Temporal Trends in Orchidopexy, Great Britain, 1992–1998

Mireille B. Toledano,[1] Anna L. Hansell,[1] Lars Jarup,[1] Mike Quinn,[2] Susan Jick,[3] and Paul Elliott[1]

[1]The Small Area Health Statistics Unit, Department of Epidemiology and Public Health, Imperial College, London, United Kingdom; [2]Office for National Statistics, London, United Kingdom; [3]Boston Collaborative Drug Surveillance Program, Lexington, Massachusetts, USA

Concern has been expressed in recent years about worsening male reproductive health, possibly mediated by increasing exposures to environmental endocrine-disrupting agents. Trends suggested large increases in cryptorchidism in Britain and the United States between the 1950s and 1980s, although published data on recent trends have been scarce. We examined numbers of orchidopexy procedures, as a marker for cryptorchidism, using routine hospital admission data for England, Wales, and Scotland for fiscal years 1992–1993 through 1998–1999. Annual trends in orchidopexy rates were analyzed by age, in-patient admission versus day case, and geographical region. Orchidopexy rates were also obtained from the General Practice Research Database (GPRD) for England to cross-validate the hospital admissions data. Orchidopexy rates for boys 0–14 years old fell by 33% (from 23.5 to 15.8 per 10,000 population) between 1992 and 1998, with the steepest decline (50%) in 5–9-year-olds. The decreasing trend for 0–14-year-olds was evident in every region in England, in Wales, and in Scotland. Rates remained stable for men 15 or more years old, at 0.7 per 10,000. There was a marked shift from in-patient to day-case procedures. Rates from the GPRD showed a similar downward trend to the hospital data. Our findings could represent either an underlying decrease in the frequency of undescended testis or a fairly dramatic improvement in the diagnosis of cryptorchidism—resulting in fewer orchidopexies performed for retractile testis—in Great Britain during the 1990s, or both. Either way, our findings do not support the postulate of a recent worsening of male reproductive health of the scale suggested by some recent commentators on the endocrine disruptor hypothesis. ***Key words:*** **cryptorchidism, endocrine, orchidopexy, routine health data, temporal trends, testes.** ***Environ Health Perspect*** **111:129–132 (2003). [Online 6 November 2002]**
doi:10.1289/ehp.5446 available via *http://dx.doi.org/*

Concern has been expressed in recent years over the apparent worsening of male reproductive health, after reports of increasing frequency of testicular cancer (Forman and Moller 1994; Toledano et al. 2001) and of congenital malformations of the male urogenital organ, such as hypospadias (Kallen et al. 1986; Paulozzi et al. 1997). There are also suggestions that sperm quality may be decreasing in both Europe and the United States, although it is unclear whether this decrease is real or artifactual (Giwercman et al. 1993; Swan et al. 1997). A hypothesis that increasing exposure to environmental endocrine-disrupting agents, such as estrogenic compounds, may be responsible for these trends has been proposed (Sharpe and Skakkebaek 1993) but remains controversial (Cooper and Kavlock 1997; Harrison 2001; Joffe 2001).

Supporting evidence (primarily from Great Britain) for adverse male reproductive effects comes from the rising incidence of cryptorchidism, defined as the absence of at least one testis in the scrotum (Cortes 1998), and of orchidopexy, the operation carried out to correct the anomaly. Findings from a large cohort study in Oxford revealed a 93% increase in cryptorchidism rates between the 1950s and late 1980s (John Radcliffe Hospital Cryptorchidism Study Group 1992), whereas in England and Wales, the hospital discharge rate for orchidopexy increased from 1.4% for boys born in 1952 to 2.9% for those born in 1977 (Chilvers et al. 1984). Larger increases in both cryptorchidism and orchidopexy rates were reported from Scotland for the early 1970s to 1985 (Campbell and Webb 1987).

Although it is often assumed that cryptorchidism (and thus orchidopexy) rates have continued to increase, few recent data on trends have been reported. This study aimed to update the descriptive epidemiology of cryptorchidism in Great Britain over the period 1992–1998. It forms part of a wider investigation into the temporal and spatial trends of testicular cancer in Great Britain (Toledano et al. 2001), because cryptorchidism is a well-established risk factor for this cancer (Depue et al. 1986; Moller et al. 1995).

Methods

Hospital episodes (defined as a "finished consultant episode") for orchidopexy procedures [Office of Population Censuses and Surveys (OPCS)-4 codes N08 and N09] (OPCS 1990) were extracted from routine hospital admission data for England [Hospital Episode Statistics (HES)], Wales (Patient Episode Data Wales), and Scotland (Scottish Hospital In-Patient Statistics) for the fiscal years 1992–1993 through 1998–1999. Readmissions, detected by matching on date of birth and postcode, were removed. Episodes for those of indeterminate sex were excluded. Where an episode included more than one orchidopexy procedure, it was counted only once.

We analyzed annual trends by age (0–4, 5–9, 10–14, and ≥ 15 years old), whether in-patient admission or day case, and by country or health region in England (1996 boundaries), using male annual population estimates from the Office for National Statistics as the denominator for rates.

Because increasing use of day-case procedures for orchidopexy may have led to incomplete capture of hospital admissions data, the General Practice Research Database (GPRD) was also examined. This is the largest national computerized source of routine information on general practice morbidity and prescribing, covering 5.6% of the population of England and Wales in 1994 (Office for National Statistics 1996). Information on orchidopexy in the GPRD comes from hospital discharge letters sent to general practitioners, covering both day-case and in-patient procedures. The first ever mention of orchidopexy by age in years and the total male person-years at risk (pyar) for the calendar years 1992–1996 were identified for general practitioner practices that had participated in the GPRD throughout this time period. Analysis was restricted to practices in England. To determine the indication for orchidopexy, 50 randomly selected and anonymized patient records from 1992 and

Address correspondence to P. Elliott, Department of Epidemiology and Public Health, Faculty of Medicine, Imperial College, St Mary's Campus, Norfolk Place, London W2 1PG UK. Telephone: 44-20-7594-3328. Fax: 44-20-7402-2150. E-mail: p.elliott@ic.ac.uk

We thank D. Wilcox (Consultant Paediatric Urologist, Great Ormond Street Hospital, London) and P. Steer (Professor of Obstetrics and Gynaecology, Chelsea and Westminster Hospital, London) for their helpful comments. We thank the (English) Department of Health, Welsh National Assembly, and General Register Office for Scotland for the provision of and permission to use the data.

The Small Area Health Statistics Unit is funded by a grant from the Department of Health; Department of the Environment, Food and Rural Affairs; Environment Agency; Health and Safety Executive; Scottish Executive; National Assembly for Wales; and Northern Ireland Assembly.

The views expressed in this publication are those of the authors and not necessarily those of the funding departments, data providers, or the Office for National Statistics.

Received 11 January 2002; accepted 5 August 2002.

50 from 1996 were examined, with approval of the Scientific Expert Advisory Group for the GPRD.

Results

Hospital data. In 1992–1993 there were 13,054 orchidopexy episodes for boys 0–14 years old in hospitals in Great Britain; by 1998–1999 there were only 8,762—a 33% decline over the study period. Corresponding rates also fell by 33% from 23.5 to 15.8 per 10,000 population. Rates for men ≥ 15 years old remained stable at 0.7 per 10,000 over the study period.

Annual trends by age. As shown in Figure 1, the rates of orchidopexy declined in all age groups in boys < age 15. However, although there was a 15% decline in the rate for boys 0–4 years old and a 30% decline in those 10–14 years old, the steepest decline (50%, from 29.1 to 14.4 per 10,000) was seen in boys 5–9 years old. Thus, at the beginning of the study period, the highest orchidopexy rate was in boys 5–9 years old, but from 1995 onward the highest rate was among those 0–4 years old.

Annual trends by region. The decreasing trend for those 0–14 years old was evident in every region in England and in Wales and Scotland (Table 1), although in some regions rates in 1998–1999 were higher than those in the preceding year. In 1992–1993, regional rates for 0–14-year-olds ranged from 16.5 to 34.7 per 10,000, whereas by 1998–1999 regional rates ranged from 13.5 to 18.5 per 10,000 (Table 1). Except in the most recent year (1998–1999), the highest rates were found for Scotland, and North Thames had the lowest rates.

Annual trends by type of admission. As well as a decline in episodes, a shift from in-patient to day-case procedures was seen (Table 2). This pattern was observed in all regions and across all age groups. Among those 0–14 years old, there was a 60% decline in in-patient episodes between 1992 and 1998, with a contemporaneous 18% rise in the number of day-case episodes. The largest proportional increase (51%) in day-case episodes in those < 14 years old was seen among 0–4-year-olds. By the end of the study period, some 200 episodes for those ≥ 15 years old were shifted from in-patient to day-case procedures, resulting in an increase of (almost) 150% over the small number of day-case procedures in 1992–1993.

GPRD data. Orchidopexy rates for 0–14-year-olds in the GPRD fell by 47% from 18.1 per 10,000 pyar in 1992 (relating to 267 patients) to 9.5 per 10,000 pyar in 1996 (163 patients). Results by age showed similar trends to those seen in the hospital data: The decline was less steep for 0–4-year-olds than for 5–9-year-olds, leading to a crossover between these two age groups in 1994. Analysis by region showed that each region experienced a time trend similar to that seen nationally (not shown).

Examination of anonymized patient records (all ages) showed that the percentage of orchidopexies performed for undescended testis in 1992 was 70% (26 of 37 records where a diagnosis was listed) and in 1996 was 72% (31 of 43 records with a diagnosis).

Discussion

Recent concerns about possible environmental influences on trends of cryptorchidism have highlighted the need for a current appraisal of its epidemiology. Contrary to expectations, this study showed an overall 33% decline in orchidopexy rates in Great Britain in the 1990s using hospital admissions data, and a 47% decline in England using GPRD data. There were declines in all age groups (most marked in 5–9-year-olds) and in all regions.

Temporal trends in cryptorchidism. Reported worldwide incidence of undescended testis varies considerably as a result of differing study populations and diagnostic criteria (Toppari and Kaleva 1999), although introduction of a standardized definition of maldescent (Scorer 1964), reproduced in large cohort studies (Berkowitz et al. 1993; John Radcliffe Hospital Cryptorchidism Study Group 1986, 1992), has enabled meaningful comparisons. In London in the late 1950s, the prevalence of cryptorchidism was just under 1% at 3 months (Scorer 1964), but by the late 1980s in an Oxford study it was 1.8% (John Radcliffe Hospital Cryptorchidism Study Group 1992).

Information on time trends in cryptorchidism can also be obtained from congenital anomaly registers. Although data from the International Clearinghouse for Birth Defects Monitoring Systems indicated no general increase in cryptorchidism rates from 1970 to the mid-1990s (Paulozzi 1999), U.S. national rates increased markedly from approximately 20 to 40 per 10,000 total births between 1970 and 1993, and rates in the Canadian national system increased until about 1980 but thereafter stabilized (Paulozzi 1999). English data (Paulozzi 1999) showed a sharp drop in rates around 1990, coinciding with a change in reporting procedures (OPCS 1995).

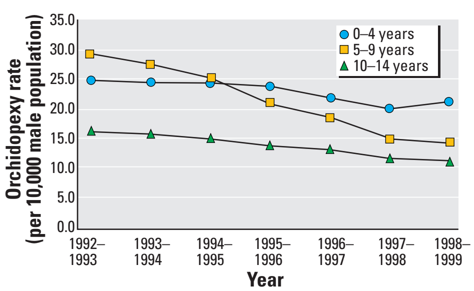

Figure 1. Orchidopexy rate per 10,000 (male) population in Great Britain by year and age group, 1992–1993 through 1998–1999.

Table 2. Number (%) of orchidopexy episodes (codes N08 and N09) in Great Britain by type of admission (% of year's admissions), year, and age, 1992–1993 through 1998–1999.

	0–14-year-olds		15-year-olds and older	
Year	In-patient	Day case	In-patient	Day case
1992–1993	8,653 (66)	4,401 (34)	1,403 (92)	127 (8)
1993–1994	7,152 (57)	5,423 (43)	1,330 (86)	209 (14)
1994–1995	5,982 (50)	6,039 (50)	1,202 (83)	245 (17)
1995–1996	5,025 (46)	5,897 (54)	1,261 (82)	281 (18)
1996–1997	4,429 (44)	5,528 (56)	1,320 (80)	320 (20)
1997–1998	3,630 (42)	5,059 (58)	1,129 (78)	327 (22)
1998–1999	3,581 (41)	5,180 (59)	1,172 (79)	314 (21)

Table 1. Orchidopexy rate per 10,000 (male) population by region and year in Great Britain, 0–14-year-olds, 1992–1993 through 1998–1999.

	England									
Year	Northern and Yorkshire	Trent	Anglia and Oxford	North Thames	South Thames	South and west	West Midlands	Northwest	Wales	Scotland
1992–1993	25.1	22.3	24.3	16.5	21.6	24.7	22.2	23.7	22.9	34.7
1993–1994	23.6	23.3	23.4	14.8	19.7	25.0	22.3	24.5	21.4	31.4
1994–1995	22.7	17.3	24.0	14.9	20.2	22.4	22.6	24.7	20.8	28.6
1995–1996	20.0	17.6	24.6	14.8	19.3	19.2	21.0	20.3	18.3	23.3
1996–1997	16.5	16.8	19.1	14.3	16.6	18.0	18.2	19.6	20.4	23.1
1997–1998	13.3	17.6	17.5	11.4	15.1	15.5	15.3	16.3	16.4	21.4
1998–1999	13.9	16.9	18.5	13.5	16.6	15.7	14.5	16.4	15.2	18.1

Interpretation of hospital and general practitioner data on orchidopexy. The use and interpretation of hospital admission data are complex. Hospital activity in the United Kingdom depends not only on the underlying prevalence of disease but also on the diagnostic accuracy and referral practice of the primary care clinician, patient-specific factors such as individual preferences, distance of residence from hospital, and socioeconomic class and on hospital-specific factors, such as quality of the hospital data collected, supply of hospital beds, admission policies, and hospital access (Hansell et al. 2001). Given such complexities, we investigated whether the observed decline in orchidopexy rates could have been artifactual, related to changes in clinical coding or data-capture problems.

First, an alternative code to those examined here could have been used for orchidopexy ("other operations on testis—fixation of testis," OPCS-4 code N132) (OPCS 1990). Although the number of episodes given this code fluctuated annually, there was an overall decline of 17% over the study period, and it is unlikely that simple coding transfer could explain our findings because the largest annual decline in orchidopexy episodes was four times greater than the largest annual decline in the number of operations given this code. Ideally, our examination would have included English hospital admissions data from the 1970s and 1980s and allowed us to compare time trends in hospital admissions with those from an individual cohort study (John Radcliffe Hospital Cryptorchidism Study Group 1992). Unfortunately, hospital admissions data between 1987 and 1991 are of variable quality (Aylin et al. 2001), whereas U.K. national data for the 1970s and 1980s are not readily available.

Second, increasing use of day-case procedures may have led to incomplete capture of the frequency of orchidopexy in hospital episode records. To investigate this possibility, we used an alternative source of data, the GPRD, which has proven valuable for examining rates over time (Kaye et al. 2000). In validation studies for a range of conditions, the GPRD has been shown to capture a high proportion of patient referrals and hospitalizations (Jick et al. 1991; Kaye et al. 2000). There seems no obvious reason why these results should not also apply to orchidopexy. The GPRD also showed a decline in orchidopexy rates, which was comparable with, but larger than, that seen in HES, with similar age-specific trends.

The recorded rates of orchidopexy in the GPRD were within the range of those reported by region in 1992–1993 but declined to approximately two-thirds the rate of the lowest region by 1996. There are a number of possible explanations for the discrepancies in rates between the two data sources. Although broadly representative, GPRD practices are self-selected with underrepresentation in inner London and of single-handed (one practitioner) practices (Walley and Mangani 1997), and it should probably not be surprising that prevalence and/or referral rates differ from national or regional rates. It is also possible that, through computerization, these general practitioners were more readily able to access records showing that the testes were descended after birth and thus less likely to misdiagnose retractile testes as cryptorchidism. Another explanation is that improvements in diagnosis occurred faster than that seen nationally. A final possibility is that the HES data used overestimate the true prevalence of orchidopexy: GPRD rates were based on patients, whereas HES records are based on episodes. Although we attempted to remove duplicate episodes and readmissions from the HES records, it is possible that some were missed.

Changes in surgical practice. By 1995, the orchidopexy rate was highest for boys 0–4 years old, in contrast to 5–9 years in the earlier period. The trend for earlier age at orchidopexy may be a reflection of both academic (Kass et al. 1996) and, more recently, policy recommendations (Hall 1996) that cryptorchidism be detected and corrected operatively before 2 years of age. In fact, late orchidopexy rates (orchidopexies done after the age of 5 years) are used to monitor the adequacy of child health screening programs, and regional rates are routinely published each year (Department of Health 1997). If, however, such changes in surgical practice during the early 1990s were the sole cause of the observed decline in orchidopexy, we would expect to see an increase in the number of operations performed in the 0–4-year-old group, whereas a decrease was observed. While shifting age trends may reflect changes in surgical practice, they could also be indicative of an underlying birth cohort effect, although with the limited numbers of years of data available to us, we were unable to explore this possibility further.

Over the past two decades, hormone therapy has been proposed in the treatment of undescended testes, with equivocal reports of its efficacy (Behrman et al. 2000; Madden 2002). Although the introduction of such treatment could affect orchidopexy rates, use in the treatment of cryptorchidism is not standard practice in the United Kingdom (Madden 2002) and therefore could not have greatly influenced the observed declining trends in orchidopexy reported here.

Use of orchidopexy as a proxy for cryptorchidism. The use of orchidopexy rates as a marker for the prevalence of cryptorchidism is not straightforward, because interpretation involves untangling factors that can directly influence the prevalence of cryptorchidism from those that influence the relationship between orchidopexy and cryptorchidism.

Gestational age at delivery will affect prevalence of cryptorchidism, because physiologic descent of the testes takes place in the third trimester of pregnancy (O'Rahilly and Muller 2001). In recent years obstetric care, especially regarding high-risk pregnancies, has improved, and this may be a factor influencing the observed declining trends in orchidopexy—for example, if there were fewer prematurely born babies during the late 1980s and 1990s than previously. Information from a large maternity database in London [St Mary's Maternity Information System (SMMIS); for a general account of the system, see Chapple (1997)], however, indicated no systematic change in the incidence of preterm labor for those babies born at 32 weeks or later over this time period (Philip Steer. Personal communication). SMMIS data also showed a small increase in the number of babies born with < 32 weeks of gestation, which, in contrast to the findings presented here, has the potential to slightly increase the frequency of undescended testes.

A further issue is the relationship between orchidopexy and the underlying prevalence of cryptorchidism. Previous studies have suggested that orchidopexy rates might be double (Chilvers et al. 1984) or even several times (Campbell and Webb 1987; Cooper and Little 1985; Snick 1984) higher than the prevalence of cryptorchidism in infancy. Large differences in these rates increase the possibility that underlying trends in cryptorchidism will be masked.

The differences between orchidopexy and cryptorchidism rates might partly reflect either misdiagnosed cases of retractile testes (Chilvers et al. 1984; Cooper and Little 1985; Snick 1984) or the possibility that cryptorchidism is acquired after birth (Donaldson et al. 1996; Jackson and John Radcliffe Hospital Cryptorchidism Research Group 1988), for which various etiologies have been postulated (Atwell 1985; Clarnette et al. 1997; Hutson and Goh 1993; Rabinowitz and Hulbert 1997). The cremaster reflex cannot retract the testes from the scrotum to the superficial inguinal pouch until about 6 months of age (Cortes 1998). Peak prevalence of retractile testes is suggested to be between 5 and 8 years old (Cortes 1998), and improved diagnosis might therefore have resulted in a decline in orchidopexy performed on this age group. Although this may help explain the patterns in our data, our analysis of a small sample of general practitioner patient records reported here suggests that around 70% of orchidopexies were carried out for cryptorchidism, with no change in this proportion over time.

Nonetheless, it is conceivable that a reduction in inappropriate surgery for retractile testes could account for at least some of the declining trend in orchidopexy.

To illustrate the extent to which orchidopexy rates could provide us with an indication of the underlying frequency of cryptorchidism—given the complexities in the relationship between orchidopexy and cryptorchidism outlined above—a simple mathematical model was constructed for boys < 15 years.

The relationship between the observed rates of orchidopexies and the true prevalence of cryptorchidism could be represented by the equation $y = x + k_i x$, where y represents the observed rate of orchidopexies and x represents the rate of orchidopexies performed for cryptorchidism. The rate of orchidopexies performed because of misdiagnosed cryptorchidism (e.g., for retractile testes) can be expressed as $k_i x$, where k_i is the multiplying factor for year i. We have assumed that the number of operations performed for reasons other than true or misdiagnosed cryptorchidism, for example, for torsion or hydrocele, in this age group is very small and constant and therefore of negligible impact.

The observed rate of orchidopexies in 0–14-year-olds in 1992–1993 was 23.5 per 10,000 males. If 50% of orchidopexies in that year were performed because of misdiagnosed retractile testes, a figure consistent with the John Radcliffe cohort study findings for the late 1980s (John Radcliffe Hospital Cryptorchidism Research Group 1986) and the calculations of Chilvers et al. (1984), then the value of $k_{1992–1993} = 1$ and the underlying rate of cryptorchidism could be estimated as 11.75 per 10,000.

The observed rate of orchidopexies in 1998–1999 in 0–14–year-olds was 15.8 per 10,000. If we assume no change in the underlying rate of cryptorchidism between 1992–1993 and 1998–1999, this gives the equation $15.8 = 11.75 + k_{1998–1999}(11.75)$, and therefore the value $k_{1998–1999} = 0.34$. This means that for each orchidopexy performed for true cryptorchidism, a further 0.34 were performed for misdiagnosed cryptorchidism; therefore, the proportion of orchidopexies performed for misdiagnosed retractile testes was $0.34/(1 + 0.34)$ or 25%, half that in 1992–1993. This would represent a fairly dramatic improvement in diagnostic ability affecting the whole country in the relatively short time period of 6 years.

If the underlying rate of cryptorchidism had actually increased over this time period, the corresponding improvement in diagnostic ability would have had to have been even greater than this to result in the observed decline in orchidopexy rates. The data also allow for an interpretation of a decrease in the underlying frequency of cryptorchidism, accompanied by a smaller or no improvement in diagnostic ability.

Conclusion. Although the relationship between orchidopexy and cryptorchidism is complex, we believe that our findings may reflect either an underlying decrease in the frequency of undescended testis or a marked improvement in the diagnosis of cryptorchidism—resulting in fewer orchidopexies performed for retractile testis—in Great Britain during the 1990s, or both. An increase in the prevalence of cryptorchidism cannot be ruled out, but for this to be a possibility, given the observed trends in orchidopexy, a dramatic improvement in diagnostic ability would have had to have occurred simultaneously over a short period, which we regard as an unlikely scenario. Our findings warrant further investigation with individual-level studies, because this is a surprising finding given reported trends of large increases in cryptorchidism for previous decades and the postulate of a recent worsening of male reproductive health as suggested by the endocrine disruptor hypothesis.

References

Atwell JD. 1985. Ascent of the testis: fact or fiction. Br J Urol 57:474–477.

Aylin P, Bottle A, Wakefield J, Jarup L, Elliott P. 2001. Proximity to coke works and hospital admissions for respiratory and cardiovascular disease in England and Wales. Thorax 56(3):228–233.

Behrman RE, Kliegman RM, Jenson HB. 2000. Nelson Textbook of Pediatrics. 16th ed. Philadelphia: W.B. Saunders.

Berkowitz GS, Lapinski RH, Dolgin SE, Gazella JG, Bodian CA, Holzman IR. 1993. Prevalence and natural history of cryptorchidism. Pediatrics 92(1):44–49.

Campbell DM, Webb JA. 1987. Cryptorchidism in Scotland. Br Med J 295:1235–1236.

Chapple JC. 1997. The North West Thames experience—the St Mary's Maternity Information System (SMMIS). In: The Effective Use of Maternity Data (Steer PJ, Beard RW, eds). London:Clinical Accountability, Service Planning and Evaluation, 21–27.

Chilvers C, Pike MC, Forman D, Fogelman K, Wadsworth MEJ. 1984. Apparent doubling of frequency of undescended testis in England and Wales in 1962–81. Lancet I:330–332.

Clarnette TD, Rowe D, Hasthorpe S, Hutson JM. 1997. Incomplete disappearance of the processus vaginalis as a cause of ascending testis. J Urol 157:1889–1891.

Cooper BJ, Little TM. 1985. Orchidopexy: theory and practice. Br Med J 291:706–707.

Cooper RL, Kavlock RJ. 1997. Endocrine disruptors and reproductive development: a weight-of-evidence overview. J Endocrinol 152:159–166.

Cortes D. 1998. Cryptorchidism: aspects of pathogenesis, histology and treatment. Scand J Urol Nephrol 196(suppl):1–54.

Department of Health. 1997. Public Health Common Data Set 1996: Incorporating Health of the Nation Indicators and Population Health Outcome Indicators, England. Guildford:National Institute of Epidemiology, University of Surrey.

Depue RH, Pike MC, Henderson BE. 1986. Cryptorchidism and testicular cancer. J Natl Cancer Inst 77:830–833.

Donaldson KM, Tong SYC, Hutson JM. 1996. Prevalence of late orchidopexy is consistent with some undescended testes being acquired. Ind J Pediatr 63:725–729.

Forman D, Moller H. 1994. Trends in cancer incidence and mortality: testicular cancer. Cancer Surv 19/20:323–341.

Giwercman A, Carlsen E, Keiding N, Skakkebaek NE. 1993. Evidence for increasing incidence of abnormalities of the human testis: a review. Environ Health Perspect 101(suppl 2):65–71.

Hall DMB (ed). 1996. Health for All Children—Report of the Third Joint Working Party on Child Health Surveillance. Oxford: Oxford University Press.

Hansell A, Bottle A, Shurlock L, Aylin P. 2001. Accessing and using hospital activity data. J Public Health Med 23(1):51–56.

Harrison PTC. 2001. Endocrine disrupters and human health. Br Med J 323:1317–1318.

Hutson JM, Goh DW. 1993. Can undescended testes be acquired? Lancet 341:504–506.

Jackson MB, John Radcliffe Hospital Cryptorchidism Research Group. 1988. The epidemiology of cryptorchidism. Horm Res 30:153–156.

Jick H, Jick SS, Derby LE. 1991. Validation of information recorded on general practitioner based computerised data resource in the United Kingdom. Br Med J 302:766–768.

Joffe M. 2001. Are problems with male reproductive health caused by endocrine disruption? Occup Environ Med 58:281–288.

John Radcliffe Hospital Cryptorchidism Study Group. 1986. Cryptorchidism: an apparent substantial increase since 1960. Br Med J 293:1401–1404.

———. 1992. Cryptorchidism: a prospective study of 7500 consecutive male births, 1984–8. Arch Dis Child 67:892–899.

Kallen B, Bertollini R, Castilla E, Czeizel A, Knudsen LB, Martinez-Frais ML, et al. 1986. A joint international study on the epidemiology of hypospadias. Acta Paediatr Scand 324(suppl):1–52.

Kass EJ, Kogan SJ, Manley C, Wacksman JA, Klykylo WM, Meza A. 1996. Timing of elective surgery on the genitalia in male children with particular reference to the risks, benefits, and psychological effects of surgery and anesthesia. Pediatrics 97:590–594.

Kaye JA, Derby LE, Melero-Montes MM, Quinn M, Jick H. 2000. The incidence of breast cancer in the General Practice Research Database compared with national cancer registration data. Br J Cancer 83:1556–1558.

Madden NP. 2002. Testis, hydrocele and varicocoele. In: Essential of Paediatric Urology (Thomas DFM, Rickwood AMK, Duffy PG, eds). London: Martin Dunitz, 189–201.

Moller H, Prener A, Skakkebaek NE. 1995. Testicular cancer, cryptorchidism, inguinal hernia, testicular atrophy, and genital malformations: case-control studies in Denmark. Cancer Causes Control 7:264–274.

Office for National Statistics. 1996. Key Health Statistics in General Practice 1998. London: The Stationery Office.

OPCS. 1990. Tabular List of the Classification of Surgical Operations and Procedures, 4th revision. London:The Stationery Office.

———. 1995. The OPCS Monitoring Scheme for Congenital Malformations. Occasional paper 43. London:Office of Population Censuses and Surveys.

O'Rahilly R, Muller F. 2001. Human Embryology and Teratology. 3rd ed. New York:Wiley-Liss.

Paulozzi LJ. 1999. International trends in rates of hypospadias and cryptorchidism. Environ Health Perspect 107:297–302.

Paulozzi LJ, Erickson JD, Jackson RJ. 1997. Hypospadias trends in two US surveillance systems. Pediatrics 100:831–834.

Rabinowitz R, Hulbert WC. 1997. Late presentation of cryptorchidism: the etiology of testicular re-ascent. J Urol 157:1892–1894.

Scorer CG. 1964. The descent of the testis. Arch Dis Child 39:605–609.

Sharpe RM, Skakkebaek NE. 1993. Are oestrogens involved in falling sperm counts and disorders of the male reproductive tract? Lancet 341:1392–1395.

Snick HKA. 1984. The excessive frequency of orchidopexy: investigation and measures in the island of Walcheren. Ned Tijdschr Geneeskd 128(44):2077–2081.

Swan SH, Elkin EP, Fenster L. 1997. Have sperm densities declined? A reanalysis of global trend data. Environ Health Perspect 105:1228–1232.

Toledano MB, Jarup L, Best N, Wakefield J, Elliott P. 2001. Spatial variation and temporal trends of testicular cancer in Great Britain. Br J Cancer 84(11):1482–1487.

Toppari J, Kaleva M. 1999. Maldescendus testis. Horm Res 51:261–269.

Walley T, Mangani A. 1997. The UK General Practice Research Database. Lancet 350:1097–1099.