there is not enough evidence to allow a rank of 3 to be given. Finally, a rank of 1 is given when there is no evidence of delay or dysfunction to represent CNS damage.

The final component of the diagnosis is the overall ranking of prenatal alcohol exposure. Alcohol exposure receives a ranking of 4 and is considered high risk when there is confirmed alcohol use during pregnancy consistent with high peak blood alcohol concentrations at least weekly early in pregnancy. Alcohol exposure is given a rank of 3 if there is confirmed alcohol exposure that is less than rank 4 or the level is unknown. A rank of 2 is given when the use of alcohol during pregnancy is unknown. A rank of 1 is given when alcohol use during pregnancy is confirmed to be completely absent from conception to birth (Astley, 2004).

While the 4-digit diagnostic code does create clear criteria for the diagnosis of FASD across the spectrum and provides a standardized method of measuring facial dysmorphology, the diagnostic guide does not provide any type of template for the physical exam. Astley (2004) does reference other syndromes that share symptoms with FAS including: Fetal Hydantoin syndrome, Maternal PKU fetal effects, and Fetal Valproate syndrome. However, this is not a complete list of pertinent syndromes nor is there an outline of distinguishing features that would help to rule out other differential diagnoses. The guideline can be applied once other diagnoses have been ruled out and FASD is suspected. Without a clearly defined physical exam and table with similar syndromes, making a clear diagnosis can be challenging for the medical provider if the 4-digit diagnostic code is used exclusively.

Clarification of the IOM criteria. Hoyme et al. (2005) proposed a clarification of the 1996 IOM guidelines for diagnosis for FASD. First the guideline recommends an interdisplinary team approach to the diagnosis of a FASD. The diagnosis of full FAS requires: confirmed

maternal alcohol exposure, evidence of greater than or equal to two of the following facial abnormalities (short palpebral fissures less than or equal to the 10th percentile), thin vermilion border of the upper lip (score 4 or 5 with the lip/philtrum guide), smooth philtrum (score 4 or 5 with the lip/philtrum guide), evidence of prenatal or postnatal growth restriction (height or weight less than or equal to the 10th percentile using corrected racial norms if possible, evidence of deficient brain growth or abnormal morphogenesis, including greater than or equal to one of the following (head circumference less than or equal to the 10th percentile, or structural brain abnormalities). FAS without confirmed maternal alcohol exposure is based on all the same criteria without confirmed history of prenatal alcohol use.

Partial FAS with confirmed maternal alcohol exposure requires confirmed alcohol use during pregnancy. There must also be evidence of a characteristic pattern of minor facial abnormalities including two or greater of the following: short palpebral fissures (less than or equal to the 10th percentile), thin vermillion border of the upper lip (score 4 or 5 with the lip/philtrum guide), one of the following: evidence of prenatal or postnatal growth restriction less than or equal to the 10th percentile, evidence of deficient brain growth or abnormal morphogenesis including one or more of the following: structural brain abnormalities, head circumference less than or equal to the 10th percentile. There must also be evidence of a pattern of behavior or cognitive function that is not consistent with developmental norms. These aberrations may include difficulties with complex tasks (problem solving, metacognition, arithmetic, judgment, planning, or abstract thought), receptive or expressive language deficits, and abnormal behaviors (emotional lability, motor dysfunction, poor academic performance, or difficulties with social interaction). Partial FAS without confirmed maternal alcohol exposure

includes the above criteria without recorded history of prenatal alcohol consumption (Hoyme et al., 2005).

The diagnosis of an alcohol-related birth defect (ARBD) requires confirmed maternal alcohol exposure. There must be evidence of two or greater minor facial abnormalities including short palpebral fissures (less than the 10th percentile), thin vermilion border of the upper lip (score 4 or 5 with the lip/philtrum guide), or smooth philtrum (score 4 or 5 with the lip/philtrum guide). There must also be congenital structural defects greater than or equal to one of the following: atrial septal defects, aberrant great vessels, ventricular septal defects, conotruncal heart defects, radioulnar synostosis, vertebral segmentation defects, large joint contractures, scoliosis, aplastic/hypoplastic/dysplastic, horseshoe kidneys /ureteral duplications, strabismus, ptosis, retinal vascular anomalies, optic nerve hypoplasia, conductive hearing loss, or neurosensory hearing loss. If minor anomalies are present, then there must be two or greater of the following: hypoplastic nails, short fifth digits, clinodactyly of fifth fingers, pectus carinatum/excavatum, camptodactyly, “hockey stick” palmar creases, refractive errors, or “railroad track” ears (p. 44).

The diagnosis of alcohol-related neurodevelopment disorder (ARND) must have confirmed maternal alcohol exposure. There must be one or more of the following: structural brain abnormalities, or head circumference less than or equal to the 10th percentile. Behavioral or cognitive abnormalities such as those described for the diagnosis of partial FAS must also be present.

In the footnote of the diagnostic criteria, the authors conclude that first genetic and medical assessment must rule out other genetic or malformation syndromes (Hoyme et al., 2005). Thus, FAS, partial FAS, ARBD, and ARND remain a diagnosis of exclusion. The genetic

syndromes with similar manifestations as FAS discussed by Hoyme et al. (2005) include Williams syndrome, Blepharophimosis syndrome, Dubowitz syndrome, Cornelia de Lange syndrome, and Velocardiofacial syndrome. Though the authors report that this is not an exhaustive list, it elucidates the need to rule out other genetic conditions.

Although the guideline clarification of the IOM criteria does help to define the diagnostic parameters of FASD, it does not provide a specific recommendation for the physical exam portion of the diagnostic process. The ARBDs mentioned in the diagnostic criteria do identify malformations that are associated with the condition, but a clear recommendation or template would make the guideline more clinically practical. The discussion of other genetic conditions with similar presentations also adds clarity to the diagnostic process, but a more complete list and a table with distinguishing features would streamline clinical practice and facilitate educating providers about potential alternative diagnoses.

The Canadian guidelines for diagnosis. Chudley et al. (2005) created guidelines for Canada's public health agency by combining, IOM recommendations, the 4-digit diagnostic code, and recommendations from expert panels. A multidisciplinary team consisting of a case manager, a medical provider trained in FASD diagnosis, a psychologist, an occupational therapist, and a speech-language pathologist is recommended for the diagnosis of an FASD. Additional members of the care team may include geneticists, dysmorphologists, neuropsychologists, family therapists, childcare workers, addiction counselors, and cultural interpreters.

The physical abnormalities associated with prenatal alcohol consumption include: atrial septal defects, ventricular septal defects, aberrant great vessels, tetralogy of the Fallot, hypoplastic nails, shortened fifth digits, radioulnar synostosis, flexion contractures,

camptodactyly, clinodactyly, pectus excavatum and carinatum, Klippel-Feil syndrome, hemivertebrae, scoliosis, aplastic, dysplastic, hypoplastic kidneys, horseshoe kidneys, ureteral duplications, hydronephrosis, refractive problems, strabismus, retinal vascular anomalies, conductive hearing loss, and neurosensory hearing loss. Though many other malformations have been found in patients with FAS, the etiologic nature of those abnormalities remains uncertain. The physical exam should also look for anomalies such as cleft palate, high arched palate, poorly aligned teeth or abnormal teeth, hypertelorism, micrognathia, abnormal hair patterns, skin lesions, and abnormal palmar creases to aid in the exclusion of other genetic disorders (Chudley et al., 2005).

ARNDs can be defined by evidence of physical abnormalities such as decreased cranial size at birth, structural brain abnormalities (microcephaly, partial or complete agenesis of the corpus callosum, cerebellar hypoplasia), neurological hard or soft signs (impaired fine motor skills, poor tandem gait, poor eye-hand coordination, or other neurological signs). ARNDs can also be identified as a pattern of cognitive or behavioral abnormalities: learning disabilities, poor school performance, lack of impulse control, social problems, deficits in higher level receptive or expressive language, decreased ability for abstract thought or metacognition, difficulty with math, memory problems, poor attention span, and problems with judgment (Chudley et al., 2005).

The genetic syndromes listed in the Canadian guidelines include Aarskog syndrome, Cornelia de Lange syndrome, Dubowitz syndrome, fetal anticonvulsant syndrome, maternal phenylketonuria fetal effects, Noonan syndrome, Toluene embryopathy, Williams syndrome, and chromosome deletion and duplication syndromes. The guideline does provide a table that lists

the similar features of the condition and the distinguishing features that differentiate the syndromes from an FASD (Chudley et al. 2005).

The combination of the IOM criteria and the 4-digit diagnostic code with recommendations for the physical exam and pertinent genetic differentials helps to address many of the short-comings of other diagnostic guidelines. While Chudley et al. (2005) do improve the clinical practicality of the diagnostic process, their recommendations are made for Canada and there is not an equivalent guideline in the United States. There has also been a great deal of research published in the last 11 years regarding the malformations associated with prenatal alcohol exposure. A comprehensive physical anomaly checklist based on current research would improve diagnostic accuracy for the United States FASD diagnostic teams.

Problem Statement

Nurse practitioners in a North American interdisciplinary FASD diagnostic team expressed concerns about the consistency of their current practice. Although all team members complete the University of Washington FASD 4-digit diagnostic code training, the nurse practitioners who provide the medical evaluation for each case reported that a lack of guidance on associated physical anomalies and a lack of guidance on appropriate differential diagnoses complicated their diagnostic process. During two observed team meetings some team providers observed malformations that are known to occur with prenatal alcohol exposure but were unsure if these anomalies were related to the prenatal alcohol exposure. During these meetings providers also expressed concerns of not knowing when to refer a child to a geneticist for evaluation for a possible genetic condition. These observations and concerns voiced from the FASD medical team providers lead to the purpose and goals of this project.

While the diagnostic process for identifying children with FASD has improved since the first descriptions of FAS were identified in the literature, there are gaps in the evaluation process. A clear guideline for the physical examination of children with FASD is not available. Though many associated malformations have been identified in the literature, a concise way of documenting the assessment of those conditions is not included in current guidelines. There are several genetic conditions and other prenatal exposure syndromes that have similar presentations as FASD and must be considered in the diagnostic process. A physical anomaly checklist that includes pertinent malformations would help to standardize the clinical exam. Additionally a reference table summarizing the distinguishing features would help to ensure that appropriate differential diagnoses are evaluated and excluded based on evidence from the literature.

Purpose

The purpose of this project was to create clinical reference tools to help standardize the physical exam for medical evaluation of FASD. A checklist that incorporates the physical anomalies associated with prenatal alcohol exposure will help ensure that the physical exams conducted by the team are systematic and evidence-based. The checklist will also be used to help educate future FASD team medical providers. A table of differential diagnoses with distinguishing physical features that differentiate the disorder from an FASD was compiled based on the most current guidelines. Ultimately the goal of this practice improvement project is to empower providers to assess patients in a systematic, evidenced-based manner and continue to build and improve their clinical practice based on the evidence.

Project Goals

1. Determine what physical malformations are associated with prenatal alcohol exposure and should be considered during the physical exam.

2. Determine the genetic disorders that current guidelines suggest should be considered during the FASD diagnostic process.

3. Develop a physical anomaly checklist and differential diagnosis table based on findings.

4. Increase provider awareness of the physical anomalies associated with prenatal alcohol exposure.

5. Increase provider awareness of the appropriate differential diagnoses for FASD

Framework

In the 1920s Walter Shewhart developed the Plan-Do-Study-Act (PDSA) cycle and a means to facilitate planning and organizing quality and performance improvement measures (Ransom, Joshi, Nash, & Ransom, 2008). During the *plan* phase of the cycle goals for the cycle are determined, predictions or questions are made, and the plan for carrying out the cycle is defined. The *do* phase often consists of staff education, carrying out the plan on a small scale, documenting problems and unexpected observations, and analyzing the data. The *study* phase occurs when the effect of the change is determined and the level of successfully meeting the goal is defined, the changes that need to be made are defined, and lessons gleaned from the phase are summarized. Finally the *Act* phase occurs when the identified changes are made and it is determined if the same plan should be repeated with changes or if it is necessary to make a new plan, and additional PDSA cycles are conducted until the project goals are met (Ransom et al., 2008).

Marcellus, Harrison, and MacKinnon (2012) applied the PDSA cycle to a quality improvement project aimed at the implementation of a guideline into clinical practice. Methods employed in this clinical practice improvement project will serve as a guide to the practical application of the PDSA cycle for the FASD project.

Method

Design

A critical appraisal of the literature and a review of current guidelines was utilized for the practice improvement method for this project. Findings from the review and critical appraisal were introduced to an FASD team to stimulate practice change using a quality improvement approach. The PDSA cycle was used to guide the project design and implementation of a physical anomaly checklist and differential diagnosis table into a North American FASD diagnostic team's practice. The aim of using PDSA as a framework was to encourage team providers to actively participate in the design and implementation process to create permanent evidenced-based changes that will be truly useful within the practice context.

PDSA Cycle

The goals for the initial PDSA cycle included: increasing provider awareness, developing clinical reference tools based on the literature, providing education to the team providers, and making changes based on feedback from team providers. This PDSA cycle will serve as a starting point of a continuous practice improvement process that the FASD team may continue until all the team goals are met. Table 1 provides an outline of how the PDSA cycle was applied to this practice improvement project. Further explanation of the critical appraisal procedures and findings, guideline review process and findings, and the construction of the clinical reference tools will be described in greater depth following the table. The implementation process and evaluation process will follow the method section and complete the entire PDSA cycle for this project.

Table 1
PDSA Cycle applied to the medical evaluation of FASD

Setting Aims: What is the project trying to accomplish?	**Establish Measures and Indicators: Is the change an improvement?**
▪ Increase provider awareness of the physical anomalies associated with prenatal alcohol exposure. ▪ Increase provider awareness of appropriate differential diagnoses for FASD.	▪ Provider feedback taken from the post-implementation survey following team education.
PDSA cycle 1	
Plan:	**Study:**
▪ Attend two team meetings and discuss concerns about current practice with team director ▪ Conduct a critical appraisal of the literature ▪ Review current guidelines	▪ Team discussion regarding formatting changes to the table and checklist following education presentation ▪ Post-implementation survey findings
Do:	**Act:**
▪ Construct physical anomaly checklist ▪ Construct differential diagnoses table ▪ Design group education PowerPoint presentations ▪ Present education, critical appraisal grids, physical anomaly checklist, and differential diagnoses table to FASD diagnostic team	▪ Edit physical anomaly checklist ▪ Send edited checklist to FASD diagnostic team director for distribution to the team ▪ Team encouraged to continue to modify the table and checklist based on new research

Critical appraisal procedures. A critical appraisal of the literature was performed in order to answer the research questions and identify evidence based recommendations for the physical assessment of children with FASD. Recommendations for critical appraisal and

application of evidenced-based practice were based on methods described by Melnyk and Fineout-Overholt (2011) and Dearholt and Dang (2012). The goals of a critical appraisal are to address the study's validity, reliability, and applicability to ensure that the best evidence is used to make practice changes. A hierarchy of evidence classification was applied to each article so that the strength of the evidence would be clearly evident in the critical appraisal grid (See Appendix E). According to this hierarchy articles range from level I evidence being the strongest evidence to level V being the weakest level of evidence (Dearholt & Dang, 2012).

Evidence that is gathered from well-designed experimental studies, randomized control trials, and systematic reviews or meta-analysis of randomized controlled trials (RCTs) are considered level I evidence. Level II research consists of well-designed quasi-experimental studies, systematic reviews of RCTs and quasi-experimental studies, or systematic reviews of quasi-experimental studies only with or without meta-analysis. Non-experimental studies, systematic reviews of a combination of RCTs, quasi-experimental and non-experimental, or systematic reviews of non-experimental studies only with or without meta-analysis are considered level III evidence. Level IV evidence is generated by works of respected authorities, nationally recognized expert committees and includes clinical practice guidelines and works from consensus panels. Literature reviews that are not systematic, quality improvement projects, case reports, and opinion from nationally recognized experts are all considered level V evidence (Dearholt & Dang, 2012).

Search parameters. A search of the literature was conducted utilizing Cochrane Library, CINAHL, PubMed, Dynamed, Web of Science, and Google Scholar via the University of Alaska's consortium library in collaboration with the medical librarian. Selection criteria for the studies included: peer-reviewed, English language, related to human subjects, and

publication between 2004 and 2015. Studies were excluded if they were qualitative, not in English, or were not relevant to the research question. The current edition of the diagnostic guideline used by the FASD diagnostic team was published in 2004. The studies selected for this project were published in 2004 to 2015. This will ensure that the physical assessment checklist reflects both research that is contemporary with the guideline as well as updated research. Articles selected from Google Scholar were screened by the principal investigator to ensure that the selection criteria were met as this search engine does not have a way to include search parameters. The medical librarian strongly recommended including Google Scholar as a search engine as traditional indexed databases may miss key articles.

Critical appraisal findings. Six medical databases were used to identify pertinent articles for the critical appraisal of the literature. The search terms used for each database were selected with collaboration from the University of Alaska Anchorage medical librarian. Differences in search terms were based on how the key words were cataloged in each database. An initial search using the Cochrane Library search term fetal alcohol spectrum disorder and fetal alcohol syndrome yielded one result and three results. None of the articles in the Cochrane Library addressed the research question. The search terms used in CINAHL were fetal alcohol syndrome and abnormalities initially yielded six articles in English that used human subjects. Further review of the abstracts resulted in one article that met the search criteria. Dynamed, an evidence point of care search engine, yielded one guideline fetal alcohol spectrum disorder as a search term. The Web of Science database initially resulted in 1,424 articles using the search term fetal alcohol spectrum disorder. Further review of the each abstract resulted in 84 pertinent articles. However, eight of the articles were duplicate articles from other search engines and closer inspection found that 12 of the articles did not use human subjects. The remaining articles

did not address the research question and were excluded. A final result of 13 articles were included in the critical appraisal grid from this search engine. The search term used in Pubmed was fetal alcohol spectrum disorder with the limiters human subjects and English language had an initial yield of 1032 articles. Through abstract review nine articles were selected for further analysis, five were excluded because they did not address the research question. Four articles were included in the appraisal. Google Scholar proved to be a more challenging search tool and often resulted in a very high yield with the majority of articles not being pertinent to the investigation. However, using the advanced search option and searching the exact phrase physical anomalies and fetal alcohol spectrum disorders together resulted in 153 articles. Twenty-one articles from this database were selected for further review, eight fully met the research criteria and were used in the critical appraisal of the literature.

A total of 27 articles addressed the research question and were selected for the critical appraisal. The study methods used included: clinical practice guidelines, review articles, cohort studies, prospective studies, retrospective studies, cross-sectional studies, and case-control studies. There were 20 studies that contained level III evidence, three studies with level IV evidence, and four studies with level V evidence. There were six publications from the United States including reviews and guidelines and one guideline from Canada. Study participants included participants from the United States, Canada, Italy, South Africa, England, Portugal, Russia, Finland, Australia, Spain, Argentina, and Norway. Studies from the United States included Caucasians, Native Americans and Alaska Natives, African Americans, Hawaiian/Pacific Islanders, multi-racial participants, and those of Asian descent. The full critical appraisal of each article can be reviewed in the critical appraisal grids (Appendix E).

Upon completion of the critical appraisal of current literature, data regarding physical anomalies associated with FASD was extracted and combined with data from current guidelines. This combined data was used to construct the physical anomaly checklist (Appendix B). The physical anomaly checklist contains 85 physical anomalies. Only seven of those anomalies are included in the diagnostic criteria of FASD.

Review of current guideline procedures. The most current guidelines for the diagnosis of FASD from the United States, Canada, and other countries were reviewed to combine recommendations on differential diagnoses and genetic disorders that should be considered in the diagnostic process. In addition to the CINAHL, Pubmed, Dynamed, Web of Science and Google Scholar, The National Guideline Clearing House and the Trip database were used to search for current FASD diagnostic guidelines. The Trip database was used to search for diagnostic guidelines from other countries. All guidelines had to be published in English in 2004 to 2015.

Guideline review findings. The search for guidelines in CINAHL yielded one article that did not address the purpose of this project. Google scholar resulted in five pertinent articles and four national guidelines. The web of science search yielded three articles that did not address the project purpose. The Trip Database was used to search for international guidelines and yielded seven pertinent articles. However, none of the international guidelines addressed specific differential diagnoses. Pubmed resulted in three supportive articles that provided insight into the differential diagnoses of FASD. Dynamed resulted in one guideline that provided information on the differential diagnoses of FASD. The National Guideline Clearing House did not provide any pertinent guidelines that addressed the differential diagnoses of FASD.

The combination of the guidelines and the reference articles resulted in 20 different genetic disorder differentials and four exposure related differential diagnoses. Each diagnosis is

identified and the overlapping and distinguishing features are described in the differential diagnoses tables (Appendix A). The differential diagnoses table provides a clinical reference tool that supports the providers as they are considering appropriate differentials.

Construction of clinical reference tools. During this phase of the PDSA cycle information gathered from the planning phase was used to construct the clinical reference tools. The critical appraisal of the literature provided information on the physical anomalies associated with prenatal alcohol exposure. This data was extracted and combined with the data from the current guidelines to create a physical anomaly checklist (Appendix B). The review of the guidelines provided information on the differential diagnoses that should be considered during the assessment of an individual with suspected FASD. This information was combined with data from supportive articles to generate a table of the differential diagnoses of FASD. The table consists of a list of differentials and highlights the overlapping and distinguishing features of each diagnosis (Appendix A).

Implementation

Participants

Project participants consisted of a convenience sample of members of a North American FASD medical diagnostic team comprised of nurse practitioners. In order to participate in the post-implementation survey participants had to be responsible for the medical examination of children with suspected FASD. Participants were recruited to participate via email. Initially, all five team providers agreed to participate in the educational intervention and review of the clinical reference tools. However, ultimately three of the team providers attended the educational presentation and participated in the post-implementation survey. The participants

were all nurse practitioners with a range of clinical experience from six years to 33 years and with FASD diagnostic experience from three to 20 years.

Nurse Practitioner Education

An educational presentation highlighting the physical anomaly checklist and genetic disorder/differentials table was presented to team medical providers. The education consisted of two PowerPoint presentations. The first presentation provided images and brief case discussion of pertinent genetic disorders and exposure syndromes. The second presentation included images of the physical anomalies for each body system. Images used were cited and covered under the one-time use measure as express permission for continued use did not meet project time constraints.

The critical appraisal evidence tables were printed and available for review at the educational presentation. Providers were given copies of the physical exam checklist and genetic disorder/differentials table to evaluate. Questions from providers were addressed following the educational presentation and suggestions for formatting changes were discussed as a group. Changes to the clinical reference tools were considered based on ease of use in clinical practice.

Evaluation and Application

Post Implementation Survey

A post-implementation survey was used to collect data from team providers responsible for conducting the physical exam portion of the FASD evaluation (Appendix C). Demographic information collected in the post-implementation survey included: number of years in practice, the number of years working with the FASD diagnostic team, and type of medical provider. The survey was completed following the provider education and returned to the principle investigator. No personal identifying information was linked directly to the survey.

Revision and Application to Practice

Changes were made to the physical anomaly checklist for ease of use in the practice setting based on provider feedback. After the educational session, clinicians were asked to apply the physical assessment template and genetic disorder/syndrome table during FASD evaluations. They were given permission to make future changes and to refine the checklist and table to continue to meet their practice needs.

Ethical Concerns

A North American FASD diagnostic team received a thorough explanation of how the clinical practice improvement project would be carried out. Written consent was acquired from all participating providers (Appendix D). Each participant was informed that participation was voluntary, and that withdrawal from the process could occur at any point. The participants were not subjected to any physical risk. The confidentiality of the participants was maintained by the principle investigator. All information obtained from the post-implementation surveys and signed consent forms are stored in a locked file cabinet in UAA, Health Sciences Building, Room 365 for three years after the completion of the study at which time they will be destroyed.

The project proposal and methods of this study were approved by the project chair and committee member. The project proposal was reviewed by the University of Alaska Anchorage (UAA) Institutional Review Board (IRB). The methods met the requirements for the protection of human subjects and the project was approved by the UAA IRB with exempt status.

Results

The project results include a summary of the data from the post-implementation survey. Project outcomes include critical appraisal grids (Appendix E), a physical anomaly checklist (Appendix B), and a differential diagnoses table (Appendix A). The physical anomaly checklist

and differential diagnoses table were developed for clinical use by a North American FASD diagnostic team based on the evidence identified from this project.

Post-implementation Survey

Of the five providers working on the FASD diagnostic team, three providers participated in the education and post-implementation survey. A one and a half hour presentation on physical anomalies and the differential diagnoses associated with FASD was provided. Review of the physical anomaly checklist and differential diagnoses table was provided. Following the presentation all providers indicated in the survey that they gained information from the presentation that will be useful for their practice.

Providers were asked to circle the malformations they were previously unaware were associated with FASD. A total of 23 of the malformations included in the checklist were indicated by one or more of the providers as new information. However, there was a wide range of responses for this question and some providers were more aware of the malformations than others. Due to the small number of participants and in order to protect anonymity the specific number of malformations not recognized by each provider will not be addressed. However, a complete list of anomalies some of the providers were unaware of included: low measures of the maxillary and mandibular arch, prognathism, accessory tragus, protruding ears, short or webbed neck, Klippel-Feil syndrome, intestinal atresia, horseshoe kidney, vesicoureteral reflux, radioulnar synostosis, reduced elbow pronation or supination, inability to fully extend fingers, overlapping fingers, hypoplastic nails, talipes varus, talipes valgus, brachydactyly, capillary hemangioma, naevus flammeus neonatorum, hirsutism, joint contractures and joint laxity.

One provider reported never using a checklist for the physical exam, while the other two providers reported using a template that did not address all the physical anomalies addressed in

the checklist. All providers reported that they believe the checklist will be easy to use and apply to practice. All providers reported the differential diagnoses table will be helpful in their clinical practice. All providers reported they believe the physical anomaly checklist and differential diagnostic table will improve their clinical practice. One stated I "will keep [the reference tools] in [the] exam room and be more thorough."

The only improvement providers wanted to see in the physical anomaly checklist was adding a space for written notes. This change was made and sent back to the team director via email. No additional education was requested by the team.

Significance to Advanced Nursing Practice

Advanced Practice Registered Nurses (APRNs) are charged with providing safe, effective, quality care that is evidenced-based (Iglehart, 2013). In order to improve the quality and efficacy of healthcare, evidenced-based frameworks and protocols must be applied to clinical practice (Gerrish et al., 2011). A critical appraisal of the literature and review of diagnostic guidelines resulted in 85 physical anomalies that may occur with prenatal alcohol exposure and 24 differential diagnoses that should be considered in the diagnostic process. These findings are summarized in a physical anomaly checklist and differential diagnoses table that may be used as evidenced-based clinical reference tools to help streamline the FASD diagnostic process in a North American FASD diagnostic team. These clinical reference tools will address some of the inconsistencies of the guidelines and provide a framework for the physical exam. A thorough physical exam and full consideration of appropriate differentials is needed to make a diagnosis of an FASD (Astley, 2004; Chudley et al., 2005). By providing consistent documentation of physical exam findings, advanced practice nurses can play a role in determining the full range of effects that may result from prenatal alcohol exposure. As part of

on-going practice improvement, the FASD diagnostic team has been encouraged to continue to modify and update the clinical reference tools with new research using the PDSA model to ensure that the clinical reference tools continue to be relevant to their clinical practice.

Recommendations for Future Research

Recommendations from Providers

As part of the post-implementation survey providers in the FASD diagnostic team were asked to suggest areas of study they believe would be helpful to their practice. One provider reported wanting to see more research on follow-up with families. Another provider was interested in research on the impact that prenatal alcohol exposure has on the next generation's reproductive capacity. Finally one provider would like see local research on the physical exam findings of children with FASD using the physical anomaly checklist.

Recommendations from the Literature

There is a need for continued research on the physical anomalies associated with prenatal alcohol exposure (Jones et al., 2010). Large scale cohort studies should be used to develop a guideline for the physical evaluation of FASD that is universally recognized by FASD research centers on a national level. Once a nationally recognized standard is in place a study of inter-rater reliability should be conducted using the standard guideline or checklist to ensure that the guideline does indeed produce consistent and reliable findings between examiners. Finally more population based studies should be performed in elementary schools across the United States to determine the true prevalence of FASD to help increase public awareness and prevention measures (May et al., 2014).

Conclusion

Implementing practice change in a setting where multiple healthcare providers are responsible for translating the change into practice can be challenging. The use of a quality improvement model that incorporates feedback from all providers facilitates team participation. The PDSA cycle was used as a framework for this project. This approach not only allowed team participation, but also provides a means for ongoing quality improvement and modification of the clinical reference tools by the team (Marcellus, Harrison, & Mackinnon, 2012). Team providers can apply the PDSA approach to continue to update and change the physical anomaly checklist and differential diagnoses tables to ensure that the team's approach to assessment is evidence-based.

The goals of this practice improvement project were to increase provider awareness of the physical anomalies associated prenatal alcohol exposure and to increase awareness of the differential diagnosis for FASD. The ultimate purpose of this project is to ensure that the physical examination of children with potential FASD is systematic and consistent between team providers in a North American FASD diagnostic team. While achieving this purpose was beyond the scope of this project; the team providers may use the clinical reference tools produced through this project to study team practices and achieve this goal.

Consistent assessment of children with potential FASD and documentation of physical anomalies will help to better characterize the potential outcomes of prenatal alcohol exposure (Jones et al., 2010). Furthermore, proper consideration of differential diagnoses is necessary to determining an accurate diagnosis and ultimately providing an appropriate treatment plan (Astley, 2004). All healthcare providers responsible for the care of children and their families should be aware of the many physical anomalies associated with prenatal alcohol exposure in

order to determine when appropriate referral is necessary. Providers directly participating in FASD diagnosis must be aware of the physical anomalies associated with FASD and have a working knowledge of potential differential diagnoses (Astley, 2004; Bertrand et al., 2004; Chudley et al., 2005; Jones et al., 2010). The physical anomaly checklist and differential diagnoses tables provide team providers the additional information they need to conduct an FASD evaluation in a way that is clinically practical utilizing the current evidence available.

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Appendix A

Table 2

Genetic Disorders Differential Diagnoses

Genetic disorders	Overlapping Features	Distinguishing features
Aarskog syndrome	Long and wide philtrum, mid-face hypoplasia, widely spaced eyes, small nose, anteverted nares, ADHD with impulsive traits.	Broad Forehead, Rounded face, down-slanted palpebral fissures, widow's peak, prominent ears, crease below lower lip, incomplete out folding of upper helices on the ears, dental eruption problems, hyperextension at the proximal interphalangeal joints, shawl scrotum, and short broad hands, Most have normal intellectual capacity, x-linked gene FGDI.
Blepharophimosis syndrome	Short palpebral fissures and ptosis.	Epicanthus inversus, lateral displacement of the inner canthi with a normal distance between pupils, variable infertility in females,

		autosomal dominant trait. Molecular defect.
Bloom Syndrome	Prenatal growth deficiency, microcephaly, midface hypoplasia, low attention span.	Narrow long face with prominent nose and ears and micrognathia, telangiectatic skin lesions, café-au-lait spots, moderate immune deficiency, hypogonadism, hypogammaglobulinemia, mutations in the BLM gene on chromosome 15.
Brachman-deLange or Cornelia deLange syndrome	Long philtrum, thin vermillion boarder, microcephaly, depressed nasal bridge, anteverted nares, upturned nose, low IQ, hyperactivity, and mid-face hypoplasia	Single bushy eyebrow extending over both eyes, long eyelashes, downward corners of the mouth, high arched palate, low-set posteriorly rotated ears, short upper limbs, very short stature. Molecular defect
Campomelic Dysplasia	Small palpebral fissures	Significant skeletal abnormalities, significant hypotonia, and respiratory failure.

DiGeorge syndrome	Midface hypoplasia, smooth philtrum, thin upper lip, ADHD	Hooded eyelid, bulbous nasal tip, posteriorly rotated ears, microtia, micrognathia, nasal dimple
Dubowitz syndrome	Widely spaced eyes, short-palpebral fissures, Prenatal growth deficiency, microcephaly, ptosis, clinodactyly, developmental delay.	Broad nasal tip, shallow supraorbital ridge, infantile eczema, cryptorchidism, and limb anomalies.
Duplication 10q Sequence	Microcephaly, Short palpebral fissures, Growth deficiency, Intellectual disability	Bow-shaped mouth, Prominent upper lip, High forehead, High arched eyebrows
Duplication 15q Sequence	Small palpebral fissures, short philtrum, autistic behavior	Intractable epilepsy
FG syndrome	Thin upper lip, hyperactive behavior.	Macrocephaly, prominent forehead, hair whorls or upsweep.
Floating-Harbor Syndrome	Smooth philtrum, thin lips.	Triangular face with a prominent nose and deep-set eyes.

Geleophysic Dysplasia	Flat philtrum and thin upper lip. Wide set eyes.	Full cheeks, delayed bone age, cone-shaped epiphyses, shortened long tubular bones, ovoid vertebral bodies, progressive cardiac valvular thickening, stenosis of the trachea, and respiratory insufficiency.
Miller-Dieker Syndrome	Thin upper lip	Severe developmental delay, epilepsy.
Noonan syndrome	Low nasal bridge, epicanthal folds, wide spaced eyes, and long philtrum.	Palpebral fissures are downward slanted, the mouth is wide and has a well-formed philtrum, protruding upper lip, Keratoconus, ptosis of the eyes, low nuchal hairline. Molecular defect.
Oculodentodigital Syndrome	Small palpebral fissures.	Dental abnormalities: microdontia, enamelogenesis imperfecta, and missing teeth.
Opitz Syndrome	Smooth philtrum, wide set eyes, small palpebral fissures	Grooving of the nasal tip, widow’s peak, cranial asymmetry.

Other chromosome deletion or duplication syndromes	Often short palpebral fissures, mid-facial hypoplasia, and smooth philtrum.	Chromosomal deletion by FISH probe analysis.
Velocardiofacial syndrome	Short palpebral fissures, malar hypoplasia, microcephaly, and learning disabilities.	Broad nasal root with bulbous nasal tip, deficient alae nasi, long slender fingers, higher prevalence of cardiac defects especially conotruncal type.
Trisomy 18	Small palpebral fissures	Prominent occiput, small mouth, pointy ears, short sternum, flexed fingers, index finger overlapping the third digit and the fifth digit overlapping the fourth digit.
Williams Syndrome	Short palpebral fissures, anteverted nares, microcephaly, mid-face hypoplasia, long philtrum, depressed nasal bridge, epicanthal folds, microcephaly, low IQ, learning disabilities and behavior problems.	Wide mouth with full lips, stellate pattern of the iris, periorbital fullness, broad forehead, high round cheeks with pointed chin, hoarse voice, connective tissue disorders, cardiac defects, chromosome deletion

Table 3

Exposure related syndromes differential diagnoses

Disorders related to other prenatal exposures	**Overlapping features**	**Distinguishing Features**
Fetal Hydantoin Syndrome	Wide-spaced eyes and depressed nasal bridge	Short nose and bowed upper lip.
Fetal Valproate Syndrome	Wide-spaced eyes, epicanthal folds, anteverted nares, long philtrum, and thin vermilion border	High forehead, small mouth, infraorbital crease
Maternal PKU fetal effects	Epicanthal folds, short palpebral fissures, long poorly developed philtrum, thin vermillion boarder, microcephaly	Prominent glabella, small up turned nose, round face.
Toluene Embryopathy	Short palpebral fissures, mid-face hypoplasia, smooth philtrum, and thin vermillion boarder, microcephaly	Large anterior fontanel, down turned mouth, mandibular hypoplasia, abnormal hair patterns, and ear abnormalities, Toluene exposure.

(Astley, 2004; Chudley et al., 2005; *DynaMed*, 2014, November 19; Hoyme et al., 2005; Manning & Hoyme, 2007; Bertrand et al., 2004; Leibson, 2014; Senturia & Asamoah, 2014).

Appendix B

Table 4

Physical Anomaly Checklist

Head	+	-	Notes
Microcephaly –Head circumference 2SD below the mean for age and sex			
Persistent patent fontanelles			
Face			
Hypertelorism			
Short palpebral fissure			
Thin vermilion boarder			
Flat philtrum			
Long philtrum			
Facial Asymmetry			
Hypoplastic midface			
Low measures of the maxillary and mandibular arc			

Flat-nasal bridge

Micrognathia

Prognathism

Eyes

Epicanthal folds

Ptosis

Strabismus

Decreased visual acuity

Ears

Preauricular pit

Accessory tragus

Railroad track ear

Altered shape

Low-set ears

Large ear lobes

Protruding ears

Asymmetric ears

Decreased hearing (Conductive or neurosensory) (Confirmed)

Nose

Short nose

Anteverted nares

Mouth

Cleft lip

Cleft palate

High arched palate

Dental crowding

Neck

Short or webbed neck

Klippel-Feil syndrome

Chest

Pectus Excavatum

Pectus Carinatum

Cardiovascular

Murmur

Congenital cardiac defect (Confirmed)

[ASD, VSD, aberrant great vessels, tetralogy of fallot, conotruncal heart defects (truncus arteriosus, tetralogy of the fallot, interrupted aortic arch, double outlet right or left ventricle, transposition of the arteries)].

Abdomen (GI)

Intestinal atresia (confirmed)

Renal

Aplastic/dysplastic/Hypoplastic kidneys (Confirmed)
Horseshoe kidney (Confirmed)

Ureteral duplications (Confirmed)

Hydronephrosis (Confirmed)

Vesicoureteric reflux (Confirmed)

Back

Scoliosis

Spina bifida (confirmed)

Thoracic kyphosis

Hemivertibrae (confirmed)

Cervical rib (confirmed)

Arms

Radioulnar synostosis

Reduced elbow pronation or supination

Hands

Hockey stick palmar crease

Abnormal palmar crease

Clinodactyly

Camptodactyly

Brachydactyly

Shortened fifth digits

Inability to fully extend fingers

Overlapping fingers

Hypoplastic nails

Feet

Talipes varus

Talipes valgus

Brachydactyly

Clinodactyly

Camptodactyly

Skin

Capillary hemangioma

Naevus flammeus neonatorum

Hirsutism

Neurologic

Poor tandem gate

Poor hand eye coordination

Neurosensory hearing loss (confirmed)

Nystagmus

Impaired fine motor skills

Memory problems

Meningomyelocele (confirmed)

Hydrocephalus (confirmed)

Partial or complete agenesis of the corpus callosum (confirmed)

Joints

Contractures

Laxity

Other Musculoskeletal

Hypotonia

Confirmed: History of diagnoses, or diagnoses made with testing beyond the physical exam

Other Anomalies:_____

_____

_____

_____

Appendix C

Post Implementation Survey

Physical Assessment of children with FASD: Evidence-Based Practice

Demographic information:

1.) Number of years in clinical practice at your current level of training:

2.) Type of provider:

3.) How long have you worked with an FASD diagnostic team:

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1. Have you gained information on malformations related to prenatal alcohol exposure that you did not know prior to this intervention?

2. If so, please list any malformations that you were not previously aware of.

3. Have you used a physical exam template prior to using the research template? If so how was it different than the research template?

4. Do you find the template and reference table easy to understand and do you believe it will be simple to implement into practice?

5. Do you believe that the physical exam template and genetic disorder table will improve your clinical practice? Please explain:

6. What changes could be made to template and reference tables to make them easier to use?

7. Would you like anymore education on the use of the template and diagnostic table? Please specify areas of education:

8. What clinical questions would you like to see investigated regarding FASD diagnosis in the future?

9. Is there any other information you would find helpful in your diagnosis of children with FASD?

Appendix D

Consent Form

Physical Assessment of children with FASD: Evidence-Based Practice

Principal investor:
Tabitha Waller, Family Nurse Practitioner Student, University of Alaska Anchorage
Email: tmwaller@alaska.edu Phone: (907)-720-9792

DESCRIPTION:
The purpose of this study is to review current literature and guidelines regarding the physical anomalies associated with FASD and genetic syndromes that should be considered in the differential diagnoses. Based on the evidence a physical exam template and genetic/ differentials table with distinguishing characteristics will be created. Education on these resources will be presented and copies will be given to participants. All participants will be asked to apply these resources to their clinical practice. The participants will also asked to complete a post implementation survey. Surveys will be collected following the educational intervention.

VOLUNTARY NATURE OF PARTICIPATION:
Participation in this study is voluntary. If you do not want to participate, or want to stop your participation at any time during this study, you will not be penalized.

CONFIDENTIALITY:
Your name or contact information will not be connected to your responses. Any documentation that includes name such as this consent form will be kept in a secured file cabinet and will only be accessible by me. Any publication of this study will not provide any identifying information. Direct quotes may be used but your identifiable information will not be linked to quotations or summaries of the data you provide.

BENEFITS:
There is no direct benefit to you from the participation in this study. The information obtained for the study will be used to benefit health care providers responsible for the medical assessment of children with suspected FASD.

RISKS:
There are no known risks associated with your participation.

CONTACTS:
If you have any questions about this research, please contact the principal investigator with the phone number or email listed above. If you have any further questions regarding your rights as a research participant, please contact Dr. Lisa Jackson, study chair, at (907)-786-4590

SIGNATURE:
Your signature indicates that you fully understand the above study, what is being asked of you, and your signing is of your own free will.
Signature:_____ Date:_____
Printed Name:_____

You may have a copy of this consent form