Consensus Statement on Management of Intersex Disorders
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Pediatrics 2006;118;e488-e500
DOI: 10.1542/peds.2006-0738

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http://www.pediatrics.org/cgi/content/full/118/2/e488
Consensus Statement on Management of Intersex Disorders

The birth of an intersex child prompts a long-term management strategy that involves myriad professionals working with the family. There has been progress in diagnosis, surgical techniques, understanding psychosocial issues, and recognizing and accepting the place of patient advocacy. The Lawson Wilkins Pediatric Endocrine Society and the European Society for Paediatric Endocrinology considered it timely to review the management of intersex disorders from a broad perspective, review data on longer-term outcome, and formulate proposals for future studies. The methodology comprised establishing a number of working groups, the membership of which was drawn from 50 international experts in the field. The groups prepared previous written responses to a defined set of questions resulting from evidence-based review of the literature. At a subsequent gathering of participants, a framework for a consensus document was agreed. This article constitutes its final form.

NOMENCLATURE AND DEFINITIONS

Advances in identification of molecular genetic causes of abnormal sex with heightened awareness of ethical issues and patient advocacy concerns necessitate a reexamination of nomenclature. Terms such as “intersex,” “pseudohermaphroditism,” “hermaphroditism,” “sex reversal,” and gender-based diagnostic labels are particularly controversial. These terms are perceived as potentially pejorative by patients and can be confusing to practitioners and parents alike. We propose the term “disorders of sex development” (DSD), as defined by congenital conditions in which development of chromosomal, gonadal, or anatomic sex is atypical.

The proposed changes in terminology are summarized in Table 1. A modern lexicon is needed to integrate progress in molecular genetic aspects of sex development. Because outcome data in individuals with DSD are limited, it is essential to use precision when applying definitions and diagnostic labels. It is also appropriate to use terminology that is sensitive to the concerns of patients. The ideal nomenclature should be sufficiently flexible to incorporate new information yet robust enough to maintain a consistent framework. Terms should be descri-
tive and reflect genetic etiology when available and accommodate the spectrum of phenotypic variation. Clinicians and scientists must value the nomenclature’s use, and it must be understandable to patients and their families. An example of how the proposed nomenclature could be applied in a classification of DSD is shown in Table 2.

Psychosexual development is traditionally conceptualized as 3 components: “gender identity” refers to a person’s self-representation as male or female (with the caveat that some individuals may not identify exclusively with either); “gender role” (sex-typical behaviors) describes the psychological characteristics that are sexually dimorphic within the general population, such as toy preferences and physical aggression; and “sexual orientation” refers to the direction(s) of erotic interest (heterosexual, bisexual, homosexual) and includes behavior, fantasies, and attractions. Psychosexual development is influenced by multiple factors such as exposure to androgens, sex chromosome genes, and brain structure, as well as social circumstance and family dynamics.

Gender dissatisfaction denotes unhappiness with assigned sex. Causes of gender dissatisfaction, even among individuals without DSD, are poorly understood. Gender dissatisfaction occurs more frequently in individuals with DSD than in the general population but is difficult to predict from karyotype, prenatal androgen exposure, degree of genital virilization, or assigned gender.6–7 Prenatal androgen exposure is clearly associated with other aspects of psychosexual development.8,9 There are dose-related effects on childhood play behavior in girls with congenital adrenal hyperplasia (CAH), whereby those with the more severe mutations and marked genital virilization play more with boys’ toys.10 Prenatal androgen exposure is also associated with other psychological characteristics such as maternal interest and sexual orientation. It is important to emphasize the separability of sex-typical behavior, sexual orientation, and gender identity. Thus, homosexual orientation (relative to sex of rearing) or strong cross-sex interest in an individual with DSD is not an indication of incorrect gender assignment. Understanding variations in psychosexual development in individuals with DSD requires reference to studies in nonhuman species that show marked but complex effects of androgens on sex differentiation of the brain and on behavior. Outcomes can be influenced by the timing, dose, and type of androgen exposure, receptor availability, and modification by the social environment.11–14

Data from rodent studies suggest that sex chromosome genes may also influence brain structure and behavior directly.15,16 However, studies in individuals with complete androgen insensitivity syndrome (CAIS) do not indicate a behavioral role for Y-chromosome genes, although data are limited.17 Sex differences in brain structures have been identified across species, some of which coincide with pubertal onset, perhaps suggesting hormonal responsivity.18–20 The limbic system and hypothalamus, both of which play a role in reproduction, show sex differences in specific nuclei, but it is not clear

TABLE 2 An Example of a DSD Classification

<table>
<thead>
<tr>
<th>Sex Chromosome DSD</th>
<th>46,XY DSD</th>
<th>46,XX DSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>45,X (Turner syndrome and variants)</td>
<td>Disorders of gonadal (testicular) development: (1) complete gonadal dysgenesis (Swyer syndrome); (2) partial gonadal dysgenesis; (3) gonadal regression; and (4) ovotesticular DSD</td>
<td>Disorders of gonadal (ovarian) development: (1) ovotesticular DSD; (2) testicular DSD (eg, SRY duplication, SOX9); and (3) gonadal dysgenesis</td>
</tr>
<tr>
<td>47,XXY (Klinefelter syndrome and variants)</td>
<td>Disorders in androgen synthesis or action: (1) androgen biosynthesis defect (eg, 17α-hydroxylase deficiency, StAR, Ino1, etc); (2) defect in androgen action (eg, CAIS, PAIS, MURCS); (3) luteinizing hormone receptor defects (eg, Leydig cell hypoplasia, aplasia); and (4) disorders of anti-Müllerian hormone and anti-Müllerian hormone receptor (persistent Müllerian duct syndrome)</td>
<td>Androgen excess: (1) testicular (eg, 21-hydroxylase deficiency, 11β-hydroxylase deficiency, POR P450 oxidoreductase); and (3) maternal (luteoma, exogenous, etc)</td>
</tr>
<tr>
<td>45,X/46,XY (MGD, ovotesticular DSD)</td>
<td></td>
<td>Other (eg, cloacal exstrophy, vaginal atresia, MURCS)</td>
</tr>
<tr>
<td>46,XX/46,XY (chimeric, ovotesticular DSD)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Although consideration of karyotype is useful for classification, unnecessary reference to karyotype should be avoided; ideally, a system based on descriptive terms (eg, androgen insensitivity syndrome) should be used wherever possible. StAR indicates steroidogenic acute regulatory protein.
when these differences emerge. Interpretation of sex differences is complicated by the effect of cell death and synaptic pruning on normal maturation and by effects of experience on the brain. Structure of the brain is not currently useful for gender assignment.

**INVESTIGATION AND MANAGEMENT OF DSD**

**General Concepts of Care**

Optimal clinical management of individuals with DSD should comprise the following: (1) gender assignment must be avoided before expert evaluation in newborns; (2) evaluation and long-term management must be performed at a center with an experienced multidisciplinary team; (3) all individuals should receive a gender assignment; (4) open communication with patients and families is essential, and participation in decision-making is encouraged; and (5) patient and family concerns should be respected and addressed in strict confidence.

The initial contact with the parents of a child with a DSD is important, because first impressions from these encounters often persist. A key point to emphasize is that the child with a DSD has the potential to become a well-adjusted, functional member of society. Although privacy needs to be respected, a DSD is not shameful. It should be explained to the parents that the best course of action may not be clear initially, but the health care team will work with the family to reach the best possible set of decisions in the circumstances. The health care team should discuss with the parents what information to share in the early stages with family members and friends. Parents need to be informed about sexual development, and Web-based information may be helpful, provided the content and focus of the information is balanced and sound.

Ample time and opportunity should be made for continued discussion with review of information previously provided.1

**The Multidisciplinary Team**

Optimal care for children with DSD requires an experienced multidisciplinary team that is generally found in tertiary care centers. Ideally, the team includes pediatric subspecialists in endocrinology, surgery, and/or urology, psychology/psychiatry, gynecology, genetics, neonatology, and, if available, social work, nursing, and medical ethics.22 Core composition will vary according to DSD type, local resources, developmental context, and location. Ongoing communication with the family’s primary care physician is essential.23

The team has a responsibility to educate other health care staff in the appropriate initial management of affected newborns and their families. For new patients with DSD, the team should develop a plan for clinical management with respect to diagnosis, gender assignment, and treatment options before making any recommendations. Ideally, discussions with the family are conducted by one professional with appropriate communication skills.24 Transitional care should be organized with the multidisciplinary team operating in an environment that includes specialists with experience in both pediatric and adult practice. Support groups can have an important role in the delivery of care to patients with DSD and their families (see Appendix 1).

**Clinical Evaluation**

A family and prenatal history, a general physical examination with attention to any associated dysmorphic features, and an assessment of the genital anatomy in comparison to published norms need to be recorded (Table 3). Criteria that suggest DSD include (1) overt genital ambiguity (eg, cloacal exstrophy), (2) apparent female genitalia with an enlarged clitoris, posterior labial fusion, or an inguinal/labial mass, (3) apparent male genitalia with bilateral undescended testes, micropenis, isolated perineal hypospadias, or mild hypospadias with unde-

<table>
<thead>
<tr>
<th>TABLE 3</th>
<th>Anthropometric Measurements of the External Genitalia</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sex</strong></td>
<td><strong>Population</strong></td>
</tr>
<tr>
<td>M</td>
<td>United States</td>
</tr>
<tr>
<td>M</td>
<td>United States</td>
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<tr>
<td>M</td>
<td>Japan</td>
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<tr>
<td>M</td>
<td>Australia</td>
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<td>M</td>
<td>China</td>
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<td>M</td>
<td>India</td>
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<td>M</td>
<td>North America</td>
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<td>Europe</td>
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<td>M</td>
<td>Europe</td>
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<td>F</td>
<td>United States</td>
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<tr>
<td>F</td>
<td>United States</td>
</tr>
<tr>
<td>F</td>
<td>United States</td>
</tr>
</tbody>
</table>

GA indicates gestational age.
scended testis, (4) a family history of DSD such as CAIS, and (5) a discordance between genital appearance and a prenatal karyotype. Most causes of DSD are recognized in the neonatal period; later presentations in older children and young adults include (1) previously unrecognized genital ambiguity, (2) inguinal hernia in a female, (3) delayed or incomplete puberty, (4) virilization in a female, (5) primary amenorrhea, (6) breast development in a male, and (7) gross and occasionally cyclic hematuria in a male.

**Diagnostic Evaluation**

Considerable progress has been made with understanding the genetic basis of human sexual development, yet a specific molecular diagnosis is identified in only ~20% of cases of DSD. The majority of virilized 46,XX infants will have CAH. In contrast, only 50% of 46,XY children with DSD will receive a definitive diagnosis. Diagnostic algorithms do exist, but with the spectrum of findings and diagnoses, no single evaluation protocol can be recommended in all circumstances. Some tests, such as imaging by ultrasound, are operator dependent. Hormone measurements need to be interpreted in relation to the specific assay characteristics and to normal values for gestational and chronological age. In some cases, serial measurements may be needed.

First-line testing in newborns includes karyotyping with X- and Y-specific probe detection (even when prenatal karyotype is available), imaging (abdominopelvic ultrasound), measurement of 17-hydroxyprogesterone, testosterone, gonadotropins, anti-Müllerian Hormone, and serum electrolytes, and urinalysis. The results of these investigations are generally available within 48 hours and will be sufficient for making a working diagnosis. Decision-making algorithms are available to guide additional investigation. These assessments include human chorionic gonadotropin and adrenocorticotropic stimulation tests to assess testicular and adrenal steroid biosynthesis, urinary steroid analysis by gas chromatography mass spectroscopy, imaging studies, and biopsies of gonadal material. Some gene analyses are performed in clinical service laboratories. However, current molecular diagnosis is limited by cost, accessibility, and quality control. Research laboratories provide genetic testing, including functional analysis, but may face restrictions on communicating results.

**Gender Assignment in Newborns**

Initial gender uncertainty is unsettling and stressful for families. Expediting a thorough assessment and decision is required. Factors that influence gender assignment include diagnosis, genital appearance, surgical options, need for lifelong replacement therapy, potential for fertility, views of the family, and, sometimes, circumstances relating to cultural practices. More than 90% of patients with 46,XX CAH and all patients with 46,XY CAIS assigned female in infancy identify as females. Evidence supports the current recommendation to raise markedly virilized 46,XX infants with CAH as female. Approximately 60% of 5-alpha-reductase (5αRD2)-deficient patients assigned female in infancy and virilizing at puberty (and all assigned male) live as males. In 5αRD2 and possibly 17β-hydroxyysteroid dehydrogenase deficiencies, for which the diagnosis is made in infancy, the combination of a male gender identity in the majority and the potential for fertility (documented in 5αRD2 but unknown in 17β-hydroxyysteroid dehydrogenase deficiencies) should be discussed when providing evidence for gender assignment. Among patients with partial androgen insensitivity syndrome (PAIS), androgen biosynthetic defects, and incomplete gonadal dysgenesis, there is dissatisfaction with the sex of rearing in ~25% of individuals whether raised male or female. Available data support male rearing in all patients with micropenis, taking into account equal satisfaction with assigned gender in those raised male or female but no need for surgery and the potential for fertility in patients reared male. Those making the decision on sex of rearing for those with ovotesticular DSD should consider the potential for fertility on the basis of gonadal differentiation and genital development and assuming that the genitalia are, or can be made, consistent with the chosen sex. In the case of mixed gonadal dysgenesis (MGD), factors to consider include prenatal androgen exposure, testicular function at and after puberty, phallic development, and gonadal location. Individuals with cloacal exstrophy reared female show variability in gender identity outcome, but >65% seem to live as female.

**Surgical Management**

The surgeon has a responsibility to outline the surgical sequence and subsequent consequences from infancy to adulthood. Only surgeons with expertise in the care of children and specific training in the surgery of DSD should perform these procedures. Parents now seem to be less inclined to choose surgery for less severe clitoromegaly. Surgery should only be considered in cases of severe virilization (Prader III–V) and be performed in conjunction, when appropriate, with repair of the common urogenital sinus. Because orgasmic function and erectile sensation may be disturbed by clitoral surgery, the surgical procedure should be anatomically based to preserve erectile function and the innervation of the clitoris. Emphasis is on functional outcome rather than a strictly cosmetic appearance. It is generally felt that surgery that is performed for cosmetic reasons in the first year of life relieves parental distress and improves attachment between the child and the parents; the systematic evidence for this belief is lacking.

Currently, there is inadequate evidence in relation to establishment of functional anatomy to abandon the practice of early separation of the vagina and urethra.
The rationale for early reconstruction is based on guidelines on the timing of genital surgery from the American Academy of Pediatrics, the beneficial effects of estrogen on tissue in early infancy, and the avoidance of potential complications from the connection between the urinary tract and peritoneum via the Fallopian tubes. It is anticipated that surgical reconstruction in infancy will need to be refined at the time of puberty. Vaginal dilatation that surgical reconstruction in infancy will need to be refined at the time of puberty.34–36 Vaginal dilatation should not be undertaken before puberty. The surgeon must be familiar with a number of operative techniques to reconstruct the spectrum of urogenital sinus disorders. An absent or inadequate vagina (with rare exceptions) requires a vaginoplasty performed in adolescence when the patient is psychologically motivated and a full partner in the procedure. No one technique has been universally successful; self-dilation, skin substitution, and bowel vaginoplasty each have specific advantages and disadvantages.

In the case of a DSD associated with hypospadias, standard techniques for surgical repair such as chordee correction, urethral reconstruction, and the judicious use of testosterone supplementation apply. The magnitude and complexity of phalloplasty in adulthood should be taken into account during the initial counseling period if successful gender assignment depends on this procedure. At times, this may affect the balance of gender assignment. Patients must not be given unrealistic expectations about penile reconstruction, including the use of tissue engineering. There is no evidence that prophylactic removal of asymptomatic discordant structures, such as a utriculus or Müllerian remnants, is required, although symptoms in the future may indicate surgical removal. For the male who has a successful neophalloplasty in adulthood, an erectile prosthesis may be inserted but has a high morbidity.

The testes in patients with CAIS and those with PAIS, raised female, should be removed to prevent malignancy in adulthood. The availability of estrogen-replacement therapy allows for the option of early removal at the time of diagnosis that also takes care of the associated hernia, psychological problems with the presence of testes, and the malignancy risk. Parental choice allows deferral until adolescence, recognizing that the earliest reported malignancy in CAIS is at 14 years of age. The streak gonad in a patient with MGD raised male should be removed laparoscopically (or by laparotomy) in early childhood. Bilateral gonadectomy is performed in early childhood in females (bilateral streak gonads) with gonadal dysgenesis and Y-chromosome material. In patients with androgen biosynthetic defects raised female, gonadectomy should be performed before puberty. A scrotal testis in patients with gonadal dysgenesis is at risk for malignancy. Current recommendations are testicular biopsy at puberty seeking signs of the premalignant lesion termed carcinoma in situ or undifferentiated intratubular germ cell neoplasia. If positive, the option is sperm banking before treatment with local low-dose radiotherapy that is curative.

Surgical management in DSD should also consider options that will facilitate the chances of fertility. In patients with a symptomatic utriculus, removal is best performed laparoscopically to increase the chance of preserving continuity of the vas deferens. Patients with bilateral ovotestes are potentially fertile from functional ovarian tissue. Separation of ovarian and testicular tissue can be technically difficult and should be undertaken, if possible, in early life.

Sex-Steroid Replacement
Hypogonadism is common in patients with dysgenetic gonads, defects in sex-steroid biosynthesis, and resistance to androgens. The timing of initiation of puberty may vary, but this is an occasion that provides an opportunity to discuss the condition and set a foundation for long-term adherence to therapy. Hormonal induction of puberty stimulates replication of normal pubertal maturation to induce secondary sexual characteristics, a pubertal growth spurt, and optimal bone mineral accumulation, together with psychosocial support for psychosexual maturation. Intramuscular depot injections of testosterone esters are commonly used in males; another option is oral testosterone undecanoate, and transdermal preparations are also available. Patients with PAIS may require supraphysiologic doses of testosterone for optimal effect. Females with hypogonadism require estrogen supplementation to induce pubertal changes and menses. A progestin is usually added after breakthrough bleeding develops or within 1 to 2 years of continuous estrogen. There is no evidence that the addition of cyclic progesterone is beneficial in women without a uterus.

Psychosocial Management
Psychosocial care provided by mental health staff with expertise in DSD should be an integral part of management to promote positive adaptation. This expertise can facilitate team decisions about gender assignment/reassignment, timing of surgery, and sex-hormone replacement. Psychosocial screening tools that identify families at risk for maladaptive coping with a child’s medical condition are available. Once the child is sufficiently developed for a psychological assessment of gender identity, such an evaluation must be included in discussions about gender reassignment. Gender identity development begins before the age of 3 years, but the earliest age at which it can be reliably assessed remains unclear. The generalization that the age of 18 months is the upper limit of imposed gender reassignment should be treated with caution and viewed conservatively. Atypical gender-role behavior is more common in children with DSD than in the general population but should not be taken as an indicator for gender reassignment. In
affected children and adolescents who report significant gender dysphoria, a comprehensive psychological evaluation\(^7\) and an opportunity to explore feelings about gender with a qualified clinician is required over a period of time. If the desire to change gender persists, the patient’s wish should be supported and may require the input of a specialist skilled in the management of gender change.

The process of disclosure concerning facts about karyotype, gonadal status, and prospects for future fertility is a collaborative, ongoing action that requires a flexible individual-based approach. It should be planned with the parents from the time of diagnosis.\(^7\) Studies in other chronic medical disorders and of adoptees indicate that disclosure is associated with enhanced psychosocial adaptation.\(^7\) Medical education and counseling for children is a recurrent gradual process of increasing sophistication that is commensurate with changing cognitive and psychological development.\(^7\)

Quality of life encompasses falling in love, dating, attraction, ability to develop intimate relationships, sexual functioning, and the opportunity to marry and raise children, regardless of biological indicators of sex. The most frequent problems encountered in DSD patients are sexual aversion and lack of arousability, which are often misinterpreted as low libido.\(^7\) Health care staff should offer adolescent patients opportunities to talk confidentially without their parents and encourage the patient’s wish should be supported and may require the input of a specialist skilled in the management of gender change.

As a general statement, information across a range of assessments is insufficient in DSD. The following is based on those disorders for which some evidence base is available. They include CAH, CAIS, and PAIS, disorders of androgen biosynthesis, gonadal dysgenesis syndromes (complete and partial), and micropenis. Long-term outcome in DSD should include external and internal genital phenotype, physical health including fertility, sexual function, and social and psychosexual adjustment, mental health, quality of life, and social participation. There are additional health problems in individuals with DSD, including the consequences of associated problems such as other malformations, developmental delay and intellectual impairment, delayed growth and development, and unwanted effects of hormones on libido and body image.\(^7\)

### Surgical Outcome

Some studies suggest satisfactory outcomes from early surgery.\(^4\) Nevertheless, outcomes from clitoroplasty identify problems related to decreased sexual sensitivity, loss of clitoral tissue, and cosmetic issues.\(^7\) Techniques for vaginoplasty carry the potential for scarring at the introitus necessitating repeated modification before sexual function can be reliably reconstructed. Surgery to construct a neovagina carries a risk of neoplasia.\(^7\) The risks from vaginoplasty are different for high and low confluence of the urethra and vagina. Analysis of long-term outcomes is complicated by a mixture of surgical techniques and

### TABLE 4  Risk of Germ Cell Malignancy According to Diagnosis

<table>
<thead>
<tr>
<th>Risk Group</th>
<th>Disorder</th>
<th>Malignancy Risk, %</th>
<th>Recommended Action</th>
<th>Patients, n</th>
<th>Studies, n</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>GD(^+)+Y(^b) intraabdominal</td>
<td>15–35</td>
<td>Gonadectomy(^c)</td>
<td>12</td>
<td>&gt;350</td>
</tr>
<tr>
<td></td>
<td>PAIS nonscrotal</td>
<td>50</td>
<td>Gonadectomy(^c)</td>
<td>2</td>
<td>24</td>
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<tr>
<td></td>
<td>Frasier</td>
<td>60</td>
<td>Gonadectomy(^c)</td>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Denny-Drash (+Y)</td>
<td>40</td>
<td>Gonadectomy(^c)</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Intermediate</td>
<td>Turner (+Y)</td>
<td>12</td>
<td>Gonadectomy(^c)</td>
<td>11</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>17(^\beta)-hydroxysteroid</td>
<td>28</td>
<td>Watchful waiting</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>GD (+Y)(^b) scrotal</td>
<td>Unknown</td>
<td>Biopsy(^a) and irradiation?</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>PAIS scrotal gonad</td>
<td>Unknown</td>
<td>Biopsy(^a) and irradiation?</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Low</td>
<td>CAIS</td>
<td>2</td>
<td>Biopsy(^a) and ???</td>
<td>2</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>Ovotesticular DSD</td>
<td>3</td>
<td>Testicular tissue removal?</td>
<td>3</td>
<td>426</td>
</tr>
<tr>
<td></td>
<td>Turner (−Y)</td>
<td>1</td>
<td>None</td>
<td>11</td>
<td>557</td>
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<tr>
<td>No (?)</td>
<td>SexRD2</td>
<td>0</td>
<td>Unresolved</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Leydig cell hypoplasia</td>
<td>0</td>
<td>Unresolved</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

\(^a\) Gonadal dysgenesis (including not further specified, 46,XY, 46,X/46,XY, mixed, partial, and complete).  
\(^b\) GYB region positive, including the TSPY (testis-specific protein Y encoded) gene.  
\(^c\) At time of diagnosis.  
\(^d\) At puberty, allowing investigation of at least 30 seminiferous tubules, preferentially diagnosis on the basis of OCT3/4 immunohistochemistry.
<table>
<thead>
<tr>
<th>Gene</th>
<th>Protein</th>
<th>OMIM No.</th>
<th>Locus</th>
<th>Inheritance</th>
<th>Gonad Structures</th>
<th>External Genitalia</th>
<th>Associated Features/Variant Phenotypes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>46,XY DSD</strong></td>
<td>Disorders of gonadal (testicular) development: single-gene disorders</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WT1</td>
<td>TF</td>
<td>607102</td>
<td>1p13</td>
<td>AD</td>
<td>Dysgenetic testis</td>
<td>+/-</td>
<td>Female or ambiguous</td>
</tr>
<tr>
<td>SF1 (NR5A1)</td>
<td>Nuclear receptor TF</td>
<td>184757</td>
<td>9q33</td>
<td>AD/AR</td>
<td>Dysgenetic testis</td>
<td>+/-</td>
<td>Female or ambiguous</td>
</tr>
<tr>
<td>SRY</td>
<td>TF</td>
<td>480000</td>
<td>Yp11.3</td>
<td>Y</td>
<td>Dysgenetic testis</td>
<td>+/-</td>
<td>Female or ambiguous</td>
</tr>
<tr>
<td>SOX9</td>
<td>TF</td>
<td>608160</td>
<td>17q24-25</td>
<td>AD</td>
<td>Dysgenetic testis</td>
<td>+/-</td>
<td>Female or ambiguous</td>
</tr>
<tr>
<td>DHH</td>
<td>Signaling molecule</td>
<td>605423</td>
<td>12q13.1</td>
<td>AR</td>
<td>Dysgenetic testis</td>
<td>+/-</td>
<td>Female</td>
</tr>
<tr>
<td>ATRX</td>
<td>Helicase (1 chromatin remodeling)</td>
<td>300032</td>
<td>Xq13.3</td>
<td>X</td>
<td>Dysgenetic testis</td>
<td>+/-</td>
<td>Female, ambiguous, or male</td>
</tr>
<tr>
<td>ARX</td>
<td>TF</td>
<td>300382</td>
<td>Xp22.13</td>
<td>X</td>
<td>Dysgenetic testis</td>
<td>+/-</td>
<td>Ambiguous</td>
</tr>
<tr>
<td><strong>Disorders of gonadal (testicular) development: chromosomal changes involving key candidate genes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DMRT1</td>
<td>TF</td>
<td>602424</td>
<td>9p24.3</td>
<td>Monosomic deletion dupXp21</td>
<td>Dysgenetic testis</td>
<td>+/-</td>
<td>Female or ambiguous</td>
</tr>
<tr>
<td>DAX1 (NR0B1)</td>
<td>Nuclear receptor TF</td>
<td>300018</td>
<td>Xp21.3</td>
<td>dupXp21</td>
<td>Dysgenetic testis</td>
<td>+/-</td>
<td>Female or ambiguous</td>
</tr>
<tr>
<td>WNT4</td>
<td>Signaling molecule</td>
<td>603490</td>
<td>1p35</td>
<td>dup1p35</td>
<td>Dysgenetic testis</td>
<td>+/-</td>
<td>Ambiguous</td>
</tr>
<tr>
<td><strong>Disorders in hormone synthesis or action</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>LHGCGR</td>
<td>G-protein receptor</td>
<td>152790</td>
<td>2p21</td>
<td>AR</td>
<td>Testis</td>
<td>+/-</td>
<td>Female, ambiguous, or micropenis</td>
</tr>
<tr>
<td>DHCR7</td>
<td>Enzyme</td>
<td>602858</td>
<td>11q12-13</td>
<td>AR</td>
<td>Testis</td>
<td>+/-</td>
<td>Female</td>
</tr>
<tr>
<td>STAR (steroidogenic acute regulatory protein)</td>
<td>Mitochondrial membrane protein</td>
<td>600617</td>
<td>8p11.2</td>
<td>AR</td>
<td>Testis</td>
<td>+/-</td>
<td>Female</td>
</tr>
<tr>
<td>CYP11A1</td>
<td>Enzyme</td>
<td>118485</td>
<td>15q23-24</td>
<td>AR</td>
<td>Testis</td>
<td>+/-</td>
<td>Female or Ambiguous</td>
</tr>
<tr>
<td>HSD3B2</td>
<td>Enzyme</td>
<td>201810</td>
<td>1p13.1</td>
<td>AR</td>
<td>Testis</td>
<td>+/-</td>
<td>Ambiguous</td>
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## TABLE 5  Continued

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<tr>
<th>Enzyme/Receptor</th>
<th>Gene Symbol</th>
<th>Chromosome</th>
<th>Sex</th>
<th>Function</th>
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<tr>
<td>CYP17</td>
<td>Enzyme</td>
<td>202110</td>
<td>10q24.3</td>
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<tr>
<td>POR (P450 oxidoreductase)</td>
<td>CYP enzyme electron donor</td>
<td>124015</td>
<td>7q11.2</td>
<td>AR</td>
</tr>
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<td>9q22</td>
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<td>SRD5A2</td>
<td>Enzyme</td>
<td>607360</td>
<td>2p23</td>
<td>AR</td>
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<tr>
<td>Anti-Müllerian hormone signaling molecule</td>
<td>Sezine-threonine kinase transmembrane receptor</td>
<td>600957</td>
<td>19p13.3-13.2</td>
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<tr>
<td>Androgen receptor</td>
<td>Nuclear receptor TF</td>
<td>313700</td>
<td>Xq11-12</td>
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</table>

### 46,XX DSD

**Disorders of gonadal (ovarian) development**

<table>
<thead>
<tr>
<th>Enzyme/Receptor</th>
<th>Gene Symbol</th>
<th>Chromosome</th>
<th>Sex</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>SRY</td>
<td>TF</td>
<td>480000</td>
<td>Yp11.3</td>
<td>Translocation</td>
</tr>
<tr>
<td>SOX9</td>
<td>TF</td>
<td>608160</td>
<td>17q24</td>
<td>dup17q24</td>
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<tr>
<td>Androgen excess</td>
<td>HSD3B2</td>
<td>Enzyme</td>
<td>201810</td>
<td>1p13</td>
</tr>
<tr>
<td>CYP21A2</td>
<td>Enzyme</td>
<td>201910</td>
<td>6p21-23</td>
<td>AR</td>
</tr>
<tr>
<td>CYP11B1</td>
<td>Enzyme</td>
<td>202010</td>
<td>8q21-22</td>
<td>AR</td>
</tr>
<tr>
<td>POR (P450 oxidoreductase)</td>
<td>CYP enzyme electron donor</td>
<td>124015</td>
<td>7q11.2</td>
<td>AR</td>
</tr>
<tr>
<td>CYP19</td>
<td>Enzyme</td>
<td>107910</td>
<td>15q21</td>
<td>AR</td>
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<tr>
<td>Glucocorticoid receptor</td>
<td>Nuclear receptor TF</td>
<td>138040</td>
<td>5q31</td>
<td>AR</td>
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</table>

OMIM indicates Online Mendelian Inheritance in Man; TF, transcription factor; AD, autosomal dominant (often de novo mutation); AR indicates autosomal recessive; Y, Y-chromosomal; X, X-chromosomal. Chromosomal rearrangements likely to include key genes are included. Modified from Achermann JC, Ozisik G, Meeks JJ, Jameson JL. Genetic causes of human reproductive disease. J Clin Endocrinol Metab. 2002;87:2447-2454.
diagnostic categories. Few women with CAIS need surgery to lengthen the vagina.

The outcome in undermasculinized males with a phallicus depends on the degree of hypospadias and the amount of erectile tissue. Feminizing genitoplasty as opposed to masculinizing genitoplasty requires less surgery to achieve an acceptable outcome and results in fewer urologic difficulties. Long-term data regarding sexual function and quality of life among those assigned female as well as male show great variability. There are no controlled clinical trials of the efficacy of early (<12 months of age) versus late (in adolescence and adulthood) surgery or of the efficacy of different techniques.

**Risk of Gonadal Tumors**

Interpretation of the literature is hampered by unclear terminology and effects of normal cell-maturation delay. The highest tumor risk is found in TSPY (testis-specific protein Y encoded) positive gonadal dysgenesis and PAIS with intraabdominal gonads, whereas the lowest risk (<5%) is found in ovotestis and CAIS. Table 4 provides a summary of the risk of tumor development according to diagnosis and recommendations for management.

**Cultural and Social Factors**

DSD may carry a stigma. Social and cultural factors, as well as hormonal effects, seem to influence gender role in 5αRD2 deficiency. Gender-role change occurs at different rates in different societies, suggesting that social factors may also be important modifiers of gender-role change.

In some societies, female infertility precludes marriage, which also affects employment prospects and creates economic dependence. Religious and philosophical views may influence how parents respond to the birth of an infant with a medical condition. Fatalism and guilt feelings in relation to congenital malformations or genetic conditions have an influence, whereas poverty and illiteracy negatively affect access to health care.

**FUTURE STUDIES**

Establishing a precise diagnosis in DSD is just as important as in other chronic medical conditions that have lifelong consequences. Considerable progress has been achieved with molecular studies, as illustrated in Table 5, which summarizes the genes known to be involved in DSD. Use of tissue-specific animal knock-out models, comparative genomic hybridization, and microarray screens of the mouse urogenital ridge will provide benefits in identifying new genes causing DSD. It is essential that the momentum for an international collaborative approach to this task be maintained.

Much remains to be clarified about the determinants of gender identity in DSD. Future studies require representative sampling to carefully conceptualize and measure gender identity, recognizing that there are multiple determinants to consider, and gender identity may change into adulthood. In terms of psychological management, studies are needed to evaluate the effectiveness of information management with regard to timing and content. The pattern of surgical practice in DSD is changing with respect to the timing of surgery and the techniques used. It is essential to evaluate the effects of early versus later surgery in a holistic manner, recognizing the difficulties posed by an ever-evolving clinical practice.

The consensus has clearly identified a major shortfall in information about long-term outcome. Future studies should use appropriate instruments that assess outcomes in a standard manner and take cognizance of guidelines relevant to all chronic conditions. These studies would preferably be prospective in nature and designed to avoid selection bias. A number of countries already have registers of DSD cases, but there could be added benefit from pooling such resources to enable prospective, multicenter studies to be undertaken on a larger number of cases that are clearly defined. Allied to this should be an educational program to ensure that multiprofessionals tasked with providing care to families with a child with DSD are suitably trained to discharge their responsibilities.

**APPENDIX 1: ROLE OF SUPPORT GROUPS**

The value of peer and parent support for many chronic medical conditions is widely accepted, and DSD, being lifelong conditions that affect developmental tasks at many stages of life, are no exception.

Those affected by DSD and parent members value the following:

- Peer support ends isolation and stigma, providing a context in which conditions are put into perspective and intimate issues of concern can be discussed safely with someone who has “been there.”
- Children who form relationships with peers and affected adults early in their lives benefit from a feeling of normalcy early on, with support in place well before adolescence. Adolescents often resist attempts to introduce them to peer support.
- Support groups can help families and consumers find the best quality care.

Although clinical practice may focus on gender and genital appearance as key outcomes, stigma and experiences associated with having a DSD (both within and outside the medical environment) are more salient issues for many affected people.

Support groups complement the work of the health care team and, together, can help improve services. Initiatives by support groups have led to improvements in
management of DSD and research directed toward clinically relevant issues. Dialogue between health care professionals and support groups and collaboration as partners is to be encouraged.

APPENDIX 2: LEGAL ISSUES
Basic principles of medical law will remain even as research and clinical experience evolve in etiology, diagnosis, and treatment. This Appendix draws on practice in 3 countries on standards of medical negligence and patient informed consent. In the United States, the medical profession sets standards of care on the basis of prevailing medical custom. However, a treatment may also be that used by a respected minority of practitioners.

Informed consent in the United States was founded on the principle of battery, whereby it is an offense to violate another person’s bodily integrity without consent. Nowadays, most states are concerned with negligent nondisclosure to the patient. The standard of adequate disclosure may be physician based, requiring conduct of a reasonable practitioner, or it may be patient based, asking what a reasonable patient would find material. Physician-based disclosure must include information about risks, alternatives, outcomes, and prognosis, with or without treatment.

US courts assume that parents know what is best for their child when parental authority applies to consent for the child (substituted judgment). Parental decisions are deferred to except in situations in which potentially life-saving treatment is withheld. Consent to treatment by a child depends on an understanding of its nature and consequences.

Medical negligence in the United Kingdom defines treatment that falls below the standard expected of a reasonably competent practitioner. The standard of proof in court is whether negligence is demonstrated on the balance of probabilities. It is incumbent on the practitioner to demonstrate that treatment was consistent with a rationally defensible body of medical opinion. A shift in parental prerogative to consent to treatment was reflected in the Children Act 1989 in which parental rights were replaced by parental responsibilities. United Kingdom courts can intervene with orders made requiring or preventing a specific action related to the child. Age is not a barrier to informed consent, providing that a minor demonstrates an understanding of the issues sufficient to have the capacity to consent.

Colombian law is noted for a reasoned set of guidelines advanced by the highest court in cases of DSD. A protocol was formulated for parental and physician intervention. The process of consent requires “qualified and persistent informed consent” over an extended period of time. Authorization is given in stages to allow time for the parents to come to terms with their child’s condition. The court aimed to strike a balance between parental autonomy for those who did and those who did not want early surgery for their child until there was clear evidence of harm in deferring surgery until the child was competent to decide. Parents cannot consent for children over 5 years of age, because by then, children are deemed to have identified with a gender and, thus, are considered to be autonomous.

ACKNOWLEDGMENTS
The Lawson Wilkins Pediatric Endocrine Society and the European Society for Paediatric Endocrinology gratefully acknowledge unrestricted educational grant support for the consensus meeting from Pfizer Endocrine Care, Novo Nordisk, Ferring, and Organon.

Participants in the International Consensus Conference on Intersex were: John Achermann (London, United Kingdom), Faisal Ahmed (Glasgow, UK), Lawrence Baskin (San Francisco, CA), Sheri Berenbaum (University Park, PA), Sylvano Bertelloni (Pisa, Italy), John Brock (Nashville, TN), Polly Carmichael (London, UK), Cheryl Chase (Rohnert Park, CA), Peggy Cohen-Kettenis (Amsterdam, Netherlands), Felix Conte (San Francisco, CA), Kenneth Copeland (Oklahoma City, OK), Patricia Donohoue (Iowa City, IA), Chris Driver (Aberdeen, UK), Stenvert Drop (Rotterdam, Netherlands), Erica Eugster (Indianapolis, IN), Kenji Fujieda (Asahikawa, Japan), Jay Giedd (Bethesda, MD), Richard Green (London, UK), Melvin Grumbach (San Francisco, CA), Vincent Harley (Victoria, Australia), Melissa Hines (London, UK), Olaf Hiort (Lübeck, Germany), Christopher Houk (Hershey, PA), Ieuan Hughes (Cambridge, UK), Peter Lee (Hershey, PA), Leendert Looijenga (Rotterdam, Netherlands), Bernadice Mendoza (Sao Paulo, Brazil), Heino Meyer-Bahlburg (New York, NY), Claude Migeon (Baltimore, MD), Yves Morel (Lyon, France), Pierre Mouriquand (Lyon, France), Anna Nordenström (Stockholm, Sweden), Phillip Ransley (London, UK), Robert Rapaport (New York, NY), William Reiner (Oklahoma City, OK), Hertha Richter-Appelt (Hamburg, Germany), Richard Rink (Indianapolis, IN), Emilie Rissman (Charlotteville, VA), Paul Saenger (New York, NY), David Sandberg (Buffalo, NY), Justine Schober (Erie, PA), Norman Spack (Boston, MA), Barbara Thomas (Rotenburg am Neckar, Germany), Ute Thyen (Lübeck, Germany), Eric Vilain (Los Angeles, CA), Garry Warne (Melbourne, Australia), Jean Wilson (Dallas, TX), Amy Wisniewski (Des Moines, IA), Christopher Woodhouse (London, UK), and Kenneth Zucker (Toronto, Ontario, Canada).

The work of Alan Rogol, Joanne Rogol, Pauline Bertrand, and Pam Stockham in organizing the meeting is gratefully appreciated.

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**Consensus Statement on Management of Intersex Disorders**

Peter A. Lee, Christopher P. Houk, S. Faisal Ahmed, Ieuan A. Hughes and in collaboration with the participants in the International Consensus Conference on Intersex organized by the Lawson Wilkins Pediatric Endocrine Society and the European Society for Paediatric Endocrinology

*Pediatrics* 2006;118;e488-e500  
DOI: 10.1542/peds.2006-0738

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