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Prevalence of undescended testis, age at surgery and outcomes: a population-based cohort study

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Abbreviations: UDT: undescended testis; NSW: New South Wales; IQR: interquartile range; PDC: Perinatal Data APDC: Collection; Admitted Patient Data Collection; ICD: International Classification of Diseases; ACHI: Australian Classification of Health Interventions

What's Known on This Subject

Recent reports have revealed that a majority of undescended testis cases are operated after the recommended age of 12 months, but most include acquired cases that have later presentation. There is also a lack of population-based information about outcomes following surgery

What This Study Adds

Two thirds of undescended testis cases are treated later than the recommended age, with the age at surgery decreasing in the past decade, however, diagnosis at birth remains inadequate. One in ten boys require revision surgery

Contributors' Statement:

Drs Schneuer and Nassar conceived and designed the study, conducted the statistical analysis, drafted the initial manuscript, and approved the final manuscript as submitted.

Dr Holland provided clinical advice, critically reviewed and revised the manuscript, and approved the final manuscript as submitted.

Drs Pereira, Jamieson and Bower provided epidemiological advice, critically reviewed and revised the manuscript, and approved the final manuscript as submitted.

All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

Abstract

Background and Objective: Undescended testis (UDT) is the most common genital anomaly in boys**.** Current guidelines recommend surgery before 12 months to maximise fertility and potentially reduce the risk of future malignancy. We investigated the prevalence of UDT and examined the rates of surgery and the age at surgery in an Australian population.

Materials and Methods: UDT was identified from all live born infants in New South Wales, Australia in 2001-2011 using routinely collected record-linked birth and hospital data. The prevalence of UDT, surgery rates, age at surgery, post-surgical outcomes and risk factors for surgery performed later than the recommended age were evaluated.

Results: There were 10,875 (2.1%) boys with a recorded diagnosis of UDT. Corrective surgery was performed in 4,980 (45.8%) boys representing a cumulative prevalence of 9.6 per 1,000 male births. 5% of surgeries were orchidectomies and 9% of boys had revision surgery. Median age at surgery was 16.6 (IQR: 11.8-31.0) months, decreasing from 21 months for boys born in 2001 to 13 for boys born in 2010. Among those boys operated before 36 months (n=3,897), 67% had corrective surgery after the recommended 12 months of age; with socio-economic disadvantage, regional/remote area of residence and lack of private health insurance risk factors for having corrective surgery after 12 months of age.

Conclusions: One in fifty boys born are diagnosed with UDT of which two thirds had no report of corrective surgery. The age at surgery is decreasing, however, two thirds are performed after 12 months of age.

Introduction

Undescended testis (UDT) or cryptorchidism is the failure of one or both testis to descend to a normal scrotal position and is the most common genital anomaly in boys**.** The prevalence at birth, otherwise known as congenital UDT, ranges between 2% and 9%[1]. Although, a large proportion of cases descend spontaneously to a normal position by 3 months of age, nearly 1% remain undescended and require surgery[2]. UDT can also develop in a previously descended testis, considered an acquired UDT, although these tend to present later in childhood and is associated with increased prevalence in pre-pubertal boys[3]. Approximately one third of UDT are persistent and need to be treated with orchidopexy, surgical repositioning of the testis within the scrotum[4]. Although most surgical procedures are successful, up to 33% have been reported to experience failures, depending on the original location of the testis, including severe complications such as testicular atrophy. These complications may ultimately require removal of the testis (orchidectomy) or revision orchidopexy. These findings may be over-estimated as many of the previous studies have tended to be from single paediatric referral centres, which included a disproportionate number of more complex cases, more likely to be associated with surgical failure[5]. To date, there is a lack of data on outcomes of UDT surgery from large multicentre studies.

The importance of surgery for UDT is underpinned by the fact that boys with UDT have an increased risk of testicular cancer later in life[6]. Further, it has been shown that UDT inhibits the differentiation of primitive germ cells, starting at 4-12 months, which is crucial for the production of germ cells that subsequently enable spermatogenesis[7]. Delayed repositioning of an

undescended testis may result in a reduction in germ cell development and low testicular volume, potentially diminishing subsequent fertility[8].

Given these findings, there has been a general consensus that early orchidopexy improves results associated with markers of fertility and testicular malignancy[8]. Recent International guidelines have recommended orchidopexy to be performed before 12 months of age to preserve fertility potential and avoid risk of malignancy[10,11]. Despite guideline recommendations, a recent systematic review reported that more than 75% of orchidopexies were performed later than the recommended age[12], with most studies combining congenital and acquired UDT cases. Combining both types of UDT may be misleading as they have different underlying aetiology and outcomes, and results may be skewed. Persistent congenital cases are of particular interest as research suggests longer testicular exposure to higher temperatures leads to increased risks of sub-fertility and cancer[13]. Hence, population-based monitoring of cases from birth to distinguish congenital from acquired cases, current practices and identification of potential factors contributing to delays in orchidopexy are important to assure future reproductive health of affected boys. We hypothesize that a majority of boys with congenital UDT in Australia undergo corrective surgery later than the recommended age. The aims of this population-based study were to investigate the prevalence of UDT and to examine the rates of corrective surgery, their success or failure, current trends in age at surgery and factors influencing early or late surgery in an Australian population.

Materials and Methods

Study population and data sources

The study population included all live born males diagnosed with UDT in New South Wales (NSW), Australia between 1st January 2001 and 31st December 2011. NSW is the most populated Australian state comprising one third of all births in the nation. Healthcare is based on a combination of a national publically funded (60%) and private healthcare (40%) system[14].

The main data sources used were the NSW Perinatal Data Collection (PDC) and the NSW Admitted Patient Data Collection (APDC). The PDC is a statutory surveillance system covering all livebirths and stillbirths in NSW. The APDC is a census of all in-patient hospital admissions from NSW public and private hospitals which collects demographic and clinical information. All diagnoses and procedures for each admission are coded according to the 10th revision of the International Classification of Diseases, Australian Modification (ICD10-AM) and the Australian Classification of Health Interventions (ACHI), respectively. Longitudinal record linkage of individual birth and hospital data was conducted to provide information on each boy's birth and any subsequent hospital admissions until March 2014. Record linkage was conducted by the NSW Centre for Health Record Linkage independent of the research. Ethics approval for access and linkage of data was obtained from the NSW Population and Health Services Research Ethics Committee.

Boys with UDT were identified from the APDC if they had a relevant ICD-10-AM code (Q53, **Table 1**) recorded in any birth or hospital admission. These were classified as unilateral,

bilateral, unspecified and ectopic. Isolated UDT was defined in cases for which no other congenital anomaly diagnosis was recorded. For those diagnosed with other anomalies, boys with other testicular anomalies, hypospadias and other genitourinary anomalies were each differentiated from all other types. All related ICD10-AM coded diagnoses are presented in **Table 1**.

Study outcomes and data

The main study outcomes were primary surgical procedures, testicular atrophy, testicular torsion, procedures following failed orchidopexy and readmissions for post-surgical wound-related complications. Primary surgical procedures were orchidopexy (including codes for fixation of testis) and orchidectomy. All surgical procedures were identified using ACHI procedure codes and are listed in **Table 1**. Procedures after failed orchidopexy included revisions of orchidopexy, re-fixation of testis and repeat orchidopexy. We excluded repeat orchidopexy performed within 12 months following primary orchidopexy for non-palpable testis to avoid including routine second stage orchidopexy [15]. Post-surgical complications were defined as readmissions to hospital occurring within 28 days if caused by surgery-related wound infections or haematomas.

Study factors included timing of diagnosis, coexistent congenital anomalies, preterm birth (<37weeks gestation), age at primary surgery, public or private health insurance status, area of residence and socioeconomic disadvantage. The age at primary surgery and time at first recorded diagnosis were categorized into 6 groups: birth, <12 months, 12-<18 months, 18-<24 months,

24-<36 months and 36+ months. The area of residence was dichotomized into major cities vs. regional/remote areas using the Accessibility/Remoteness Index of Australia[16], while socioeconomic disadvantage was determined using the Socioeconomic Indexes for Areas relative disadvantage scores developed by the Australian Bureau of Statistics[17] and classified as disadvantaged (<20th centile) versus non-disadvantaged (>20th centile).

Statistical analysis

The proportion of UDT diagnosed and the prevalence of those undergoing surgery was examined as total number of reported cases per 1,000 male births in NSW, 2000-2011. The trend in annual prevalence was evaluated including only boys with similar follow up time, i.e. born up to 2010 and with corrective surgery performed before 36 months of age. Descriptive statistics were calculated to assess characteristics of boys undergoing surgery and association between study factors, procedures and age of surgery assessed using Chi-squared tests and Cochran-Armitage Test for trend. Spearman's coefficient was used to determine correlation between the date of birth and the date at surgery and multivariate logistic regression applied to examine the association between risk factors for primary corrective surgery performed before or later than the recommended 12 months of age[10,11]. Characteristics of boys and age of subsequent surgery by timing of first recorded diagnosis (birth or later) was also investigated. A P-value <0.05 was considered statistically significant and all analyses were performed using SAS, 9.3 (SAS Institute, Cary, NC, USA).

Results

There were 518,846 live born boys in NSW between 2001 and 2011 and of these, 10,875 (2.1%) had a recorded diagnosis of UDT. Overall, 4,980 (45.7%) boys with a recorded diagnosis of UDT had corrective surgery (in 65 hospitals), representing a prevalence of 9.6 per 1,000 male births. Of these, 80% (n=3,987) had surgery before 36 months, with the prevalence of these cases decreasing from 11.6 in 2001 to 7.8 per 1,000 male births in 2010.

Of boys undergoing surgery, over three-quarters (78%) had unilateral and 17% bilateral UDT, while 5% were either ectopic or unspecified. Most cases were isolated (72%) with 8.7% having other genitourinary anomalies and 14.7% anomalies of other organs. Although the majority of boys had an orchidopexy (97.8%), 589 (11.8%) required surgery for impalpable testis and 223 (4.5%) had an orchidectomy. As such, a small proportion of boys (n=92, 1.8%) were diagnosed with testicular atrophy and 58 (1.2%) had an associated diagnosis of testicular torsion. Overall, there were 26 (0.5%) boys readmitted to hospital within 28 days following surgery with post-procedural complications. Almost 10% (n=446) required revision procedures after one year for failed primary surgery, and of these, 16 (3.6%) had a recorded diagnosis of testicular atrophy.

Amongst boys undergoing surgery, 78% were aged less than and 22% over 36 months (**Table 3**), with the overall median age (inter-quartile range: IQR) at primary surgery of 16.6 (IQR 11.8-31.0) months. As age of surgery increased, there was a decreasing trend in rates of orchidectomy and surgery for impalpable testis, unilateral UDT and testicular atrophy ($P<0.01$); but an increasing trend in surgery for bilateral UDT ($P<0.01$) (**Table 3**). For those with complete follow-up to 36 months (n=3,897), one-third had surgery at age less than one year and 54% between 12-24 months. The trend in the median age at surgery for these boys decreased from

14.7 months in 2001 to 12.7 in 2010 (r= -0.05; P<0.01)**.** Primary surgery was more likely to be performed after 12 months of age for boys from socio-economic disadvantaged backgrounds (adjusted odds ratio (aOR) 1.37; 95%CI: 1.13-1.67) and those living in regional/remote areas (aOR 1.27; 95%CI: 1.08-1.49); and less likely among boys from families with private health insurance (aOR 0.61; 95%CI: 0.53-0.71). There was no association between preterm birth or coexistent congenital anomalies and surgery after 12 months of age.

When age at surgery was examined by timing of diagnosis, only one-third of boys (35%) had a recorded diagnosis of UDT at birth with the remaining diagnosed in later health checks but first identified in this study at the time of surgery. Even for boys undergoing surgery at less than 12 months, less than half (44%) had UDT recorded at birth (**Figure 1**). However, there was no difference in the characteristics of boys and timing of reported diagnosis by socioeconomic or health insurance status, area of residence, preterm birth or type of surgery; those with other congenital anomalies were more likely to have UDT recorded at birth (**Supplementary Table 1**). Even after excluding those with a recorded diagnosis at birth, 18% (n=877/4,980) of boys in our cohort were treated for UDT after 36 months of age.

Discussion

This is one of the largest population-based cohort studies examining the diagnosis and treatment of UDT with long term follow-up up to 12 years. We found that more than one in fifty boys had a recorded diagnosis of UDT and 1% prevalence of boys undergoing surgery in NSW. Both the prevalence and the age at surgery decreased over the past decade, however, nearly two

thirds of cases still underwent surgery later than the recommended age of 12 months. We also found that almost 1 in 10 boys required subsequent revision.

The proportion of UDT diagnosed at birth (1.9%) and those subsequently treated (1%) in NSW is similar to that published by a recent Danish population-based study[18]. We found a decrease in prevalence of treated UDT over the past decade which appears consistent with worldwide reported trends in Germany, New Zealand, Norway and Russia[19]; and also to other Australian states of Victoria and Western Australia[20,21].

To our knowledge, this is the first population-based study (n=4,980, 65 sites) reporting rates for testicular atrophy (1.8%), torsion (1.2%) and subsequent outcomes of orchidopexy, with 9% of patients requiring revision surgery and a rate of testicular atrophy at second surgery of 3.6%. To date, the only other published multi-centre study (10 sites, n=281 patients) reported an overall 7.2% and 6.1% rate of failure and atrophy, respectively, in patients undergoing laparoscopic orchidopexy[22].

We found that at least two-thirds of corrective surgeries for UDT were performed later than recommended guidelines. This is of concern as late orchidopexy may be associated with increased risk of testicular cancer and diminished fertility potential in boys[26-30]. Two recent systematic reviews have reported a 2 to 32-fold increased risk of testicular cancer in men with a history of UDT, with the risk lower for younger age at orchidopexy, but higher for previous bilateral UDT[8,27]. Such findings have prompted a significant reduction in the recommended age to perform orchidopexy in the past decades; to its current 12 months of age[31]. Although we found an encouraging and decreasing trend in age at surgery, consistent with recent reports from different settings[12,32], the current rates of late surgery are particularly concerning, especially for

those with bilateral UDT. We found that the overall proportion of primary surgery performed after 12 months was 74%. But, when limited to complete follow-up of 36 months, this was 67%. Two studies that were limited to congenital cases have reported 70% to 82% of cases having surgery after 12 months[12,33]. Other studies have also reported a high proportion of orchidopexy performed later than the recommended age, but most potentially included cases of acquired UDT, which are diagnosed and treated at later age[12]. To date, there are no current Australian guidelines that specify the importance of the timing of early surgery.

One of the motivations of our study was to try and differentiate congenital from late diagnosed and potentially acquired cases. Although, we had information on recorded diagnosis at birth, we found identification of congenital cases difficult due to the under-reporting of cases at birth (only 35%) and a majority reported at time of surgery with no information on previous testis position. Our findings suggest that the characteristics of boys undergoing surgery before 36 months of age without diagnosis at birth are similar to those diagnosed at birth and may potentially be congenital cases. The 18% having surgery after 36 months (without a recorded UDT diagnosis at birth) may be more likely to be acquired cases. A previous longitudinal cohort study (n=1,072) with examination of testicular position at 0, 3, 18, 36 and 54 months of age reported an 18% rate of acquired UDT[35], however, the proportion of acquired UDT may have been overestimated due to 45% loss to follow-up.

Strategies to reduce the age at orchidopexy require the identification of factors that may delay surgery. These may involve missed diagnosis at birth, delays in follow-up by parents, missed diagnosis or timely referral by general practitioners or limited availability of hospital resources to conduct surgery[39,40]. Missed diagnosis at birth may have occurred because infants

were not examined or UDT was missed due to a lack of experience or training of maternity care providers. Previous studies reveal that when the examination is performed by trained experts, the prevalence of UDT detected at birth is higher as reported in cohorts from Denmark (9%)[2] and Lithuania (5.4%)[41], compared to the 2.1% reported here. Following birth, delays in diagnosis may also occur and be due to lack of parental awareness and/or limited attendance to routine health visits in the child's first year of life. Lack of assessment, follow-up or timely referral by general practitioners may also be a contributing factor. Thus, adherence to monitoring during routine health checks is essential to ensure timely intervention. This is particularly important because the testicular position may vary in early life.

Given that interventions providing advice to general practitioners and parents in the UK have been shown to be effective in the reduction of age at orchidopexy[42], our results suggest that these may need to be implemented for future improvements in practice in Australia. This is further confirmed by results from a recent survey reporting that 75% of UK general practitioners still consider two years to be the optimal age for performing orchidopexy[34]. Another potential influence on the age at surgery remains the limited capacity and availability of NSW hospitals to perform orchidopexy before one year of age, with NSW health policy considering this a major surgical procedure to be performed only by surgeons credentialed in paediatric surgery with specialist anaesthetists involved[43]. Given more urgent cases and limited resources, delays in surgery may occur in the public hospital system. Therefore, increasing the availability and access to surgery in more NSW hospitals would reduce demand and redistribute the burden and access to surgery[44]. One alternative is for surgery to be undertaken in private hospitals, which do not have the same demands on limited resources. In Australia, patients without private health insurance are treated in the public health system and placed on a waiting list which is determined

by urgency, while those with private health insurance are managed more immediately according to the availability of the paediatric surgeon. This issue is supported by our findings that boys with private health insurance had earlier primary surgery, compared with those publicly insured and from lower socio-economic background or rural areas.

The main strength of this study was the use of a large record-linked population-based cohort of boys that allowed the assessment and follow-up from 65 hospitals across NSW for up to 12 years. The health datasets used are accurate and reliable with validation studies reporting high levels of agreement with medical records[45] and congenital anomaly registers[46]. One limitation of our study is that 65% of cases undergoing surgery did not have a recorded UDT diagnosis at birth and we did not have information as to whether these were missed diagnoses at birth, delayed diagnoses or acquired cases. To overcome this issue, we categorized cases according to the time of the first recorded diagnosis of UDT and age at surgery to identify potential cases of acquired UDT. Another limitation was that we could not stratify our analysis by the pre-surgical position of the testis (canalicular/inguinal/intra-abdominal), the surgical approach of orchidopexy (inguinal canal/abdominal cavity) or the type of surgery (single stage vs. staged Fowler-Stephens orchidopexy). Although there are ICD-10-AM codes to identify the position of the undescended testis and ACHI codes for the surgical approach, we were unable to report these because a majority of records had unspecified information. Therefore, our results for testicular atrophy, testicular torsion and outcomes following surgery represent overall rates and may not correspond to specific case-mix or type of corrective surgery.

Conclusions

In conclusion, one in forty eight boys are born with UDT, however, two thirds of cases had no report of corrective surgery. The prevalence of treated UDT was 1%, with almost one in 10 requiring subsequent revision. The median age at surgery is decreasing, however, two-thirds of cases were still performed after the recommended age of 12 months. Further interventions are needed to improve detection of UDT at birth; and increase understanding of the diagnosis by parents and management of UDT by primary health care providers. Importantly, the significance of early diagnosis and surgical correction before 12 months of age should be implemented in Australian guidelines, as well as changes in health policy to increase health care resources to perform surgery at earlier ages.

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Table 1: Definitions and diagnostic and procedures codes related to undescended testis

Table 2: Infant characteristics of cases of undescended testis (UDT) in NSW, 2001 – 2011

Table 3: Characteristics of treated undescended testis (UDT) by age at surgery in NSW, 2001 – 2011

Figure 1: Proportion of boys undergoing surgery by age at surgery in NSW, 2001 – 2011

Table 1: Definitions and diagnostic and procedures codes related to undescended testis

Definition	ICD10-AM diagnostic codes
Undescended testicle, unilateral	Q53.1, Q53.10, Q53.11, Q53.12, Q53.13 and Q53.19
Undescended testicle, bilateral	Q53.2, Q53.20, Q53.21, Q53.22, Q53.23 and Q53.29
Undescended testicle, unspecified	Q53.9, Q53.90, Q53.91, Q53.92, Q53.93 and Q53.99
Ectopic testis	Q53.0, Q53.01, Q53.00, Q53.02, Q53.03 and Q53.09
Bifid scrotum, absence of scrotum, polyorchism and other unspecified congenital malformations of testis or scrotum	Q55.2, 55.8, Q55.9, Q55.3 and Q55.4
Hypospadias	Q54.0, Q54.1 Q54.2, Q54.3, Q54.8 and Q54.9
Other congenital malformations of male genital organs, lower urinary system and indeterminate sex	Q56 and Q64
Other congenital malformations deformations and chromosomal abnormalities[1]	Q00 - Q99 (Excluding the above codes)
Atrophy of testis	N50
Torsion of testis	N44
Post-surgical complications	
Complications resulting from surgical procedure including wound infection, sepsis, haemorrhage and haematoma	T81, T88, Z98, N99
Definition	**ACHI procedure codes**
Primary procedures	
Orchidopexy for undescended testis, unilateral	37803-00, 37806-00 and 37806-02
Orchidopexy for undescended testis, bilateral	37803-01, 37806-01 and 37806-03
Orchidectomy, unilateral	30641-00 and 30641-02
Orchidectomy, bilateral	30641-01 and 30641-03
Exploration of scrotal contents with fixation of testis, unilateral and bilateral	37604-04 and 37604-05
Exploration of groin for impalpable testis	37812-00
Laparoscopy	30390-00 and 30391-00
Secondary procedures	
Revision orchidopexy for undescended testis, unilateral and bilateral	37809-00 and 37809-01
Refixation of testis, unilateral and bilateral	37604-07 and 37604-08

[1]Excluding minor congenital anomalies i.e. tongue-tie, naevus, skin tags, unstable hip and feet defects; ICD10-AM: International Classification of Diseases, Tenth Revision, Australian Modification; ACHI: Australian Classification of Health Interventions

Figure 1: Proportion of boys undergoing surgery by age at surgery in NSW, 2001 – 2011

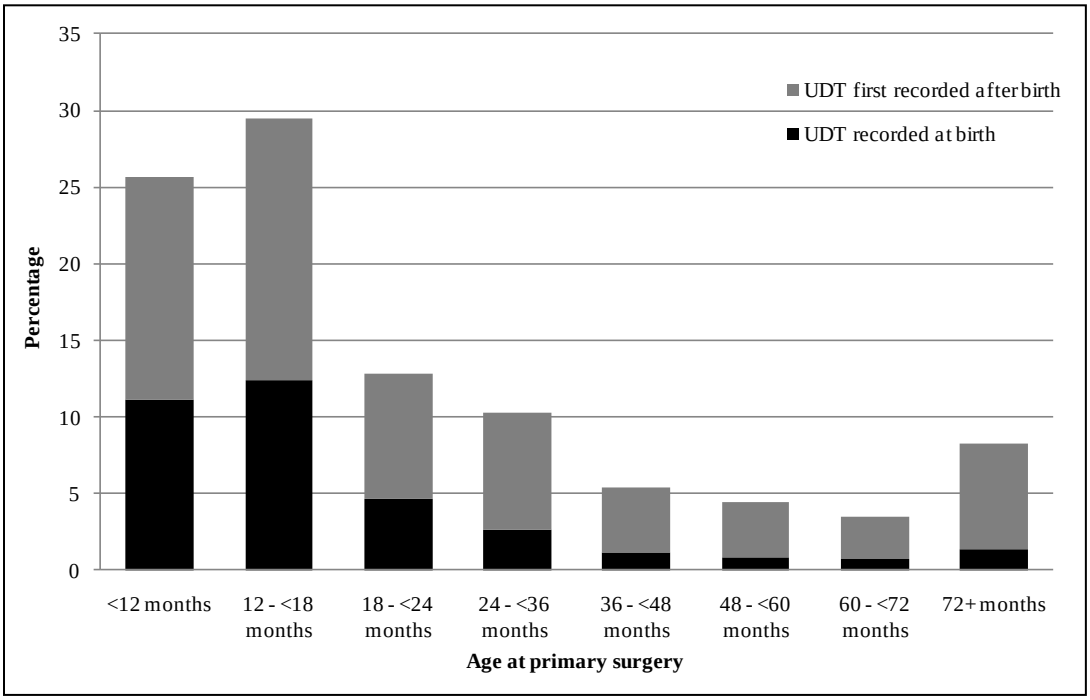

Table 2: Infant characteristics of cases of undescended testis (UDT) in NSW, 2001 – 2011

Infant characteristics	UDT requiring surgery n (%)
All cases	N=4,980
Health care insurance	
Public	3,353 (67.3)
Private	1611 (32.3)
Area of residence	
Major cities	3468 (69.6)
Regional/remote	1,510 (30.3)
Socio economic status	
Disadvantaged (<20th centile)	877 (17.6)
Non-disadvantaged (>20th centile)	4,100 (82.3)
Age at first recorded diagnosis	
Birth	1,717 (34.5)
<6 months	137 (2.8)
6 - 12 months	625 (12.6)
12 - 18 months	862 (17.3)
18 - 24 months	397 (8.0)
24 - 36 months	372 (7.5)
36+ months	870 (17.5)
Type of UDT	
Unilateral	3,870 (77.7)
Bilateral	853 (17.1)
Ectopic	55 (1.1)
Unspecified	202 (4.1)
Isolated UDT	3,593 (72.1)
UDT associated with other congenital anomalies[1]	
Other testicular anomalies	194 (3.9)
Hypospadias	149 (3.0)
Other genitourinary anomalies	433 (8.7)
Anomalies of other organs or chromosomal abnomalies[2]	731 (14.7)
Preterm birth <37 weeks	588 (11.8)

[1] Not mutually exclusive; [2]Excluding minor congenital anomalies i.e. tongue-tie, naevus, skin tags, unstable hip and feet defects; - Numbers <5 not presented

Table 3: Characteristics of treated undescended testis (UDT) by age at surgery in NSW, 2001 – 2011

Infant characteristics	<12 months n(%)	12- <18 months n(%)	18 - <24 months n(%)	24 - <36 months n(%)	36+ months n(%)
All cases (N=4,980)	N=1,277	N=1,469	N=639	N=512	N=1,083
Health care insurance					
Public	751 (58.8)	965 (65.7)	488 (76.4)	388 (75.8)	761 (70.3)
Private	519 (40.6)	500 (34.0)	147 (23.0)	123 (24.0)	322 (29.7)
Area of residence					
Major cities	945 (74.0)	1,049 (71.4)	431 (67.4)	350 (68.4)	693 (64.0)
Regional/remote	332 (26.0)	419 (28.5)	208 (32.6)	162 (31.6)	389 (35.9)
Socio economic status					
Disadvantaged (<20th centile)	174 (13.6)	250 (17.0)	116 (18.2)	103 (20.1)	234 (21.6)
Non-disadvantaged (>20th centile)	1,103 (86.4)	1,217 (82.8)	523 (81.8)	409 (79.9)	848 (78.3)
Surgeries	1,277	1,469	639	512	1,083
Orchidopexy	1,256 (98.4)	1428 (97.2)	622 (97.3)	502 (98.0)	1,066 (98.4)
Orchidectomy[1]	78 (6.1)	69 (4.7)	29 (4.5)	19 (3.7)	28 (2.6)
Impalpable testis[2]	137 (10.7)	149 (10.1)	66 (10.3)	40 (7.8)	55 (5.1)
Type of surgery					
Unilateral	1,151 (90.1)	1,326 (90.3)	571 (89.4)	443 (86.5)	900 (83.1)
Bilateral	126 (9.9)	142 (9.7)	68 (10.6)	69 (13.5)	183 (16.9)
Associated diagnosis at surgery admission					
Testicular atrophy	37 (2.9)	27 (1.8)	13 (2.0)	8 (1.6)	7 (0.6)
Testicular torsion	28 (2.2)	8 (0.5)	-	6 (1.2)	16 (1.5)
Re-admissions for post procedural complications	9 (0.7)	7 (0.5)	-	-	5 (0.5)
Revision procedures for failed primary surgery[3]	137 (10.7)	146 (9.9)	56 (8.8)	34 (6.6)	73 (6.7)

[1]Some simultaneous orchidopexy and orchidectomy; [2]Included record of surgical exploration of groin or laparoscopy;
[3]Including subsequent revision of orchidopexy, re-fixation of testis or repeat orchidopexy; IQR: Interquartile range;
- Numbers <5 not presented

Supplementary table: Characteristics of boys with treated UDT before 36 months of age by time of recorded diagnosis in NSW, 2001 – 2010

Infant characteristics	Recorded UDT diagnosis at birth n(%)	First recorded UDT diagnosis after birth n(%)	P value
All cases	N=1,543	N=2,354	
Isolated UDT	1,042 (67.5)	1,753 (74.5)	<0.01
Associated with[1]			
Other testicular anomalies	55 (3.6)	101 (4.3)	0.32
Hypospadias	50 (3.2)	64 (2.7)	0.34
Other genitourinary anomalies	154 (10.0)	198 (8.4)	0.09
Anomalies of other organs or chromosomal abnormalities	257 (16.7)	314 (13.3)	<0.01
Preterm birth <37 weeks	161 (10.4)	274 (11.6)	0.21
Health care insurance			0.33
Public	1,041 (67.5)	1,551 (65.9)	
Private	494 (32.0)	795 (33.8)	
Area of residence			0.14
Major cities	1,122 (72.7)	1,653 (70.2)	
Regional/remote	421 (27.3)	700 (29.7)	
Socio economic status			0.80
Disadvantaged (<20th centile)	257 (16.7)	386 (16.4)	
Non-disadvantaged (>20th centile)	1286	1,966 (83.5)	
Surgeries			
Orchidectomy	79 (5.1)	116 (4.9)	0.81
Impalpable testis	162 (10.5)	230 (9.8)	0.52
Type of orchidopexy			0.14
Unilateral	1,368 (88.7)	2,123 (90.2)	
Bilateral	175 (11.3)	230 (9.8)	
Associated diagnosis at surgery admission			
Testicular atrophy	41 (2.7)	44 (0.1)	0.11
Testicular torsion	15 (1.0)	27 (1.1)	0.62
Revision procedures for failed primary surgery	196 (12.7)	177 (7.5)	<0.01

[1] Not mutually exclusive