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## Toward the Effective Surveillance of Hypospadias

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Concern about apparent increases in the prevalence of hypospadias—a congenital male reproductive-tract abnormality—in the 1960s to 1980s and the possible connection to increasing exposures to endocrine-disrupting chemicals have underlined the importance of effective surveillance of hypospadias prevalence in the population. We report here the prevalence of hypospadias from 1980 to 1999 in 20 regions of Europe with EUROCAT (European Surveillance of Congenital Anomalies) population-based congenital anomaly registers, 14 of which implemented a guideline to exclude glanular hypospadias. We also report data from the England and Wales National Congenital Anomaly System (NCAS). Our results do not suggest a continuation of rising trends of hypospadias prevalence in Europe. However, a survey of the registers and a special validation study conducted for the years 1994–1996 in nine EUROCAT registers as well as NCAS identified a clear need for a change in the guidelines for registration of hypospadias. We recommend that all hypospadias be included in surveillance, but that information from surgeons be obtained to verify location of the meatus, and whether surgery was performed, in order to interpret trends. Investing resources in repeated special surveys may be more cost-effective than continuous population surveillance. We conclude that it is doubtful whether we have had the systems in place worldwide for the effective surveillance of hypospadias in relation to exposure to potential endocrine-disrupting chemicals. **Key words:** endocrine-disrupting chemicals, Europe, hypospadias, prevalence, surveillance. *Environ Health Perspect* 112:398–402 (2004). doi:10.1289/ehp.6398 available via <http://dx.doi.org/> [Online 18 November 2003]

Hypospadias is a congenital abnormality of the male genitalia characterized by incomplete development of the urethra so that the external urethral opening (meatus) is on the ventral surface of the penis or on the scrotum, rather than at the tip of the penis. Hypospadias, particularly when proximal, is often accompanied by chordee, curvature of the penis. The more proximal the location and the greater the associated chordee, the more functional impairment results. In some glanular cases, the deformity is only cosmetic.

There is some evidence that the prevalence of hypospadias has been increasing in the 1960s, 1970s, and 1980s in Europe (Czeizel 1985; Kallen and Winberg 1982; Matlai and Beral 1985; Paulozzi 1999; Toppari et al. 1996) and in the United States (Paulozzi et al. 1997), although recent reports suggest that these trends might not be continuing (Paulozzi 1999; Toppari et al. 1996). At the same time as hypospadias prevalence has appeared to be rising, increases in the incidence of related abnormalities such as cryptorchidism (undescended testes) and testicular cancer have been reported, as well as a fall in male fertility (Sharpe and Skakkebaek 1993). Although there are problems with the interpretation of the epidemiologic data on trends for all the

various disorders, the concomitant increase in apparently etiologically related disorders has tended to strengthen the interpretation of these changes as real phenomena. The possibility is under active investigation that the underlying cause of the change in frequency of all these conditions, as well as reproductive abnormalities observed in fish and other animals, may be exposure to endocrine-disrupting chemicals (Burdorf and Nieuwenhuisen 1999; Colborn 1995; Joffe 2001; Sharpe and Skakkebaek 1993; Toppari et al. 1996). In relation to hypospadias, evidence suggests that an antiandrogen mechanism (one that hampers the activity of male hormones) would be most likely (Baskin et al. 2001).

Concern about widespread exposure to endocrine-disrupting chemicals should lead us to evaluate the effectiveness of current population surveillance of potential adverse health outcomes, including hypospadias. One of the main difficulties in reliably documenting changes in prevalence of hypospadias is the relatively common occurrence of more distal forms compared with severe forms, and the potential for incomplete, inaccurate, or inconsistent diagnosis and reporting of the more distal forms (Aho et al. 2000; Dolk 1998; Paulozzi 1999).

The EUROCAT (European Surveillance of Congenital Anomalies) network of population-based congenital anomaly registers is the main source of epidemiologic surveillance data on congenital anomalies in Europe. Data are available from 1980 (EUROCAT Working Group 2002). The EUROCAT guidelines specify that hypospadias is to be registered with the exclusion of the most distal cases where the meatus lies before the coronary sulcus, glanular or first-degree hypospadias. The National Congenital Anomaly System (NCAS) is a national system for the reporting of congenital anomalies in England and Wales and was the source of one of the early reports of a rising trend in hypospadias prevalence (Matlai and Beral 1985). Since 1990, NCAS has operated the EUROCAT exclusion guideline for distal hypospadias. In this study we aimed *a*) to document the prevalence of

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hypospadias recorded by EUROCAT registries and NCAS since 1980, *b*) to investigate the effectiveness of the current EUROCAT exclusion guideline for hypospadias surveillance, and *c*) to make recommendations for the surveillance of hypospadias.

## Materials and Methods

EUROCAT registries are regional population-based registries actively ascertaining congenital anomalies from multiple sources. Descriptions of EUROCAT registries are available elsewhere (EUROCAT Working Group 2002). The EUROCAT list of minor anomalies for exclusion specifies that cases of hypospadias when the meatus lies before the coronary sulcus, glanular or first-degree hypospadias are to be excluded unless occurring in combination with specified (major) anomalies (EUROCAT Working Group 2001). Registries implement the EUROCAT list of minor anomalies for exclusion either by asking their notifiers not to notify these cases and/or by excluding these cases before transmission of data to the Central EUROCAT Registry.

A questionnaire concerning hypospadias registration practice was sent to all registries (EUROCAT Working Group 2003). Nine EUROCAT registries (Northern Netherlands; Paris, France; Odense, Denmark; Basque Country, Spain; Mainz, Germany; Vaud, Switzerland; and Northeast Italy, Tuscany,

Emilia Romagna, Italy) participated in a special retrospective validation study of cases in live births between 1994 and 1996, surviving the first week of life, and without chromosomal anomalies. Data collection for this validation study took place in 1999–2000. The nine registries contacted the pediatric surgeons who had treated the hypospadias cases, asking them to fill in a succinct questionnaire relating to when operation was planned/performed, and mark on the diagram the location of hypospadias and degree of chordee. The surgeons were also asked if they had operated on any further eligible nonglanular cases born 1994–1996 not known to the register. In one of the nine registries (Mainz), extra standardized examinations are carried out on all newborns by registry pediatricians for registration and research purposes, and information was obtained only from records of these examinations.

The NCAS is not a EUROCAT registry but a national voluntary congenital anomaly notification system based on a notification form filled out by health providers, usually in the neonatal period. It was set up in 1964. In 1990, the EUROCAT list of minor anomalies for exclusion (including glanular hypospadias) was implemented. We conducted a small validation study in two phases. Case lists from three pediatric surgery centers in England for cases first operated on in 1996 and born 1993–1995 were compared with

NCAS registrations. Cases notified to the NCAS from three health districts in England (with geographical areas overlapping the selected surgical centers) were followed up with surgeons to verify case status and location of hypospadias. Full details of this and the EUROCAT validation study are available (EUROCAT Working Group 2003), and summary results are reported here.

Prevalence rates of hypospadias for 20 registries that had completed a questionnaire concerning registration practice and that had data at least as recent as 1998 covering a period of at least 5 years were extracted from the Central EUROCAT database in 2001 for the period 1980–1999. England and Wales NCAS data were extracted for the years 1980–1996. Prevalence rates were calculated as the number of hypospadias cases registered divided by the total number of live and stillbirths (of either sex) in the population covered by the register. Change in annual prevalence rates over time was assessed by the chi-square test for trend.

Some of the registries that are members of the International Clearinghouse for Birth Defect Monitoring Systems have contributed to a previous publication of trends in prevalence rates for overlapping time periods (England and Wales NCAS and the EUROCAT registries of Northeast Italy, Northern Netherlands, Paris, Emilia Romagna, and Dublin, Ireland; Paulozzi 1999).

**Table 1.** Hypospadias prevalence per 1,000 births in EUROCAT registries, 1980–1999.

Registry	Years of data	No. of cases	Total births	Prevalence per 1,000	1980–1984	1985–1989	1990–1994	1995–1999	Trend <sup>a</sup>
Implementing guideline to exclude glanular hypospadias <sup>b,c</sup>									
Antwerp, Belgium	1990–1999	78	108,753	0.7	—	—	0.69	0.73	No trend
Hainaut, Belgium <sup>d,e</sup>	1980–1999	248	214,340	1.2	0.93	1.31	1.06	1.30	No trend
Basque Country, Spain <sup>e</sup>	1990–1998	117	144,316	0.8	—	—	0.85	0.77	No trend
Emilia Romagna, Italy	1981–1999	281	445,289	0.6	0.71	0.56	0.54	0.74	No trend
Northeast Italy <sup>c</sup>	1981–1999	554	894,344	0.6	0.76	0.72	0.64	0.45	↓ <i>p</i> < 0.05
Galway, Ireland	1981–1999	24	54,509	0.4	0.22	0.20	0.62	0.77	↑ <i>p</i> < 0.01
Northern Netherlands	1981–1999	285	288,012	1.0	1.73	0.87	0.90	0.92	↓ <i>p</i> < 0.01
Odense, Denmark	1980–1999	121	105,848	1.1	1.30	0.85	0.95	1.45	No trend
Paris, France <sup>e,f</sup>	1981–1999	839	698,681	1.2	1.05	1.10	1.63	1.00	No trend
Strasbourg, France <sup>e</sup>	1982–1998	481	225,983	2.1	1.30	2.33	2.62	1.87	No trend
Changes in guideline implementation <sup>b</sup> or ascertainment <sup>g</sup>									
Glasgow, United Kingdom <sup>b,e</sup>	1980–1999	313	243,634	1.3	1.64	1.87	0.90	0.58	↓ <i>p</i> < 0.05
Tuscany, Italy <sup>b</sup>	1980–1999	233	306,517	0.8	1.07	1.43	0.70	0.46	↓ <i>p</i> < 0.05
Malta <sup>e,g</sup>	1986–1999	94	71,354	1.3	—	0.96	1.33	1.63	↑ <i>p</i> < 0.05
Zagreb, Croatia <sup>g</sup>	1983–1999	111	103,255	1.1	0.99	1.52	1.09	0.64	↓ <i>p</i> < 0.001
Not implementing guideline to exclude glanular hypospadias									
Vaud, Switzerland <sup>d,e</sup>	1988–1999	106	84,471	1.3	—	1.11	0.94	1.61	No trend
Styria, Austria <sup>d,e</sup>	1985–1999	269	192,348	1.4	—	0.75	2.11	1.32	↑ <i>p</i> < 0.001
Dublin, Ireland <sup>e</sup>	1980–1999	603	420,564	1.4	1.50	1.00	1.38	1.86	↑ <i>p</i> < 0.01
Mainz, Germany <sup>e,h</sup>	1990–1999	90	37,968	2.4	—	—	2.85	1.83	↓ <i>p</i> < 0.01
Saxony-Anhalt, Germany	1987–1999	236	143,044	1.6	—	1.45	1.73	1.78	No trend
Sicily, Italy <sup>e</sup>	1991–1998	237	152,237	1.6	—	—	1.61	1.50	No trend

<sup>a</sup>↑ = rising trend; ↓ = decreasing trend. <sup>b</sup>Implementation of exclusion guideline only since 1990 in Glasgow (previously registering glanular cases who had surgery), and since 1992 in Tuscany. <sup>c</sup>Northeast Italy excludes glanular and coronal cases. <sup>d</sup>Glanular cases with surgery registered. <sup>e</sup>Registry that obtains case notifications, among multiple sources, from pediatric surgeons or hospital discharge records, including pediatric surgery. <sup>f</sup>Paris and Mainz included 3 false positive cases. <sup>g</sup>Zagreb included cases of unspecified location, and access to information about location improved during the study period; Malta has obtained several new sources of information since 1993, including hospital activity analysis records covering pediatric surgery discharges. <sup>h</sup>Mainz conducts special standardized examination of all newborns for registration and research purposes.

## Results

**EUROCAT prevalence data 1980–1999: 20 registries.** Fourteen of the 20 registries analyzed were implementing the guideline to exclude glanular cases or type 1 cases (Table 1). Of the 10 with consistent application of the guideline over the time period, Northern Netherlands and Northeast Italy recorded a decreasing trend in prevalence, and Galway, Ireland, an increasing trend. Prevalence in the two French regions seemed to peak in the early 1990s with no overall trend. Three registries implemented the guideline for only the latter part of the study period and recorded a decreasing trend in prevalence at least in part associated with this change (Glasgow, Scotland; Tuscany; Zagreb, Croatia; Table 1). An increasing trend in Malta was associated at least in part with a change in sources of information for case ascertainment (Table 1). By 1995–1999, the total prevalence across the 14 registries implementing the guideline was 0.80 per 1,000 [95% confidence interval (CI), 0.75–0.86], with significant variation ( $p < 0.001$ ) between registries from 0.5 in Tuscany to 1.9 in Strasbourg, France.

Six registries were not implementing the guideline, two of these registering glanular cases who had surgery (Vaud; Styria, Austria), the other four registers registering all glanular cases reported to them (Table 1). There was a significant upward trend in two registries (Styria and Dublin), although the prevalence in Styria seemed to peak in the early 1990s. There was a downward trend since 1990 in Mainz. In 1995–1999, the total prevalence rate across these registers was 1.64 (95% CI, 1.51–1.79) with a higher rate among those registering all hypospadias (1.73 per 1,000; 95% CI, 1.57–1.91) than those registering only those with surgery (1.43 per 1,000; 95% CI, 1.21–1.69).

**EUROCAT validation study: nine registries.** Of 382 cases that were included in the EUROCAT validation survey in the nine participating registers, 300 (78.5%) were isolated hypospadias (i.e., not associated with major

nongenital system congenital anomalies) to which the exclusion guideline applies. The response rate from pediatric surgeons was variable, and two registries (Emilia Romagna and Northeast Italy) are excluded from combined figures because they had response rates below 50%. The response rates in the remaining seven registries averaged 84% (76–78% in Paris, Tuscany, and Northern Netherlands; 89% in Basque Country; 96–100% in Odense, Mainz, and Vaud). It is possible that cases with normal meatal position or not requiring surgery were selectively among cases that could not be followed up.

Contact with pediatric surgeons produced extra case notifications indicating substantial underascertainment in one of the registries (20 of 45 isolated cases in Tuscany), suggesting that the prevalence figures in Table 1 for Tuscany are underestimated.

Six cases in total were found to have been false positives, that is, not to have hypospadias: three cases (4%) in Paris and three cases (11%) of incomplete prepuc in Mainz.

Among the registries implementing the guideline (Paris, Tuscany, Northern Netherlands, Basque Country, Odense), two registries found that some cases of glanular hypospadias had been incorrectly included among registered cases (11 of 47 cases of verified location in Paris, 2 of 17 in Basque Country). The two extra registries with low response rates from pediatric surgeons also had incorrectly registered glanular cases (2 of 12 cases of verified location in Emilia Romagna, 7 of 24 in Northeast Italy). Prevalence figures in Table 1 for Paris and Northeast Italy thus need to be interpreted in the light of the fact that glanular cases had not been effectively excluded.

In the two registries not implementing the guideline, the ratio of glanular to nonglanular cases was 6:12 (Vaud) and 10:12 (Mainz), an average of 40% of isolated hypospadias thus being glanular.

**England and Wales NCAS data.** Figure 1 shows the yearly prevalence of hypospadias

based on NCAS data. From 1980 through 1989 there were 10,780 cases, giving an average prevalence of 1.6 per 1,000 births. Prevalence apparently peaked in 1983, coincidentally also the final year of a previous publication (Matlai and Beral 1985) showing a steeply rising trend in hypospadias prevalence since 1964 (Figure 1). The prevalence from 1990, after implementation of the exclusion criterion, declined to an average of 0.8 per 1,000 births in 1992–1996.

In three pediatric surgical centers, 159 children were identified who were born during 1993–1995 and had their first operation for hypospadias in 1996. Twenty-five percent of cases were glanular. Of the 114 nonglanular cases eligible for notification to the NCAS, a maximum of 26% had been notified to the NCAS (including probable as well as exact case matches).

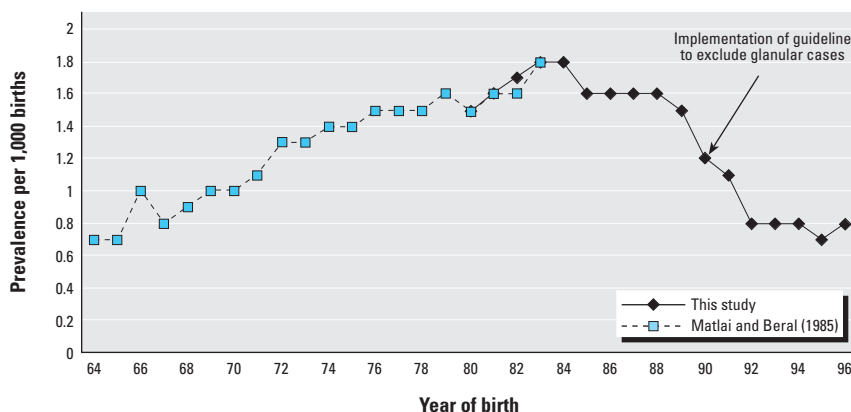
In the three district health authorities selected for study, 44 cases of hypospadias born during 1993–1995 had been notified to the NCAS. Seven (16%) of these were found not to be hypospadias cases on follow-up, and 16 (36%) were glanular and therefore not eligible for notification.

**Age at surgery.** Average age at first surgery in the nine EUROCAT survey registries varied from 1–2 years in Vaud (13.6 months), Paris (16.4 months), Northern Netherlands (19.5 months), and Mainz (22.4 months) to 2–3 years in Emilia Romagna (24.7 months), Northeast Italy (34.0 months), Basque Country (34.2 months), and Tuscany (36.0 months) to 5 years (61.0 months) in Odense. In the three surgical centers in England contacted for the NCAS validation study, the average age at first operation was 30.0 months.

## Discussion

It is a precondition for effective epidemiologic surveillance of hypospadias that comparisons over time and between countries should be based on data comparable in definition and ascertainment. We have shown variable quality of surveillance data in Europe. We are aware of two previous studies that have validated the quality of surveillance data (Aho et al. 2000; Kallen et al. 1986), also finding considerable problems. We recommend caution in interpreting international trends (Paulozzi 1999), whether for all hypospadias or “severe” hypospadias.

It is a well-known phenomenon that the existence of guidelines does not guarantee their implementation or even their feasibility. Six of the 20 EUROCAT registers in our study were found not to be following the EUROCAT guideline to exclude glanular hypospadias. Lack of resources or reliable access to appropriate sources of clinical information on location of hypospadias led some registries not to implement the guideline and



**Figure 1.** Hypospadias prevalence rates by year of birth in England and Wales, 1964–1996. Data from Matlai and Beral (1985).

others to implement with varied success. Some registries mentioned that the distinction between glanular and coronal cases was unreliable unless made by a pediatric surgeon. Moreover, the guideline itself was open to various interpretations, because it specified “glanular or type 1” hypospadias, where type 1 is often used to refer to both glanular and coronal cases. One of the registers had a policy to exclude coronal cases, and it is possible that borderline glanular–coronal cases were variably excluded by other registries. Our validation study showed that registers covering a large number of hospitals and clinicians had difficulty accurately excluding glanular cases. In these situations, an exclusion guideline may simply lead to inconsistency and incompleteness of registration. We conclude that it is difficult to ensure long-term consistency and accuracy in the implementation of this exclusion guideline for surveillance.

At the time this study was done, coding of congenital anomalies was in the *International Classification of Diseases*, 9th revision [ICD-9; World Health Organization (WHO) 1977], which did not differentiate location of hypospadias, a further impediment to implementing the exclusion guideline. Most registries now employ ICD-10 (WHO 1992), where location is specified, albeit combining glanular and coronal hypospadias in one code.

A further important reason mentioned by registries for not implementing the exclusion guideline was that the registry did not consider glanular hypospadias to be in fact minor, given that a large number of such cases were having corrective surgery. Different opinions have been expressed as to the necessity for surgery for glanular cases (Fichtner et al. 1995), and the proportion of surgically corrected cases in the literature is variable. A Danish study reported 48% of all identified hypospadias cases born 1983–1993 with a record of surgical treatment (Weidner et al. 1998). A New York study for 1983–1995 (Choi et al. 2001) compared a total prevalence of 3.6 per 1,000 births with a surgical repair rate of 0.6 per 1,000 births, suggesting that only 17% have surgery. An English study for the period 1992–1994 (Chambers and Malone 1999) based on a surgical series stated a policy to recommend surgery in virtually all cases of hypospadias. A Finnish study also reported a policy of surgical correction for minor cases (Aho et al. 2000), and a small Dutch study for 2000 (Pierik et al. 2002) found that 78% of cases had been recommended surgery, including one-quarter of glanular cases. Before the 1980s, a study in Rochester, New York (USA; Sweet et al. 1974) on a single hospital series for the period 1940–1970 reported a surgical rate of 24%, with all surgical cases being either penile or with testicular-associated abnormalities, and an international registry study (Kallen et al. 1986)

reported surgery for 40% of cases in Hungary 1975, 31% in Sweden 1974, and 27% in Denmark in 1974–1976. Among EUROCAT registries, we found two areas (Northern Ireland and Odense Denmark) where surgery is rarely recommended for glanular cases, at least at pre-school age (EUROCAT 2003). We conclude from this that if surgical policy is an important criterion in considering which cases are confirmed or important enough for registration, there is ample scope for variation in surgical policy to underlie variation in reported prevalence rates of hypospadias.

Our validation study suggested that underascertainment was a particular problem in the England and Wales NCAS system, where notification is mainly done by midwives in the first 10 days of life. An estimate for the period 1972–1978 (Knox et al. 1984) suggested better sensitivity for hypospadias before the exclusion guideline was implemented (75 vs. 25% estimated in our study). In the only previous study considering underascertainment, an international study of registries (Kallen et al. 1986) estimated that the proportion of missed cases among those with surgery was 46% for Hungary (1975), 30% for Sweden (1974), and 64% for Denmark (1974–1976). We conclude that access to surgical or hospital discharge records is essential for high case ascertainment. However, the relatively late age at surgery ( $\leq 5$  years of age) in some registries implies a consequent delay in surveillance.

Overascertainment (or incorrect notification) of hypospadias may result if registry information is based on neonatal examinations by nonspecialists without further verification. The borderline between incomplete prepuce and hypospadias may be the most problematic. We found little evidence of incorrect notification in the EUROCAT survey. In the small England and Wales NCAS sample, 16% of cases were incorrectly notified as hypospadias, and a previous study for the 1970s estimated 14% incorrect notifications to the NCAS (Knox et al. 1984). A previous international study of registries (Kallen et al. 1986) found that in Sweden in 1974, 5% of cases were false positives, and in Hungary in 1975, 21% of cases were false positives. In a recent Dutch study, Pierik et al. (2002) trained 30 child health center physicians in a standardized examination of newborns to detect hypospadias. Of the 60 boys referred to the pediatric urologist/endocrinologist as cases of hypospadias, seven had a preputial abnormality only. A Finnish study found that during a period when 19 cases of hypospadias were diagnosed among births in one hospital, seven additional cases had a foreskin malformation alone (Virtanen et al. 2001). It could be argued that incomplete prepuce is not embryologically or etiologically distinct from hypospadias and

thus should be included in surveillance. We believe this suggestion is impractical, however, because the more minor the malformation, the less likely it is to be consistently and reliably diagnosed and registered, especially in the neonatal period, thus giving even more potential for temporal and geographic variation. Also, the term “hypospadias” refers to abnormal position of the meatus, and thus confusion would arise in including cases with a normal meatal position.

Most estimates of prevalence in Europe and the United States range up to a maximum of 3 per 1,000 births, with two-thirds to three-quarters of cases being glanular or coronal. Our estimates from EUROCAT data are within this range. A Dutch population-based study reported a higher prevalence of 3.8 per 1,000 (Pierik et al. 2002), which may be partly related to sensitization to diagnosis by special training of child health center physicians for the survey, although the proportion of distal cases was not higher than usual. A cohort study in Bristol (North et al. 2000) also reported a prevalence of 3.2 per 1,000 births, but cases were not confirmed by pediatric surgical records. The influential early Rochester single hospital series (Sweet et al. 1974) for 1940–1970 quoted in many pediatric urology and surgery textbooks reported a relatively high prevalence of 4 per 1,000 births but also a high proportion of glanular and coronal cases (87%), suggesting more complete diagnosis of glanular cases and/or a shifted boundary between “normal” and “abnormal.” A German study of 500 adult men (Fichtner et al. 1995) found that 13% had hypospadias (equivalent to a rate of 65 per 1,000 births), of which 75% had glanular hypospadias, 98% coronal or glanular. It is probable that the high proportion of glanular hypospadias in this study was related to measurement and designation of the “normal/abnormal” boundary in adult men. We suggest that the three indicators—prevalence of hypospadias, proportion of glanular or coronal cases, and proportion of cases undergoing surgery—are interrelated and must be interpreted together (Dolk 2004).

Retrospective data validation studies are difficult to carry out successfully. They encounter problems of data confidentiality and protection, resistance of health professionals to completing more paperwork, and problems with retrieval of information and tracing of cases. Data validation on samples of cases therefore has to be built into surveillance systems on a prospective basis. Requirements for anonymity or patient consent for consultation of records can greatly increase the difficulty and expense of carrying out data validation (Verity and Nicoll 2002).

On the basis of the results of this study, we recommend the following practice for the surveillance of hypospadias:

- All cases of hypospadias should be registered, regardless of location. Attention should be given to exclusion of cases of incomplete prepuce.
- Information on location of hypospadias should be coded for all cases.
- Surgeons should be among the multiple sources of case notification and should be consulted for verification of case status and meatal location for all cases. This may imply a delay before reporting prevalence rates for surveillance purposes, especially in countries where surgery is conducted later in the first 5 years of life.
- Information on whether surgery has been recommended or performed should be recorded.
- Information on whether hypospadias is an isolated abnormality should be recorded.
- Analyses of trends in prevalence should consider changes in the distribution of location of recorded isolated cases, as well as changes in the proportion undergoing surgery by location.

In light of the above guidelines, surveillance systems could consider whether it is more cost-effective for hypospadias registration to be the subject of periodic intensive ad hoc surveys, or routine registration. This may depend on the size of the registry, the methods and sources of information usually used, and the resources routinely available.

The EUROCAT data do not indicate a continuing increasing prevalence of hypospadias in Europe since 1980. However, at present, it is doubtful whether we have the

systems in place worldwide for the effective surveillance of hypospadias in relation to concerns regarding exposure to potential endocrine-disrupting chemicals.

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