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**THE UROLOGICAL MANAGEMENT OF CHILDREN
WITH SPINAL DYSRAPHISM**

**A dissertation towards Part III of the degree
Master of Medicine (Urology).**

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To my parents, Vadia and Don Jee

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CHAPTER 1

INTRODUCTION

- 1.1 Aims of the study.
- 1.2 Terms and definitions used in this report.
- 1.3 Classification of spinal dysraphism.
- 1.4 Normal embryology of the central nervous system.
- 1.5 Theories for the pathogenesis of spina bifida aperta.
- 1.6 Aetiological factors in the development of neural tube lesions.

AIMS OF THE STUDY

This project was undertaken with the following aims:

- 1) To generate a data base concerning the management of children with congenital spinal anomalies, who are known to form a significant proportion of the patients being treated in the Department of Paediatric Urology at Red Cross Hospital.
- 2) To assess the results of the management of these children, with special attention to the goals of therapy, namely preservation of renal function, establishment of urinary continence and protection from urinary tract infection.
- 3) To compare the treatment methods and results obtained to those reported in the literature.
- 4) To evaluate critically the treatment methods and results obtained with a view to identifying areas where improvements are possible.

TERMS AND DEFINITIONS USED IN THIS REPORT

Neural Tube Defect:	A defect involving structures at any level of the entire central nervous system which results from an abnormality of fusion of the primitive neural tube. The most common conditions in this group are myelomeningocele and anencephaly.
Spinal Dysraphism:	A general term implying defective fusion of spinal structures that usually unite.
Spina Bifida Aperta:	A general term including the 'open' forms of spinal dysraphism (see classification, Table 1.1). Preferred to 'spina bifida cystica' which does not include the open leaking lesions and 'myelodysplasia' which implies a malformation of spinal cord structure whether it be the open, covered or occult form.
Myelomeningocele:	An open variety of spinal dysraphism in which both meninges and neural tissue are displaced from their usual position in the spinal canal.
Meningocele:	An open variety of spinal dysraphism in which only meningeal tissue is displaced from the spinal canal.
Lumbosacral Lipoma:	A variety of occult spinal dysraphism heralded by a subcutaneous lipoma overlying the lumbar or sacral spine, which may extend through a posterior spina bifida to an extradural or intradural location, to attach to the conus medullaris, cauda equina or filum terminale. It is thought to result from inclusion of adipose cells from overlying mesodermal tissues into

the neural tube or the caudal tube which is developing by canalization.

Occult Spinal

Dysraphism:

A group of diverse conditions of varying complexity in which neural tissue or covering membranes do not prolapse. The condition may be heralded by a hairy patch, lipoma, or sinus overlying the lesion. The disability involved varies from nil to severe, and may present later in life as a result of traction on neural structures. (see Table 1.1).

TABLE 1.1: CLASSIFICATION OF SPINAL DYSRAPHISM.**Spina Bifida Aperta**

Myeloschisis

* Myelomeningocele

Hemimyelomeningocele

Syringomyelomeningocele

* Spinal meningocele

Spina Bifida Occulta (Occult Spinal Dysraphism)

Spinal Dermal Sinus

Tethered Cord Syndrome

* Lumbosacral lipoma

Diastematomyelia

Neuroenteric Cyst

Combined anterior and posterior spina bifida

Anterior sacral meningocele

* Conditions which occur in group of patients under discussion.

NORMAL EMBRYOLOGY OF CENTRAL NERVOUS SYSTEM

The central nervous system of the human embryo appears after the beginning of the third week as the neural plate, an elongated structure in the mid-dorsal region consisting of thickened ectoderm. The lateral edges of this plate become elevated to form the neural folds. This elevation continues until the folds join in the midline of the fourth somite and simultaneously proceeds in both cephalic and caudal directions.

Embryology of the brain.

The cephalic end of the neural tube forms 3 distinct dilatations known as primary brain vesicles, namely prosencephalon or fore-brain, mesencephalon or mid-brain, and rhombencephalon or hind-brain. The neural tube simultaneously flexes in two places; the cervical flexure at the junction of hind-brain and spinal cord, and the cephalic flexure in the mid-brain region.

By the age of 5 weeks, five components of the primitive brain can be recognised. The prosencephalon consists now of an anterior telencephalon or end-brain, which includes the primitive cerebral hemispheres, and a posterior diencephalon. The mesencephalon undergoes little change but the rhombencephalon now consists of an anterior metencephalon (later to give rise to pons and cerebellum) and a posterior myelencephalon, destined to form the medulla oblongata.

The lumen of the spinal cord, the central canal, is continuous with that of the brain vesicles. The cavity of the rhombencephalon is known as the fourth ventricle, that of the diencephalon as the third ventricle and those of the cerebral hemispheres as the lateral ventricles. The third and fourth ventricles initially communicate via the wide lumen of the mesencephalon, which later narrows considerably to form the aqueduct of Sylvius. The lateral ventricles communicate with the third ventricle through the interventricular foramina of Munro.

Cerebro-spinal fluid is produced by the choroid plexus, which consists of richly vascular tufted invaginations of mesenchymal origin projecting into the third, fourth and lateral ventricles. When the embryo is about 4 months old, areas of the roof plate of the rhombencephalon bulge outward and eventually disappear leaving 2 lateral foramina of Luschka and a medial foramen of Magendie. These openings allow circulation of cerebrospinal fluid between the ventricular system within the brain and the surrounding subarachnoid space (French, 1982). Defects in this circulation form the basis of the hydrodynamic theory for the pathogenesis of neural tube disorders (see later).

Embryology of the spinal cord.

The neural tube which ultimately forms the spinal cord develops in three phases: neurulation from 18-28 days, canalisation of the tail bud occurring from 28-40 days, and regression in the caudal region from 41 days for the remainder of foetal life, with disproportionate growth of the bony elements.

Neurulation

The midline ectoderm cephalic to Hensens node (a collection of cells located at the cephalic end of the primitive streak) thickens to form the neural plate, which is the precursor of the central nervous system. By 18 days a central depression, the neural groove, appears along the neural plate. The plate margins heap up to form the neural folds. This process begins first in the middorsal region and proceeds both cranially and caudally. Simultaneous with this development, the paraxial mesoderm on each side of the notochord condenses into paired somites, of which 30 pairs have formed by day 28. Central cavities called myocoels develop in each, to create a hollow sphere of mesoderm. The dorsomedial portion of the sphere (the myotome) forms the skeletal muscle at that segmental level. The ventromedial portion is called the sclerotome and will condense around the notochord and future neural tube to form the vertebral body and posterior elements. The ventrolateral portion or dermatome forms the connective tissue and muscles of the body wall.

By 22 days the neural folds meet in the dorsal midline converting the neural plate into a hollow neural tube. This entire process is called neurulation. The superficial ectoderm attached to the lateral edge of the neural plate is pulled towards the midline and ultimately fuses dorsal to the neural tube. Later this ectoderm separates from the neural tube and mesoderm interposes itself between the two layers. The process of neurulation forms the spinal cord only down to the level of L.1 or L.2, corresponding to the twenty-fifth somite.

Canalisation of the Tail Bud.

Caudal to the area where neurulation has occurred, Hensen's node and the primitive streak form an undifferentiated caudal cell mass. Central vacuolization of the cell mass creates a tube of neural ectoderm which merges with the neural tube at the caudal limit of neurulation (L.1 or L.2). This process of canalisation occurs under intact surface ectoderm. It is a less precise process than neurulation and numerous morphological variations of structures derived from the caudal cell mass can be encountered in otherwise normal embryos.

Regression and disproportionate growth.

Until nine weeks of development, vertebral column and spinal cord development occurs side by side, and spinal roots exit via intervertebral foramina directly opposite their point of origin. Thereafter, 2 processes account for the relative ascent of the neural tube within the vertebral column and the associated development of the cauda equina and the filum terminale. The first process is the regression or dedifferentiation of that part of the neural tube formed by canalisation, which undergoes cellular necrosis between 40 and 48 days to form the future filum terminale. The central canal just above the area of necrosis dilates to form the ventriculus terminale, which marks the caudal limit of the conus medullaris and the beginning of the filum terminale. The second process is the mechanical effect of disproportionate growth of the vertebral column and the neural tube. This results in a relative cranial movement of the more caudal parts of the neural tube within the more rapidly elongating vertebral column. The lumbosacral spinal nerves have attached to the cord by this time and thus lengthen to form the cauda equina. The conus medullaris ascends from the first to third coccygeal segment at nine

weeks to the adult level of the first or second lumbar vertebra by 2 months postnatal development. (French 1982).

THEORIES FOR THE DEVELOPMENT OF SPINA BIFIDA APERTA LESIONS

A detailed description of the mechanisms which give rise to this group of conditions is beyond the scope of this dissertation. The following are the most common hypotheses which have been advanced in an attempt to explain the formation of these lesions:

1. Developmental arrest.

This theory postulates that the lesion is caused by failure of the embryonic neural plate to close normally with secondary changes in surrounding tissues. (Warkany, 1977).

2. Overgrowth hypothesis.

This hypothesis suggests that the neural tube fails to close in early foetal development as a result of overgrowth of neural tissue, which causes eversion of the neural folds and prevents fusion of the neural tube dorsally. (Patten, 1952).

3. The Hydrodynamic theory.

This theory holds that excessive fluid in the central canal of the spinal cord, or hydromyelia, could lead to cystic dilatation of the cord with protrusion through the posterior bony and soft tissue elements, or disruption at various other sites in the central nervous system. This theory can be used to explain all dysraphic states on a mechanical basis. (Gardner, 1973).

4. Neuroschisis theory.

This theory postulates a reopening of the closed neural tube. No reason for this reopening has been described, but it permits the escape of proteinaceous fluid within the neural tube into the surrounding mesoderm giving rise to the so-called neuroschistic bleb. This bleb could rupture and expose the neural tissue to amniotic fluid. The edges of the ruptured bleb may become applied to the everted edge of the open neural tube, giving rise to secondary cutaneous neural ectodermal continuity. (Padget, 1970).

AETIOLOGICAL FACTORS IN THE DEVELOPMENT OF NEURAL TUBE DEFECTS

A number of factors have been associated with increased incidence of neural tube defects, although the exact effect of each remains unclear:

1. Socio-economic status.

Lower socio-economic groups have a higher incidence of myelomeningocele. This is possibly linked to dietary intake or deficiency (Alter 1962, Haddow & Macri 1979) of which a folic acid deficiency has been most strongly proposed (Laurence 1982, Smithells 1980). Potato blight has been implicated as a factor which contributes to the formation of the condition in an undefined way (Renwick 1972).

2. Genetic influence.

Certain epidemiological observations support the existence of genetic influences in the aetiology of neural tube defects. A male to female ratio of 1:1.2 has been observed (Carter 1974). Siblings of affected children have a 3 to 6 percent chance of being affected, which is 7 to 15 times higher than the general population (Carter 1974). Studies assessing the children of parents with spina bifida still involve small numbers, but the early trend suggests a 3 to 4 percent incidence of spina bifida or anencephaly, similar to the sibling incidence (Carter 1973). The first born child is at a higher risk in a particular family and the risk then falls for the second and third pregnancies and rises again for subsequent pregnancies. A U-shaped incidence is also seen when maternal age is considered with the risk being higher in young or older mothers (under 20 and over 35 years respectively) than it is in a woman of 20-35 years (Carter 1974). Ethnic differences have also been widely reported with a lower incidence in the Negroid races (Cornell 1982, Carter 1974, Alter 1962).

3. Geographical factors.

Globally the British Isles carries the highest incidence while Columbia has the lowest (Kroovand, 1986). Regional differences within a country have also been identified (Richards 1972). The influence of geography is difficult to separate from ethnic and

other factors, but evidence is present to support a geographical influence separate from ethnicity. Thus Irish couples born in Boston have relatively higher rates compared to the general population in Boston, but lower rates than first generation immigrants from Ireland (Naggan 1967).

4. Seasonal factors.

A higher incidence in children born between December and May than those born between June and November has been noted in the Northern hemisphere (Guthkelch 1962). This trend is reversed in the Southern hemisphere (Carter 1974).

CHAPTER 2

MATERIALS AND METHODS

- 2.1 Patient Population.
- 2.2 Initial assessment of patients at the Spinal Defects Clinic.
- 2.3 Urological management based on initial assessment.
- 2.4 Treatment directed towards the achievement of urinary continence.
- 2.5 Management of resistant incontinence.

2.1. PATIENT POPULATION

The patients included in this study are all regular attenders at the Spinal Defects Clinic which is held weekly at the Red Cross Children's Hospital, Cape Town. This clinic was created to provide coordinated multidisciplinary care for children with problems relating to any form of congenital or acquired spinal pathology and the sequelae thereof. The services available include Neurosurgery, Orthopaedic Surgery, Developmental Paediatrics, Physiotherapy and Stomatherapy in addition to the Urological management which is the subject of this report.

In an effort to eliminate variables, only children with congenital anomalies of the spine resulting from defects of fusion (spinal dysraphism) were accepted for analysis. These conditions included meningocele, lipomeningocele, myelomeningocele and lumbo-sacral lipomas. Children with other congenital spinal anomalies, or acquired infective or traumatic spinal lesions were excluded.

Only children who had been attending long enough to have had at least two separate radiological assessments of the urinary tract were considered. In practice this involved a minimum follow-up period of six months.

The information gathered from each patient's notes for the purposes of this study included the following:

- a) The name, age, race and sex, domicile, date of birth, date of presentation and date of assessment.
- b) The nature of the congenital spinal lesion, and the level of the spine at which it occurred.
- c) The status of the urinary tract at initial presentation, on radiological assessment.
- d) The initial management undertaken.
- e) Whether or not treatment directed at achieving urinary continence had been commenced, and if so, the nature of this treatment.
- f) The status of the urinary tract at the time of assessment.
- g) The urinary continence status of each patient.
- h) The number of documented urinary tract infections suffered by each patient. The causative organisms and antibiotic sensitivity profile were recorded for the most recent infection in each case. A urine culture was interpreted as positive only if it yielded both the presence of leucocytes and a pure growth with a colony count of $>100,000$ organisms per ml. It was not possible to distinguish between symptomatic and asymptomatic infections. In each case, the number of documented urinary tract infections was divided by the follow up period in years. This was done in an effort to remove the bias produced by the large differences present in the follow up times of individual patients, which ranged from 6 months to 15 years. Thus a patient who had been followed up for one year during which 3 urinary tract infections had been documented, would be assumed to have a similar predisposition to infection as a patient with 9 documented infections, who had been observed for 3 years.

Patients were only included in the study if all of the above information was available.

2.2 INITIAL ASSESSMENT OF PATIENTS AT THE SPINAL DEFECTS CLINIC

The following is a description of the established procedure in the urological section of the Spinal Defects Clinic. By present day standards some of the methods used would probably be considered somewhat outmoded and this will be discussed further during the conclusions of this

dissertation. Patients are first referred to the Spinal Defects Clinic for assessment by all disciplines once the lesion has been closed. In the urology section of the clinic a detailed history is taken, a physical examination is performed and radiographic investigations are arranged. The history has more relevance if the patient presents at an older age, and details of urinary continence and voiding patterns can be obtained. The history in very young infants is usually not helpful, although a specific history of unexplained fevers, longest dry interval, voiding pattern and urinary stream is always sought. Examination in the younger infant is aimed at detecting unsuspected pathology as well as the presence of retention of urine heralded by a persistently palpable bladder. An assessment of the neurological status is also made with particular attention to the sacral innervation which may give some clue as to the prognosis of urinary continence later. The radiological assessment performed at this stage consists of ultrasound examination of the upper urinary tracts as well as a micturating cysto-urethrogram (MCUG). In the past an intravenous pyelogram (IVP) was often performed as a first line investigation, before the use of ultrasound became commonplace. This evaluation is of great importance, as based on the results of these radiological investigations and the clinical examination, each patient is classified into one of three groups which influences further management and frequency of repeated radiographic investigations. The three groups are:

(a) Favourable urinary tract.

In this group of patients the ultrasound or pyelogram shows undilated upper urinary tracts. The cystogram reveals a smooth walled bladder without evidence of trabeculation, with an open bladder neck and no suggestion of infravesical obstruction. (Figure 2.1)

(b) Mild neuropathic changes.

Radiographic changes in this group include mild bladder trabeculation or mild vesico-ureteric reflux (grade I or II). The upper urinary tracts should be undilated before a patient is included in this group. Coexistence of reflux and trabeculation would result in the patient being included in the severe neuropathic changes group. (Figure 2.2)

(c) **Severe neuropathic changes.**

In this group of patients any combination of the following changes is present: Severe vesico-ureteric reflux. (Grade III or more), severe trabeculation with sacculation and bladder diverticula, persistence of a palpable bladder indicating chronic retention of urine, or mild changes combined with a documented increased predisposition to urinary tract infections. (Figure 2.3)

2.3 UROLOGICAL MANAGEMENT BASED ON INITIAL ASSESSMENT

Once the initial assessment has been performed, further management is undertaken depending on the status of the urinary tract. This management is aimed at preservation of urinary tract integrity, as this is the goal of urological treatment in the early years of life of children with myelomeningocele, which is achieved by decompressing the urinary tract where necessary and avoiding or treating infection. The other goal of treatment, namely achievement of urinary continence, only becomes a priority when the child reaches the age of five years. Although the patients are classified into groups as mentioned above, an individual approach is maintained to assess the merits of each case in turn.

Initial management of patients with favourable urinary tracts.

These patients are deemed to be at little risk of deterioration on a neuropathic basis, and the most common treatment employed in this group consists initially of six-monthly ultrasound of the upper tracts, which is changed to annual ultrasound once the child has reached the age of three or four years and the urinary tract has remained stable since presentation. Serial checks for urinary tract infections are also made. Any change in the urinary tract status or an increased predisposition to urinary tract infection would result in the child being reclassified into another group and more invasive management being instituted.

Initial management of children with mild neuropathic changes.

This group was created to ensure increased vigilance in those children who were deemed to be at risk of severe changes without actually having these changes manifest. The relevant X-rays

are repeated 3 or 6 months after the initial evaluation. If the urinary tract status has deteriorated since the original studies, the patient is reclassified into the severe neuropathic changes group and managed accordingly. If the status is unchanged, the policy of increased vigilance is pursued further. When treatment is deemed necessary in these patients, the most common form it takes is prophylactic antibiotic therapy to prevent urinary tract infection, eg in the presence of mild vesico-ureteric reflux. However, the most important aspect of the treatment of these patients is more frequent radiological investigations to detect changes at an early stage and institute treatment to prevent deterioration of the urinary tract.

Initial management of patients with severe neuropathic changes.

These patients are deemed to be at great risk of permanent renal damage if left untreated, and the most common form of treatment in these cases is a vesicostomy. This manoeuvre is a minor surgical procedure in which the bladder is opened at the dome and the edges sutured to an infraumbilical skin incision, creating a vesico-cutaneous fistula. It has been shown to be an effective means of decompressing the urinary tract and allowing unhindered growth of the kidneys to take place. The vesicostomy is left open until the age of approximately five years when the question of urinary continence becomes a priority. The Blocksom procedure is used at our institution.

2.4 TREATMENT DIRECTED AT ACHIEVING URINARY CONTINENCE

When the child reaches the age when continence becomes a priority, the upper tracts and bladder are reassessed before a graded approach is adopted to the problem of incontinence. If the urinary tract is favourable, timed voiding is introduced; the child keeps a chart of 3 hourly voided volumes, and whether he or she was wet or dry. If this fails to give adequate control and the bladder was of a reasonable volume with significant post-micturition residual volume on MCUG, intermittent clean catheterisation (ICC) is introduced. The stomatherapy staff of the Spinal Defects Clinic provide instruction in the technique to the family or institutional staff member responsible for the child. Where possible, the child participates in this exercise as well.

Persistent wetness would invite the addition of anticholinergic and/or alpha-adrenergic drugs in an attempt to render the patient dry. The compounds used are oxybutinin chloride, propantheline bromide, imipramine hydrochloride, and an alpha-adrenergic combination consisting of isopropamide iodide, phenylpropanolamine hydrochloride and diphenylpyraline hydrochloride (Eskornade). Dosages and combinations of these drugs are adjusted according to response in terms of improved continence control and the appearance of side-effects. Patients with small volume bladders would initially be treated with anticholinergics in an attempt to increase capacity before ICC is added, if necessary. These manoeuvres are all attempted on an outpatient basis.

2.5 MANAGEMENT OF RESISTANT INCONTINENCE

Failure of the combination of ICC and drugs to achieve continence results in admission to hospital where, initially, these measures are continued. If successful, this would identify poor compliance as the reason for failed treatment, and efforts would be made to improve communication and co-operation in the family unit.

Once urinary tract infection has been excluded or treated, a urodynamic assessment is carried out to define the cause of the resistance to treatment. This is done using a DISA 2100 URO-System apparatus which provides bladder, rectal and subtracted detrusor pressures using liquid cystometry. Urinary flow rates can be measured with a DISA 21C10 Mictrometer. Electromyography, urethral pressure profilometry, gas cystometry and video urodynamics are not available. Three conditions can be separated by this investigation, namely detrusor hyperreflexia, poor bladder compliance and, by inference, poor outflow resistance. The last diagnosis is made in the presence of a normal cystometry result recorded in a patient with documented incontinence resistant to inpatient treatment. The first two conditions have characteristic pressure/volume traces on cystometry. The unavailability of the investigations listed above prevents more refined analysis as well as detection of the co-existence of either detrusor hyperreflexia or poor compliance with poor outflow resistance.

The results of this urodynamic evaluation are considered together with recent radiological re-evaluation and an assessment of the patient's social, educational and family status before a decision is made concerning the most appropriate further management.

Treatment of patients with detrusor hyperreflexia or poor bladder compliance.

If the child is found to have detrusor hyperreflexia resistant to drugs, or poor bladder compliance resulting in inadequate bladder volume, an augmentation enterocystoplasty is planned. The precise procedure performed depends on whether or not ureteric reimplantation is required. Patients with vesico-ureteric reflux or who require reimplantation for any reason have a segment of sigmoid colon which has been isolated on a vascular pedicle and opened along the antimesenteric border anastomosed to the widely opened bladder, so that the ureters can be reimplanted into the taeniae of the bowel segment. In those patients who do not require reimplantation, an isolated segment of terminal ileum is used as this is technically an easier operation. In some earlier cases, the Mainz pouch procedure was used. This operation involves the use of a segment of terminal ileum in continuity with part of the ascending colon, which is opened along the antimesenteric border and then resutured to form a large pouch. The ureters are reimplanted into the taeniae of the ascending colon. This operation is no longer used as the capacity of the pouch obtained is much larger than required, and more importantly, there is reason to believe that removal of the ileo-caecal segment in children with neuropathic bowels renders control of faecal incontinence more difficult.

Treatment of children with resistant incontinence due to low urethral resistance.

When urodynamic studies suggest that poor outflow resistance is the cause of urinary incontinence, the child may undergo artificial sphincter implantation. The American Medical Systems 800 model has been used at Red Cross Hospital. As this device requires diligent supervision, a careful assessment of the child, his or her family and the social and educational status must be made before proceeding with this operation. If the artificial sphincter is deemed unsuitable for any reason, the other options available are insertion of a fascial sling around the bladder neck or injection of Teflon paste into the periurethral area or tissues surrounding the bladder neck.

Both these manoeuvres are aimed at creating increased outflow resistance in the hope that, combined with intermittent catheterisation and drugs, continence will be achieved.

Permanent urinary diversion in urinary incontinence.

The present policy regarding permanent urinary diversion in children with incontinence of urine due to neuropathic bladder is that the procedure should be used only as a last resort when all other attempts at rendering the child continent have failed. When the operation is performed, either an ileal conduit or colonic conduit is used.

Although an attempt has been made to describe most of the possible clinical options in the treatment of these patients, it is not possible to mention every manoeuvre undertaken as each patient has individual factors and circumstances which must be taken into consideration.

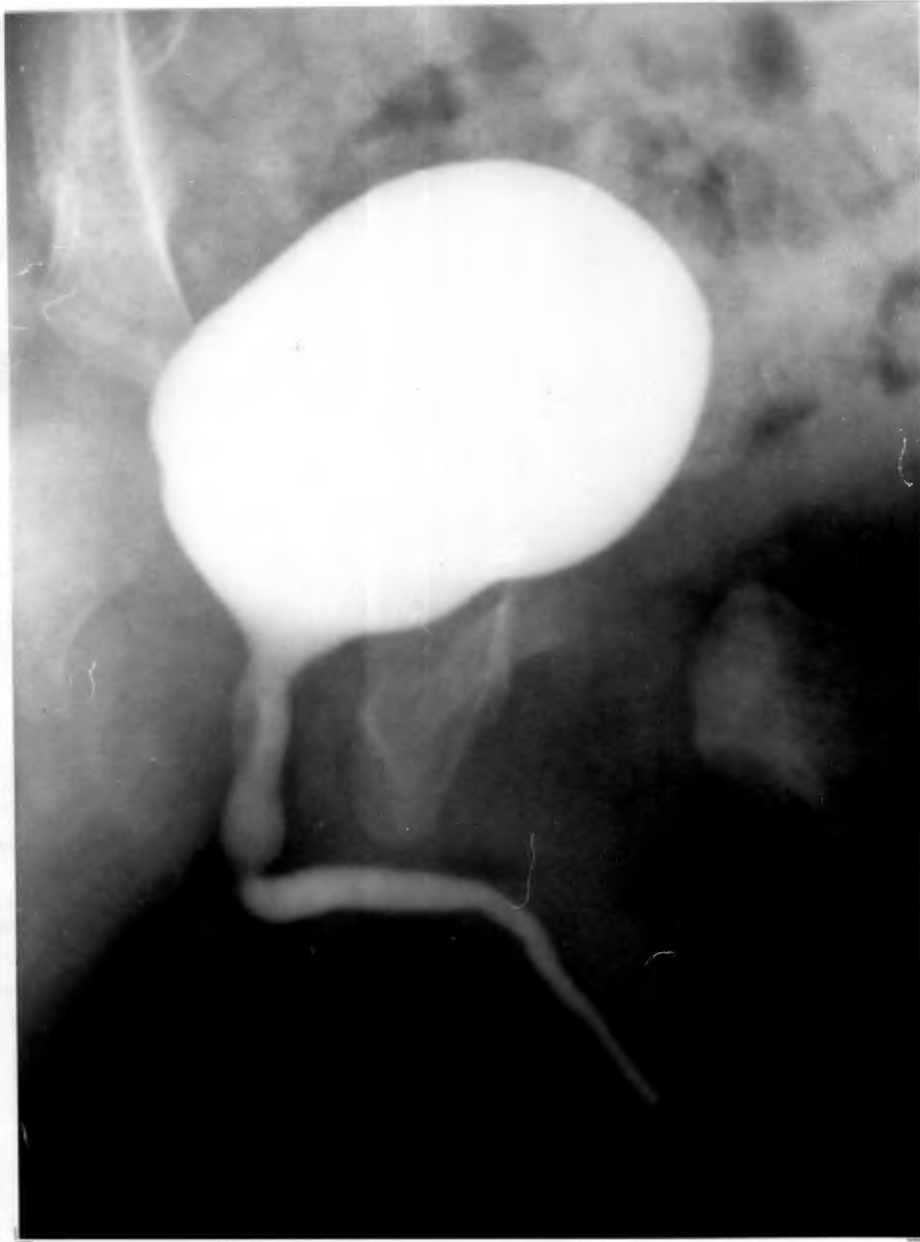


Figure 2.1 Cystogram of a child with favourable features: note smooth bladder wall and absence of vesico-ureteric reflux. The bladder neck is open and the posterior urethra is patent but not dilated. Ultrasound of this patient showed undilated upper tracts.



Figure 2.2 Mild neuropathic changes: This cystogram features a mildly trabeculated bladder and bladder neck not seen to be open. No vesico-ureteric reflux is present and the upper tracts were undilated on ultrasound



Figure 2.3 Severe neuropathic changes. This cystogram features a severely trabeculated, sacculated bladder with gross vesico-ureteric reflux, worse on the left. The bladder neck is not seen to be open.

CHAPTER 3

RESULTS

These will be discussed under the following headings:

- 3.1 Patient Population.
- 3.2 Results of initial assessment.
- 3.3 Urological management based on initial assessment.
- 3.4 Results of initial treatment.
- 3.5 Results of continence treatment, including resistant incontinence.
- 3.6 Incidence of urinary tract infections.
- 3.7 Relationship between urinary tract status and continence.
- 3.8 Relationship between urinary tract infection and urinary tract status.
- 3.9 Relationship between urinary tract infection and method of treatment.
- 3.10 Relationship between urinary tract infection and continence status.

3.1 PATIENT POPULATION

One hundred and sixty-eight patients were included in the study. There were 90 males and 78 females. One hundred children were coloured, 45 were white and 23 black. Figure 3.1 illustrates these divisions in detail.

The average age at presentation was 14 months, and the range was 3 weeks to 14 years. Figure 3.2 provides a detailed representation. The follow-up period averaged 6.5 years and ranged between 6 months and 15 years. (See Figure 3.3).

Although most of the children were domiciled in the greater Cape Town area, these cases are referred to Red Cross Hospital from the whole of the Cape Province (Fig 3.4).

The most frequent lesions encountered were lumbar (66 patients) or lumbosacral myelomeningocoeles (61 patients). Sacral (15 patients) and thoraco-lumbar myelomeningocoeles

(9) and lumbo-sacral lipomas (10 patients) formed the other large groups. Three patients had thoracic myelomeningocele. Those patients in the "Other" category included two with sacral meningoceles, one with a lumbar meningocele, and one with a lumbo-sacral lipomeningocele. Figure 3.5 details precise numbers and levels of pathology.

3.2 RESULTS OF INITIAL ASSESSMENT

Eighty seven patients had features of a favourable urinary tract at initial assessment. Forty three patients had mild neuropathic changes, and 38 patients had urinary tracts with severe neuropathic changes.

3.3 UROLOGICAL MANAGEMENT BASED ON INITIAL ASSESSMENT

Initial management of patients with favourable urinary tracts.

Of the 87 children with favourable urinary tracts at presentation, 85 underwent only regular radiological reassessment with no further intervention. One patient underwent a sigmoid conduit urinary diversion for incontinence in 1976 in spite of his favourable urinary tract status. The other patient underwent a left heminephroureterectomy for a ureterocoele draining a dysplastic upper renal moiety.

Children with mild neuropathic changes.

Twenty-nine of the 43 patients in this group had no active intervention, and 11 were placed on prophylactic antibiotics. One patient underwent vesicostomy for bladder trabeculation in the presence of concern about compliance regarding follow-up visits. A second was subjected to Otis urethrotomy for mild bilateral vesico-ureteric reflux and a third had bilateral ureteric reimplantations for mild reflux, performed in 1978.

Patients with severe neuropathic changes.

Of the 38 patients in this group, 22 had vesicostomies performed, and 2 had no treatment as a result of poor initial compliance. One patient accepted prophylactic antibiotic therapy only and 13 underwent a variety of other manoeuvres including: ureteric reimplants in 9 patients, end cutaneous ureterostomies in 2 patients and transureteroureterostomy with cutaneous ureterostomy in 2 patients. This group was treated before intermittent catheterisation had become widely accepted in the management of neuropathic bladder.

3.4 RESULTS OF INITIAL TREATMENT

The overall results of this treatment are illustrated in figure 3.6.

The following is a more detailed analysis: Of the 87 patients with favourable urinary tracts at presentation, 73 maintained this status at follow-up, 11 patients showed mild neuropathic changes, 2 had evidence of renal scarring and one had severe neuropathic changes. Twenty one of the 43 patients with mild neuropathic changes originally had favourable urinary tracts at follow-up, 17 had persistent mild neuropathic changes, 1 had renal scarring and 4 had severe changes. Thirty eight patients initially had severe neuropathic changes. Twenty of these had favourable urinary tracts on follow-up, 5 had mild neuropathic changes, 7 had evidence of renal scarring and 6 had persistent severe neuropathic changes. These results are summarised in table 3.1:

Present Status	Original Status		
	Favourable	Mild Changes	Severe Changes
Favourable	73	21	20
Mild changes	11	17	5
Scarring	2	1	7
Severe Changes	1	4	6

Table 3.1: Change in status of urinary tract between original presentation and most recent assessment.

3.5 RESULTS OF CONTINENCE TREATMENT.

One hundred and sixteen patients have begun the programme directed at establishing urinary continence. Of these, 13 have undergone permanent urinary diversion. As this procedure confers controlled incontinence rather than continence, these patients are not considered further under this heading. The results of the remaining 103 patients are as follows:

Patients treated with timed voiding only.

Twenty-four patients comprise this group. At the time of assessment, 18 were dry for 3 hours or more. Three were dry for 1-3 hours and 3 remained wet and will undergo further treatment to improve continence.

Patients on intermittent catheterisation alone.

Thirteen of the twenty patients in this group were dry for three hours or more. Six patients were dry for 1-3 hours and 1 patient was still wet.

Patients treated on drugs alone.

Two patients were receiving drugs only at the time of assessment: oxybutinin hydrochloride alone in one case and oxybutinin hydrochloride and imipramine in the second. Both are dry for 3 hours or more.

Patients treated with intermittent catheterisation and drugs.

In this group of 49 patients, 28 were dry for 3 hours or more, 15 were dry for 1-3 hours and 6 were still wet.

Patients with resistant incontinence.

Eight patients who remained incontinent after being subjected to the graded regimen of timed voiding, intermittent catheterization, and anticholinergic or alpha-adrenergic drugs have received further treatment. Six have undergone insertion of AMS 800 artificial urinary sphincters and two had augmentation cystoplasty performed. Three of the patients with sphincters are dry for 3

hours or more. Two have had the sphincter removed - both for erosion of the device through the skin with subsequent intractable infection. One of these children has since undergone urinary diversion. A third child with an artificial sphincter has severe deterioration of the upper urinary tracts and will probably require urinary diversion.

Of the 2 children who have had augmentation cystoplasty, one is dry for over three hours. The other remains wet despite adequate bladder capacity with low pressures and is at present undergoing treatment to increase outflow resistance.

3.6 THE INCIDENCE OF URINARY TRACT INFECTIONS.

One hundred and twenty two of the 168 patients have suffered at least one documented urinary tract infection. The pathogens responsible for the most recent infection in each case are detailed in figure 3.7. A single organism was present in 113 cases, and two species were cultured 9 times. *Escherichia Coli* (73 cultures) and *Proteus* species (27 cultures) were the most common pathogens. Other species included *Klebsiella* (18 cultures), *Pseudomonas* (4) and *Streptococcus faecalis* (2 cultures).

The antibiotic sensitivity of the most recent infection is illustrated in Table 3.2. A wide range of sensitivity was found to the oral preparations, from 24% for Amoxycillin to 80% for Nalidixic acid, while the parenteral preparations were much more reliably effective, with over 90% of organisms being sensitive to each preparation.

Table 3.2

Antibiotic-Oral	Percent organisms sensitive
Amoxicillin	24
Cotrimoxazole	45
Nitrofurantoin	75
Nalidixic Acid	80
Parenteral	
Gentamicin	92
Tobramycin	93
Ceftriaxone	95
Amikacin	98

Table 3.2: Sensitivity to antibiotics of organisms cultured in most recent infection of 122 patients.

3.7 THE RELATIONSHIP BETWEEN URINARY TRACT STATUS AND CONTINENCE

Table 3.3 illustrates the continence status of patients in each of the three groups with favourable, mild neuropathic changes and severe neuropathic changes at initial presentation and at most recent reassessment. Of the 64 patients with favourable urinary tracts at presentation who have already been treated for incontinence, 43 are dry for 3 hours or more, 12 are dry for 1-3 hours and 6 are still wet. Three have undergone permanent diversion. Of the 75 patients whose urinary tracts were favourable at follow-up, 48 were dry for >3hours, 16 were dry for 1-3 hours and 6 were still wet. Five patients had undergone urinary diversion. In the mild changes at presentation group, of the 30 patients already treated, 15 were dry for >3 hours, 7 were dry for 1-3 hours, and 4 were still wet, while 4 had been diverted. At present, 12 of the 23 patients with mild changes are dry, 7 are dry for 1-3 hours, and 3 are still wet, while 1 has

undergone diversion. Of the 21 patients with severe neuropathic changes at presentation who have already been treated, 7 are dry for >3 hours, 6 for 1-3 hours, and 2 are still wet. Six have been diverted. Ten patients had severe changes at follow up, of whom 4 were dry for >3 hours, 2 for 1-3 hours and 3 were still wet. One patient had been diverted. No patients had scarring at presentation, but of the 7 patients with scarring at follow up, 6 had been diverted and one was dry for >3 hours.

3.8 THE RELATIONSHIP BETWEEN URINARY TRACT INFECTION AND URINARY TRACT STATUS

Sixty two of the 87 patients with favourable urinary tracts at initial presentation had contracted at least one documented urinary tract infection, at an average rate of 0.71 infections per year(I/Y). This contrasted to 25 of the 43 patients with mild neuropathic changes at presentation (average rate 0.99 I/Y), and 35 of the 38 patients with severe neuropathic changes at presentation, who had an average infection frequency of 1.01 I/Y. (Figure 3.8a).

Of the 114 patients whose urinary tracts were favourable at the most recent reassessment, 79 had had documented infections, at an average rate of 0.81 I/Y, as had 25 of 33 patients with mild neuropathic changes (average rate 0.95 I/Y). Nine of the 10 patients with scarring had at least one documented infection, at a frequency of 0.63 I/Y), as had 9 of 11 children with severe neuropathic changes, at an average frequency of 1.17 I/Y. (Fig 3.8b).

TABLE 3.3

Urinary Tract Status	Continence Status			
	>3 Hrs	1-3 hrs	Wet	Diverted
Favourable				
Initially	43	12	6	3
Present	48	16	6	5
Mild Changes				
Initially	15	7	4	4
Present	12	7	3	1
Severe Changes				
Initially	7	6	2	6
Present	4	2	3	1
Scarring	1	0	0	6

TABLE 3.3: Relationship between urinary tract status initially and at present, and urinary continence.

3.9 THE RELATIONSHIP BETWEEN URINARY TRACT INFECTION AND METHOD OF TREATMENT

The incidence of infections in the various treatment groups was as follows: 9 of 25 patients who were treated with timed voiding alone had experienced infections during their period of follow-up, at an average rate of 0.52 I/Y. This contrasted with 16 of 20 and 42 of 49 for patients being treated with CIC alone and CIC with drugs (1.4 and .84 I/Y respectively), while both patients being treated with drugs alone had suffered infections, at a frequency of 0.32 I/Y. All 13 patients with permanent diversions had suffered infections, at an average rate of 0.48

I/Y. The untreated patients numbered 52, of whom 32 had a history of infections, at an average rate of 0.95 I/Y. (see Figure 3.9).

3.10 THE RELATIONSHIP BETWEEN URINARY TRACT INFECTION AND CONTINENCE STATUS

Of the children who have already been treated for incontinence, 47 of the 65 who are dry for 3 hours or more had a minimum of one infection at an average rate of 1.0 I/Y, as did 19 of the 25 patients dry for 1 to 3 hours. (0.78 I/Y), while 10 of the 12 patients still incontinent despite treatment had suffered at least one infection, at an average frequency of 0.50 I/Y. As mentioned earlier, all of the patients who have been permanently diverted have had an infection (14/14, average rate 0.49 I/Y) (Fig 3.10).

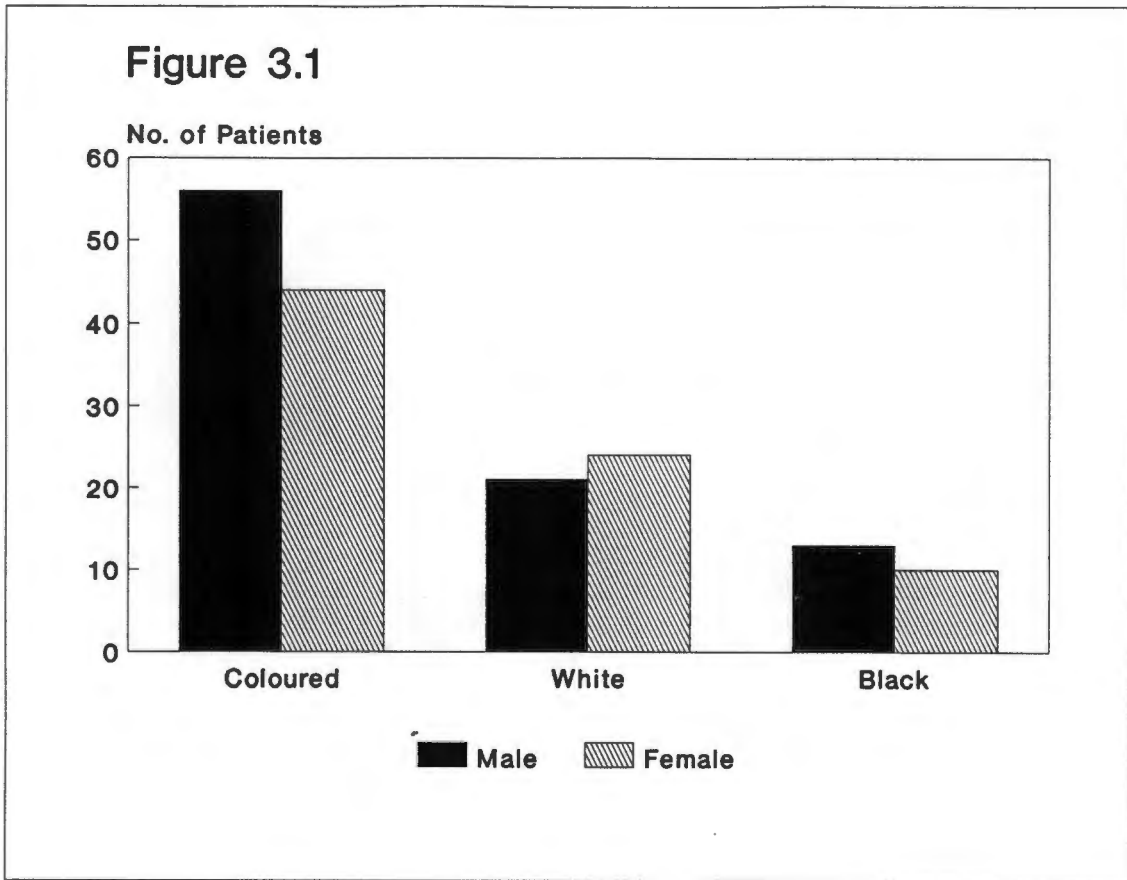


Figure 3.1 Race and sex distribution of 168 patients assessed.

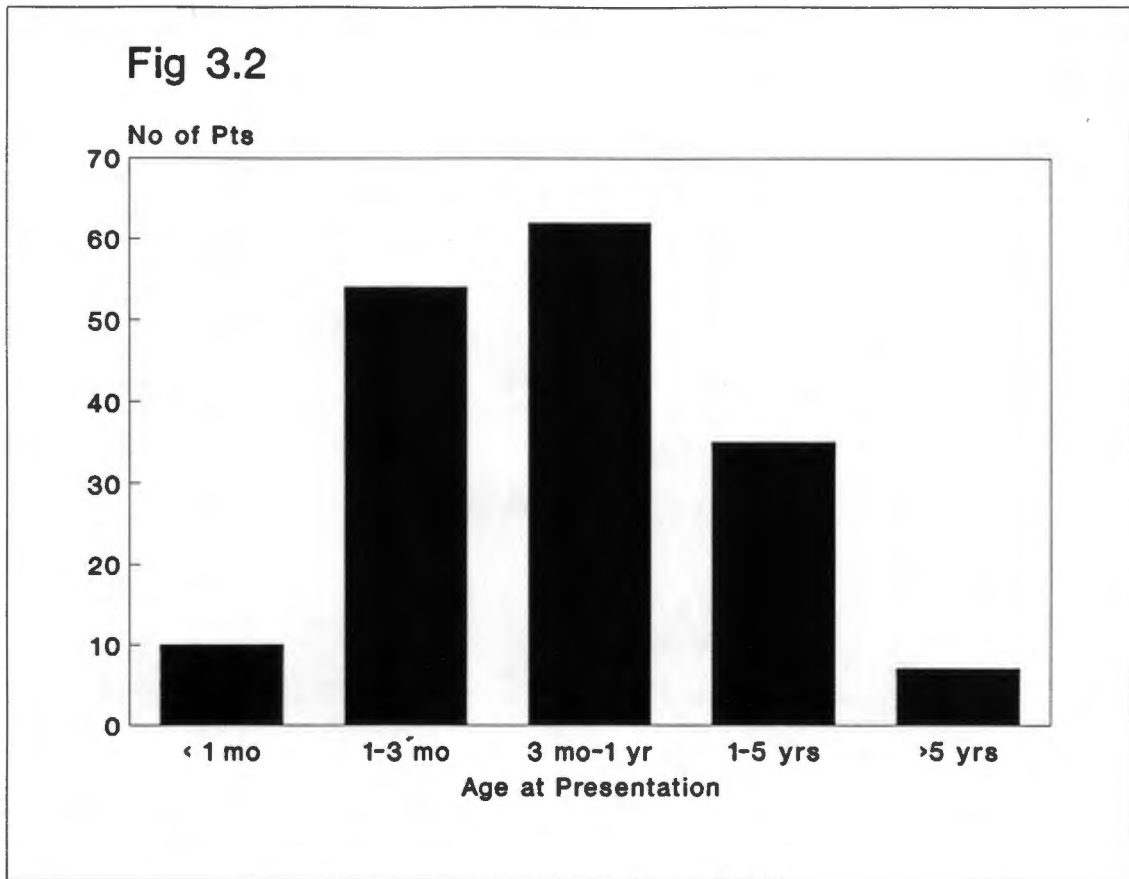


Figure 3.2 Age distribution of patients at first presentation. mo = month.

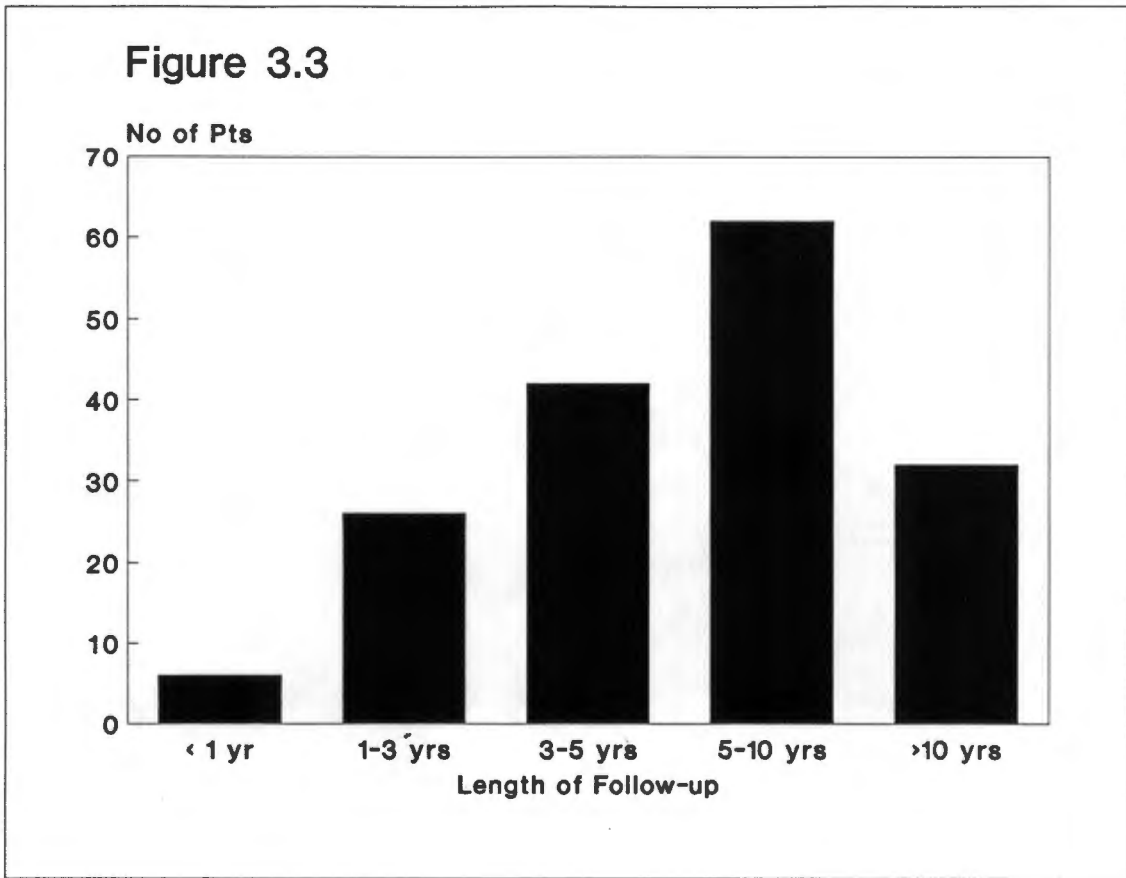


Figure 3.3 Length of follow-up in 168 patients assessed.

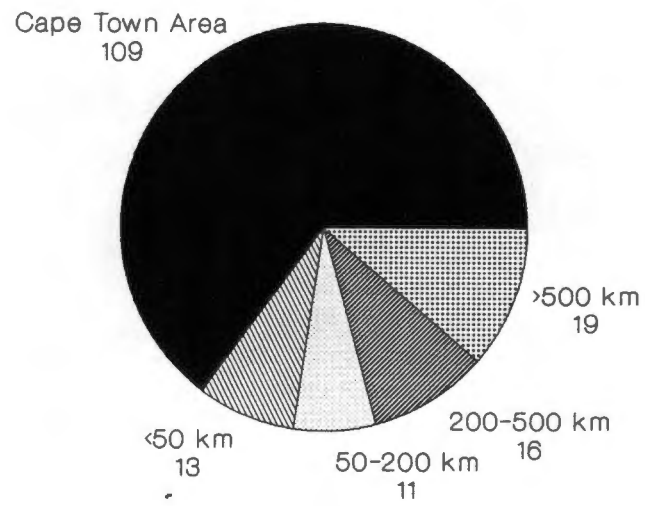
Figure 3.4**Figure 3.4** Domicile of patients assessed, in terms of distance from Cape Town.

Figure 3.5

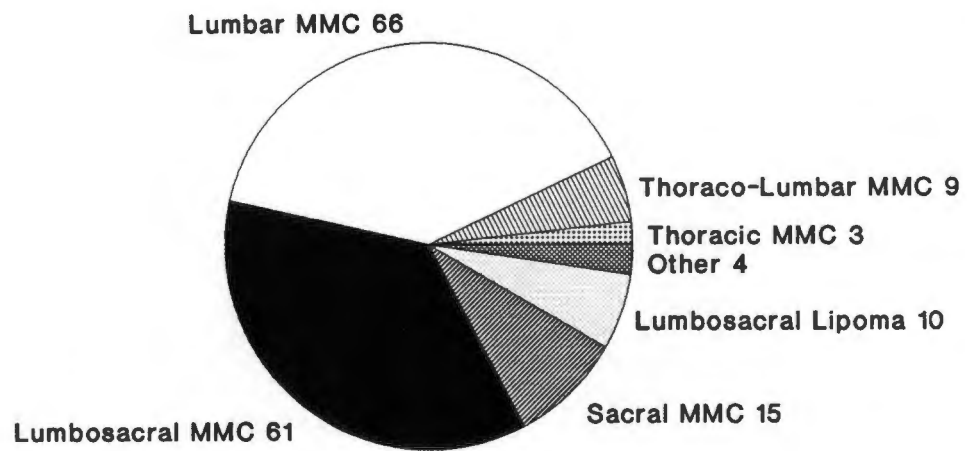


Figure 3.5 Level and nature of spinal lesion in patients included in the study. MMC = Myelomeningocele.

Figure 3.6

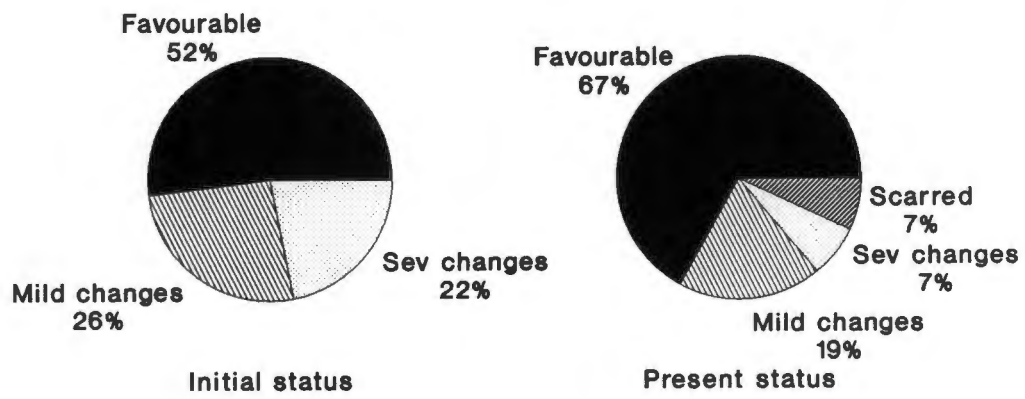


Figure 3.6 Status of urinary tract of 168 patients at initial assessment (left pie), and at most recent reassessment (right pie). Sev changes = Severe changes.

Figure 3.7

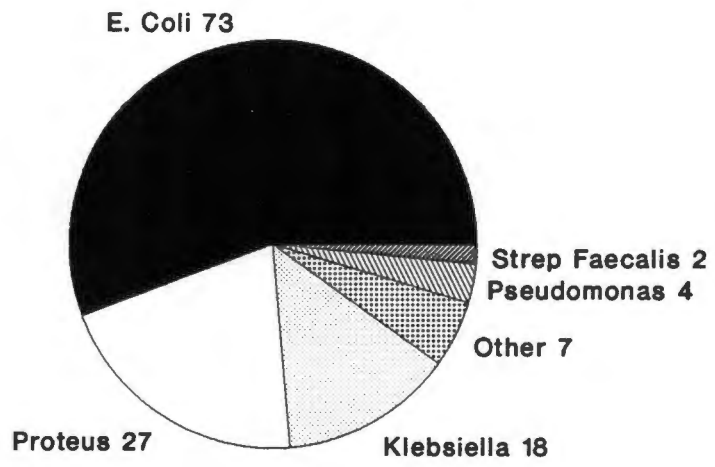


Figure 3.7 Organisms cultured in most recent urinary tract infection of 122 patients who had infections documented. 9 cultures yielded 2 organisms.

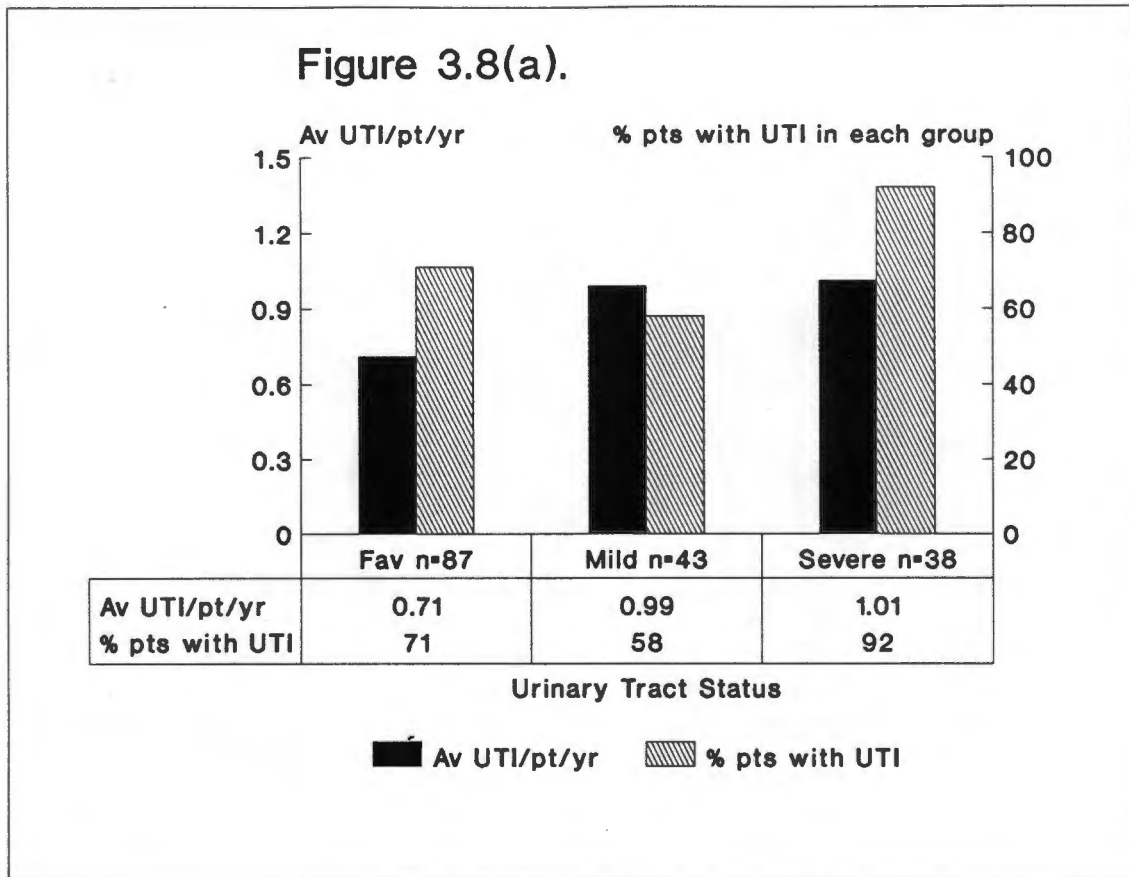


Figure 3.8(a) Incidence of urinary tract infections per patient per year (av UTI/pt/yr) and percentage of patients in each group in whom at least one infection has been documented, according to urinary tract status at initial presentation.

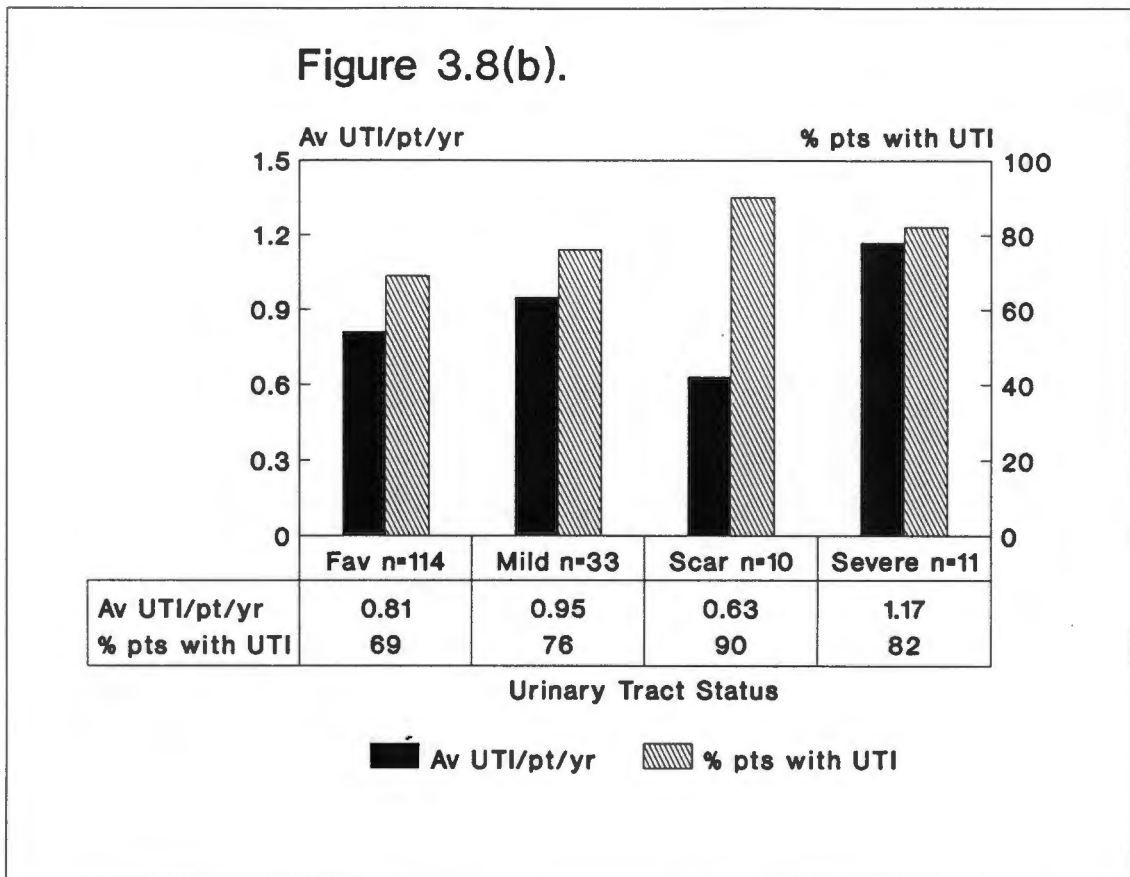


Figure 3.8(b) Incidence of urinary tract infections per patient per year (av UTI/pt/yr) and percentage of patients in each group in whom at least one infection has been documented, according to urinary tract status at most recent reassessment.

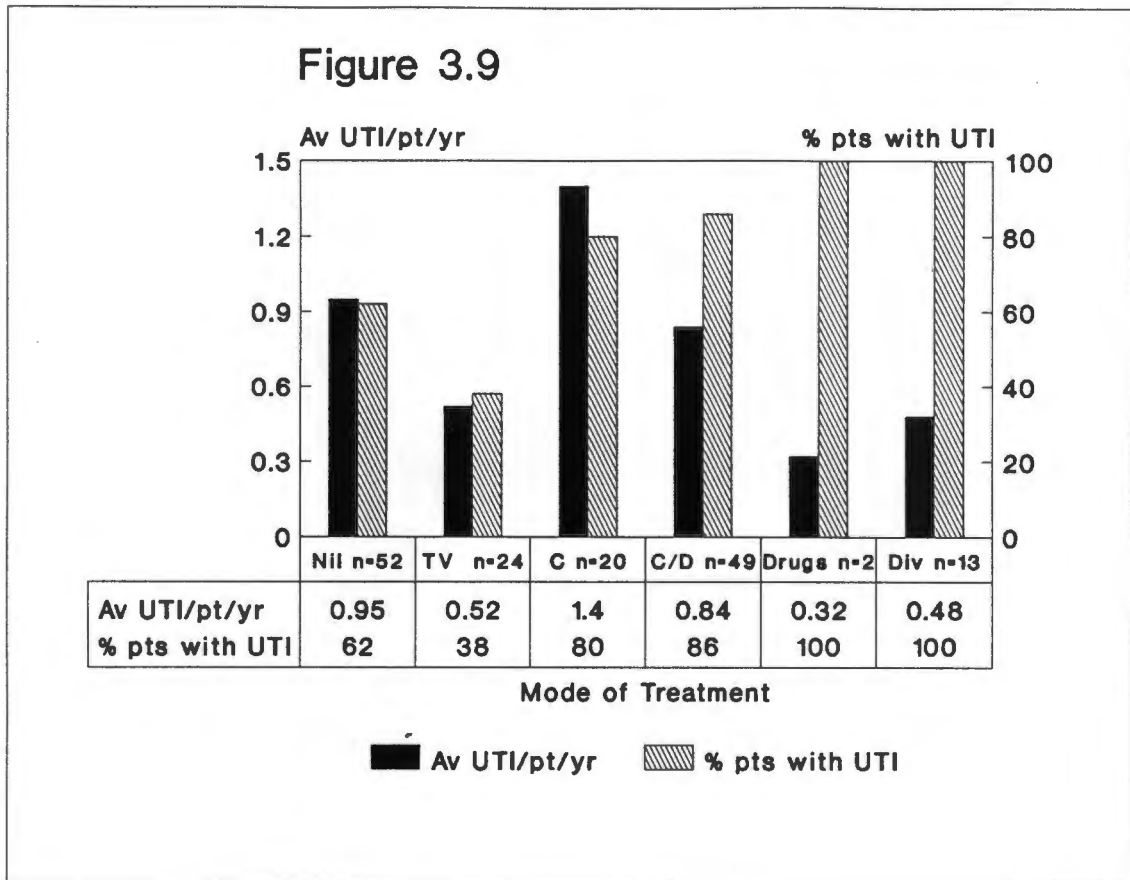


Figure 3.9 Incidence of urinary tract infections per patient per year (av UTI/pt/yr) and percentage of patients in each group in whom at least one infection has been documented, according to treatment method employed. TV = timed voiding, C = intermittent catheterisation, C/D = intermittent catheterisation plus anticholinergic or sympathomimetic drugs, D = drugs only, Div = permanent urinary diversion.

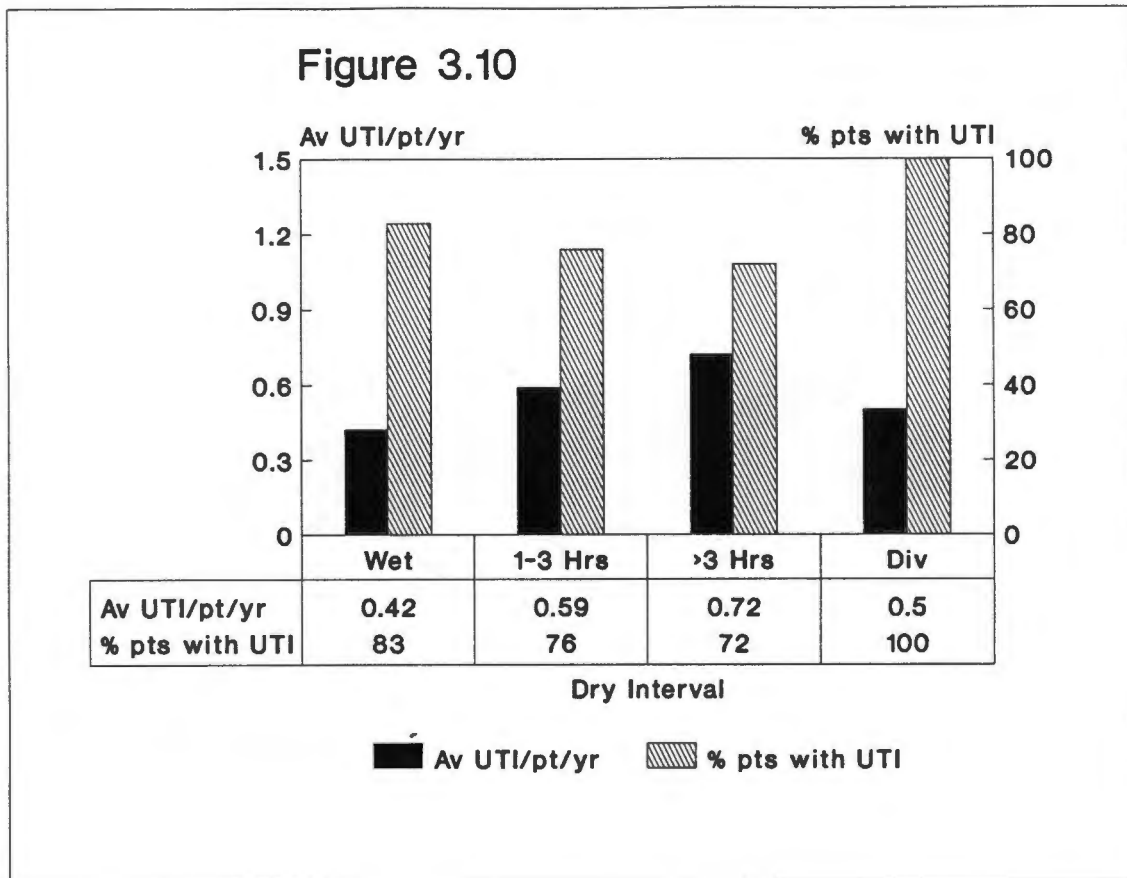


Figure 3.10 Incidence of urinary tract infections per patient per year (av UTI/pt/yr) and percentage of patients in each group in whom at least one infection has been documented, according to continence level achieved. 1-3 hrs = dry for 1 to 3 hours, >3 hrs = dry for 3 hours or more, Div = permanent urinary diversion.

CHAPTER 4

DISCUSSION

This will be subdivided into the following headings:

- 4.1 Patient Population.
- 4.2 Initial assessment
- 4.3 Initial treatment.
- 4.4 Continence treatment.
- 4.5 Relationship between urinary tract status and continence.
- 4.6 Relationship between urinary tract status and urinary tract infection.
- 4.7 Relationship between continence treatment and urinary tract infection.
- 4.8 Relationship between continence status and urinary tract infection.
- 4.9 Conclusions and recommendations.

4.1 PATIENT POPULATION

The incidence of neural tube defects per 1000 births in the Cape Peninsula area has been quoted as follows: White patients 2.0/1000 births, Coloured patients 0.47/1000 births, Black patients 0.22/1000 births. (Cornell 1983). In the study under discussion 100 of the children were Coloured, 45 were White and 23 Black. However the fact that these children firstly originated from areas both within and remote from Cape Town, and the lack of information as to whether the children presenting to Red Cross Hospital represent a true sample of the total number of children born with a spinal defect, prevents the comparison of the Red Cross figures with this more accurately controlled study.

Although the average age of presentation was 14 months the range was between three weeks and 14 years of age. That this is an unsatisfactory situation has been documented, as when

renal deterioration does occur in these children it tends to happen in the first two years of life (Light 1977). Early presentation would allow prevention of this deterioration to be implemented.

The preponderance of lesions in the lumbar and lumbosacral areas agrees with other large studies of children with spinal defects (Cooper 1967, Cass 1984, Kroovand 1986, Spindel 1987).

4.2 INITIAL ASSESSMENT

Eighty-seven patients had favourable urinary tracts at presentation (52%), 43 patients had mild neuropathic changes (26%) and 38 had severe neuropathic changes (22%). The urinary tract status reported in other series at presentation is as follows: Drago (1977) found 40% of 114 patients had no significant urological disability. Light (1977) documented urinary tract abnormalities in 29.4% of 122 children at initial presentation, although this may be an optimistic representation as 52 of these patients had only an IVP as their initial investigation. Similar reservations apply in the report of Cooper (1967) who found an overall 20% rate of upper tract dilatation in 451 children with myelomeningocele, of whom only 55 had micturating cystourethrography performed.

4.3 INITIAL TREATMENT

Initial management is based on the results of the original radiological assessment, which is done when the child first presents to the clinic after recovering from closure of the lesion. Most recent reports concerning the management of children with myelomeningocele, specify early assessment, (while the infant is in hospital for neurosurgical management) (Spindel 1987, Geraniotis 1988), as well as immediate urodynamic evaluation (Bauer 1984, Sidi 1986, Spindel 1987). However, the effect of surgery to the spinal defect on bladder function and urinary tract morphology must be borne in mind, and it has been suggested that no long-term decisions

concerning the status of the urinary tract should be made within one month of this surgery (Chiaramonte 1986).

Of concern was the number of children whose urinary tract status deteriorated between initial and final assessment and this group deserves closer scrutiny. The single patient who declined from favourable to severe changes is the patient whose upper tracts deteriorated markedly after implantation of an artificial urinary sphincter. Two patients were found to have developed renal scarring at follow-up, having originally had favourable features. One of these had been subjected to sigmoid conduit urinary diversion in 1976 for incontinence and had required two stomal revisions. The other had undergone no further treatment, and it follows that circumstances which would cause scarring were not detected at initial assessment. Of the 11 patients with mild neuropathic changes who originally had favourable urinary tracts, one had an artificial sphincter inserted in the intervening period, and removed 4 years later when the device eroded through the skin. However, the tendency towards urinary tract deterioration in this group of patients has already been documented (Aaronson 1986). Two of the remainder have not yet had continence treatment, and 6 are being treated with CIC and drugs, of whom 3 are dry for >3 hours, 2 for 1-3 hours and one is still wet. One patient is dry for >3 hours on CIC alone, and one is dry for 1-3 hours but is being treated on timed voiding only. Five patients who originally showed mild neuropathic changes, subsequently deteriorated with respect to their urinary tract status: 1 had a colonic conduit fashioned in 1976 for incontinence and has developed renal scars. The remaining four have severe neuropathic changes. All were treated with the usual sequence working up to CIC and drugs, and 2 are still wet and awaiting augmentation cystoplasty. One child has died as a result of ventriculo-peritoneal shunt complications and the other is poorly compliant, and periodically ceases treatment. In total, 15 of the 19 patients who had documented deterioration in urinary tract status had no surgical intervention which could be considered the cause of the negative change. Although 4 of the patients who originally had favourable urinary tracts are dry on treatment, it can be concluded that these patients may have benefitted from an initial assessment including urodynamic studies that would have heralded the

impending deterioration and allowed appropriate preventive measures, such as vesicostomy, to be performed.

Vesicostomy has proved in this study to be an effective means of protecting urinary tract status. Figure 4.1 depicts this status before and after vesicostomy and shows that while 22 patients had severe neuropathic changes before vesicostomy, and 1 mild changes, 20 of these changed to favourable features after this procedure, one had evidence of renal scarring, and 2 still had unfavourable features. These last 2 patients have already had the vesicostomy closed, and the reflux which provoked the procedure in the first place is still present. However both patients have had the benefit of 4 or 5 years of growth during which time the kidneys could mature in a low-pressure environment. It is our present policy when closing vesicostomies to reimplant the ureters if reflux is persistent on preoperative cystogram. Vesicostomy is a well documented means of preserving renal function and promoting bladder emptying, and does not compromise bladder volume after closure (Snyder 1983, Connolly 1988). It seems a better alternative than intermittent catheterisation at this age as proposed by Geraniotis (1988) as a means of protecting the urinary tract. The average neonate empties the bladder 20 times a day during the first month of life (Goellner 1981), and no family of an infant with a neuropathic bladder can realistically be expected to keep pace with the frequency of catheterisation which would be necessary to render the exercise effective.

4.4 CONTINENCE TREATMENT

The group of patients who have undergone urinary diversion as a primary procedure will not be considered further in this discussion. Urinary diversion to control urinary incontinence as a primary manoeuvre has fallen into disuse as a consequence of the advent of intermittent catheterisation, pharmacotherapeutic measures and attempts to maintain the integrity of the urinary tract. In addition the long-term complications of upper tract deterioration and need for frequent revisions that have been experienced with urinary diversions using ileum (Pitts 1979, Shapiro 1975, Dunn 1979) and colon (Hill 1983) must be taken into consideration.

Patients treated with timed voiding only.

Of the 24 patients in this group, 18 were completely dry, and the remaining 6 equally divided between being dry for 1-3 hours or still wet. It should be pointed out that the information gathered for this study represents the situation at a fixed moment in time and as all patients undergo a sequence of treatment aimed towards achieving continence, it is inevitable that some will be recorded as wet while in the early stages of treatment, when they might have the potential of being dry.

Few authors reported continence rates according to methods of treatment, but Drago (1977) found that 40% of his patients had minimal urologic deficit and did not require treatment to achieve continence. In Cass' study (1976) 14.5% of the patients were continent without treatment, and Cooper (1967) reported 87% of 415 cases with spina bifida had neurogenic bladders, presumably implying that the remainder needed no treatment. Other authors tend to concentrate on children with established neurogenic bladders, and those with normal bladders despite the existence of myelomeningocele are not mentioned.

Patients treated with intermittent catheterisation and drugs.

The introduction of intermittent catheterisation into the treatment of patients with a neuropathic bladder must probably be acknowledged as one of the major advances in urology over the last 20 years. Since Lapidus (1972) first reported the technique, many other authors have published their findings regarding this form of management. Brock (1981) found a 76% rate of complete or moderate continence on intermittent catheterisation. Kyker (1977) documented continence in 23 of 26 cases on intermittent catheterisation of whom 11 were on concomitant drug therapy. Cass (1984) found a 49% complete continence rate with a 17% improvement rate in his series of 84 children. Drugs were used in 63 of these cases as well. Kass (1979) used intermittent catheterisation in children less than six years old and even in this group documented good results with respect to continence. Of the 33 patients over one year of age in his study, 29 were completely dry on intermittent catheterisation and three were markedly improved. Not all reports are favourable however. Drago (1977) found only 26% of his 51 children benefitted

from intermittent catheterisation. In comparison the results of treatment at Red Cross Hospital are as follows: the total number in the group (combining patients being treated with intermittent catheterisation alone and those treated with intermittent catheterisation and drugs) is 69. Of these 42 (60%) are dry for 3 hours or more. 21 (30%) are dry for 1-3 hours and 7 (10%) are still wet. It appears that there are only two reasons why intermittent catheterisation fails to control incontinence. Firstly poor patient compliance in which catheterisation is not performed frequently enough or at all, for a variety of reasons including parental anxiety or ignorance, and inconvenient daily routines with parents at work or children at school at the time catheterisation is required. This experience has been reported by Brock as well (1981). Faulty technique in intermittent catheterisation could also be responsible for failure of therapy. The second reason for failure is inaccurate assessment of the nature of the neuropathy, with failure to appreciate that poor outflow resistance or detrusor hyperreflexia is contributing to the incontinence and is not remedied before intermittent catheterisation is undertaken.

Treatment of children with resistant incontinence

Eight children in this series have undergone further treatment after the graded approach of timed voiding, intermittent catheterisation and anticholinergic or alpha-adrenergic drugs failed to achieve control. Six of these patients received an artificial urinary sphincter. They form part of a series of eleven patients at this institution who have had this device implanted. Of the remaining five, one died of unrelated causes and the other four are being followed up outside Cape Town and no longer attend the Spinal Defects Clinic. The artificial urinary sphincter was first implanted in a human in June 1972 (Scott 1974). The early devices suffered a high rate of mechanical problems, but technical refinements have reduced these considerably in the device used in our series, namely the AS 800 artificial urinary sphincter (Gonzalez 1989). Of the six patients concerned three are completely dry with preservation of their upper urinary tracts. Two patients have had the device removed after erosion occurred; one through the skin with intractable infection of the prosthesis and the other through the urethra. In this latter case the child was found to have severe behavioural problems which were not detected pre-operatively and it is possible that he contributed to the complication by his habit of fastening an elastic band around

the penis to prevent incontinence. The last child still has the sphincter in situ, but gross upper tract deterioration has occurred and his is the most severe example in the group of the decreased bladder compliance which was documented in an early follow-up report on this group of patients (Aaronson 1986). Since this series was undertaken in 1984 and 1985, the risk of upper urinary tract deterioration as a result of decreased bladder compliance following sphincter implantation has been well documented (Light 1986, Scott 1986, Gonzalez 1989). In view of this development it has been suggested that augmentation cystoplasty should be considered when an artificial sphincter is implanted. This procedure can be carried out either simultaneously or in two stages (Strawbridge 1989).

Two children have undergone augmentation cystoplasty. One child had an isolated segment of sigmoid colon anastomosed as a cup patch to the widely opened bladder, after Goodwin (1959). The ureters were re-implanted into the taeniae of the colon. He is now completely dry on three hourly intermittent catheterisation and anticholinergic drugs. The second child underwent augmentation cystoplasty using the Mainz pouch technique (Thuroff 1986). This patient is still incontinent due to poor outflow resistance and management is presently being directed towards this problem. The rapidly broadening field of augmentation enterocystoplasty is an area which offers hope to these difficult cases of urinary incontinence. Advances in technique such as detubularization and the development of antireflux valves have gone a long way towards improving success rates. We no longer perform the Mainz pouch form of augmentation cystoplasty as it is thought to reduce the possibility of attaining faecal continence in the neuropathic bowel as a consequence of removal of the ileo-caecal valve (Webster 1990). In addition, surprisingly large volumes are obtained on detubularising the augmented segment (Koff 1988), and we do not see the need to use long portions of bowel. The development of the continent urinary diversion such as the Kock pouch, Indiana pouch, and a second generation Mainz pouch (Rowland 1988) constitutes an area of urological expertise which does not exist locally, but which could be of use in these patients. Variations of the Mitrofanoff Principle (Duckett 1986), which utilises a small diameter, supple, catheterisable conduit to the skin which

has been implanted into the bladder with a flap valve technique to prevent reflux, could also be of value.

4.5 THE RELATIONSHIP BETWEEN URINARY TRACT STATUS AND CONTINENCE

The primary aim of early treatment of children with myelomeningocele is preservation of renal function, which is achieved by preventing high voiding pressures and avoiding significant urinary tract infections. Superimposition of urinary continence upon this intact status is only undertaken at the age of four or five years, depending on individual patient circumstances. Unless the patient is among the fortunate few who is able to achieve continence on timed voiding alone, no attention is directed towards continence status during these early years. However, the relationship between the urinary tract status at initial presentation and at most recent assessment, and the urinary continence achieved, is worthy of further examination. Figure 4.2 contrasts the percentage of patients in each urinary tract status group (favourable, mild changes, severe changes) who are dry for three hours or more, at initial assessment and at present. The trend towards a higher percentage of dry patients with better urinary tract status is quite clear. As initial treatment tends to improve urinary tract status overall (Fig 3.6), it can be deduced that effective early treatment may also offer a better chance of ultimately achieving satisfactory continence. This relationship has not been previously documented.

4.6 URINARY TRACT INFECTION IN CHILDREN WITH SPINAL DYSRAPHISM

Along with preservation of the upper urinary tract and the achievement of urinary continence, the prevention of urinary tract infection has traditionally been cited as one of the goals of treatment of the neuropathic bladder. Although there is no doubt that symptomatic infections merit treatment and that the combination of infection and obstruction is lethal to renal tissue, many authors are questioning the significance of unobstructed and asymptomatic urinary

infection in these patients. Early studies implicated instrumentation of the urinary tract as the cause of infection, and associated the presence of infection with deterioration of the upper urinary tracts (Cooper 1967). Cass (1976) later showed that the presence of infection was related more to the neuropathic bladder than to instrumentation, citing a high infection rate in patients who had never undergone instrumentation. This dissociation of supposed cause and effect was given further impetus with the publication of Lapidès' work (1972), in which he claimed that urinary tract infections were predisposed towards by relative ischaemia of the bladder wall caused by distension, and that this risk could be minimised by the frequent emptying of the bladder under unsterile conditions on catheterisation. Light (1977) produced further evidence that urinary tract infection did not correlate closely with upper tract deterioration. In the ensuing years the significance of urinary tract infection in these children was brought into question in several studies (Ehrlich 1982, Brem 1987, Liptak 1988).

This study throws interesting new light on the relationship between urinary tract infection incidence and the various parameters of urinary tract status, treatment used and continence achieved. As detailed before, the figures of average urinary tract infections per patient per year are considered to be more representative than the percentage of patients in each group who have suffered urinary tract infections because of the widely differing follow-up periods which were encountered.

4.7 THE RELATIONSHIP BETWEEN URINARY TRACT STATUS AND URINARY TRACT INFECTION

Figure 3.8a and 3.8b illustrate this relationship. There is a rising incidence of urinary tract infection as the status of the urinary tract deteriorates. This can be explained bearing in mind that the less favourable urinary tract groups feature such problems as upper tract dilatation and vesico-ureteric reflux, both of which cause increased predisposition to urinary tract infections (Cooper 1967, Cass 1976). The fact that the patients are born with severe changes in many cases, presumably from a sterile intrauterine environment, suggests that the increased incidence

of UTI during life is a result of this status rather than a cause, although conclusive evidence of this has not been produced in this study.

4.8 THE RELATIONSHIP BETWEEN CONTINENCE TREATMENT AND URINARY TRACT INFECTION

Of the patients already being treated, those who are being treated with intermittent catheterisation alone have the highest incidence of infections, namely 1.4 per patient per year (Fig 3.9). Patients on intermittent catheterisation and drugs average .84 infections per year, those on timed voiding only, .52 per year and those who have been diverted .48 per year. Untreated patients average .95 infections per year. The incidence of urinary tract infection in patients who are treated with intermittent catheterisation varies quite widely in reports in the literature. Ehrlich (1982) found a higher percentage of urine cultures were positive in children with ileal conduits than in children on intermittent catheterisation, although a significant 36.8% of cultures in the latter group were positive. Drago (1977) reported that 66% of his patients had persistent positive urine cultures on intermittent catheterisation despite treatment. Only 2 of 42 patients under 6 years of age had persistently sterile urine while on intermittent catheterisation (Kass 1979). Brock (1981) documented a decrease in both sterile urine and symptomatic infection rate, but an increase in the rate of asymptomatic bacteriuria, in his patients once intermittent catheterisation had been commenced. In contrast, Diokno (1976) increased the number of patients with sterile urine from 8 to 22 of 43 patients on commencement of intermittent catheterisation, although most also received antibacterial therapy.

4.9 THE RELATIONSHIP BETWEEN CONTINENCE STATUS AND URINARY TRACT INFECTION

A number of authors have questioned the long term significance and effects of recurrent or persistent urinary tract infections (which are usually asymptomatic) in children with myelomeningocele (Light 1977, Ehrlich 1982, Liptak 1988). This study provides some data on

the subject. Reference to figure 3.10 reveals that with increasing continence regardless of treatment used, the incidence of urinary tract infection per patient per year increases. Thus one of the goals of treatment of these patients, namely acceptable urinary continence, does not appear to be dependent on the presence of sterile urine.

4.10 SUMMARY AND CONCLUSIONS

This study has assessed the methods used in the treatment of urological disease resulting from spinal dysraphism. An attempt has been made to compare the method of treatment used and results obtained to those reported in the literature. Certain points made in the study merit re-emphasis, as they highlight areas in our management which could be improved resulting in a better service to the patient, or support the value of treatment manoeuvres which have been shown to be effective, or represent new conclusions which have not previously been described.

Fewer than half of the patients assessed in this trial presented before the age of three months (Fig 3.2), and this must be regarded as an area where improvement should be brought about. Several studies have shown that when deterioration of the urinary tracts does take place this occurs most often early in life with a diminishing incidence of deterioration later (Light 1977, Spindel 1987). These children in most cases are admitted immediately after delivery for closure of their spinal lesion, and this provides an ideal opportunity to establish contact so that early post-operative assessment of the urinary tract and intervention where necessary, may take place.

The next factor that deserves critical scrutiny is the initial assessment of the patients using only radiological parameters. Sidi (1986) showed that in a group of neonates with unfavourable urodynamic features at initial assessment, only 55% had abnormal radiographic findings at the same time, while the remainder all deteriorated radiographically within the 18 month follow-up period. The introduction of early urodynamic assessment in these patients would constitute an improvement in management. The technical problems involved in performing urodynamics on

neonates in the absence of suitable small double-lumen catheters and gas cystography must however be borne in mind.

This study has proved that vesicostomy protects the urinary tract where there is evidence of high intravesical pressure, and the procedure should be used if there is any risk to the urinary tract. At the time of closure of the vesicostomy as thorough an assessment of the urinary tract as possible should be carried out so that any additional procedures, for example, ureteric re-implantation can be carried out at the same time.

The findings concerning urinary tract infection are also of interest and provide further evidence that the presence of bacteria in the urine is not necessarily a negative factor. The study showed that those children who tended to have the best continence rates also tended to have the highest rate of urinary tract infection, and the mode of treatment which is considered ideal throughout the literature (namely intermittent catheterisation) was also associated with a high rate of urinary tract infection. Conversely, more frequent urinary tract infection did not seem to have any long-term deleterious effect on continence, and as already discussed probably does not contribute directly to urinary tract deterioration in myelomeningocele patients, unless it co-exists with obstruction.

The most valuable finding to emerge from this review, is the demonstration that effective early management aimed at improvement of the urinary tract status with a view to preservation of renal function, also ultimately influences the degree of urinary continence attained. This previously undocumented information emphasizes the need for early intervention and prevention of urinary tract deterioration.

It is apparent from this study and from a review of the literature that the treatment of the urological complications of myelomeningocele requires early accurate assessment of the patient, close follow-up when necessary especially in the first few years of life and the availability of a wide range of treatment modalities and skills to cope with the variety of urological problems that can arise.

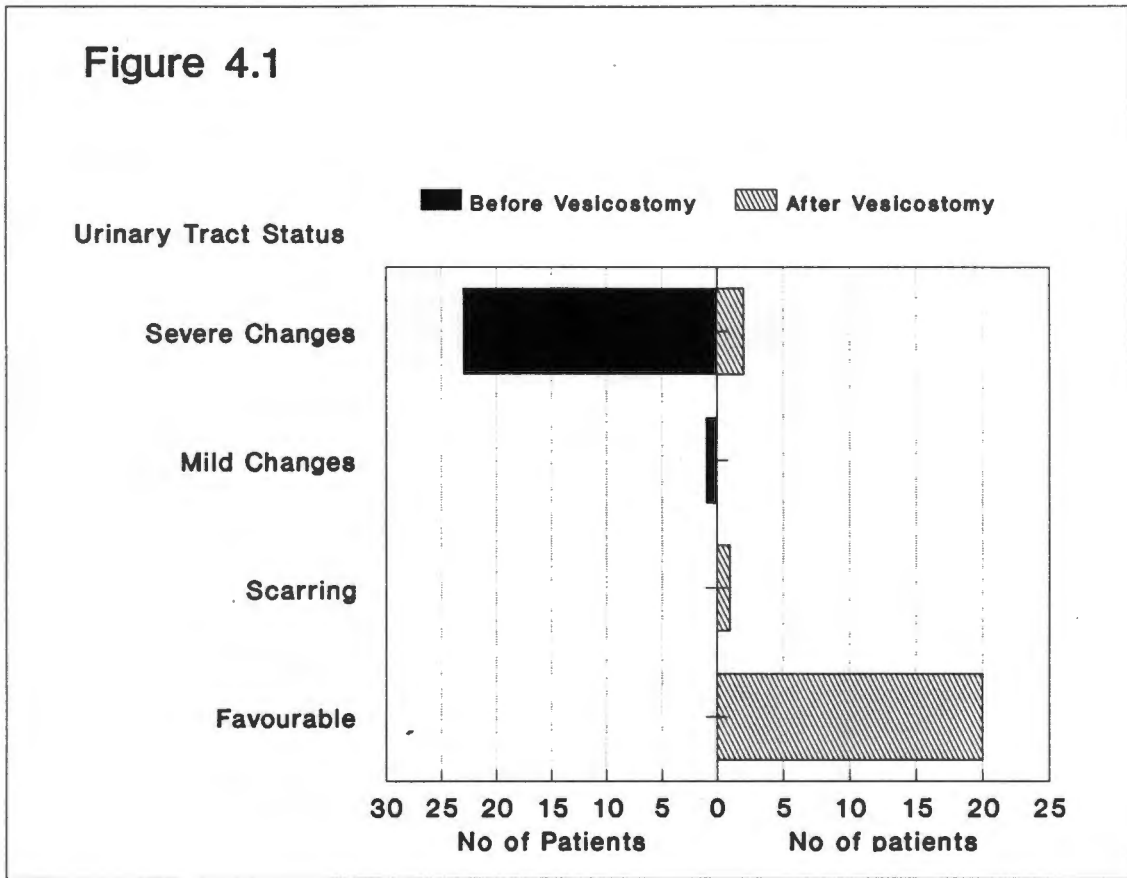


Figure 4.1 Changes in status of urinary tract after vesicostomy. Solid bars on left represent status before vesicostomy, and hatched bars on right represent status at least 6 months after vesicostomy.

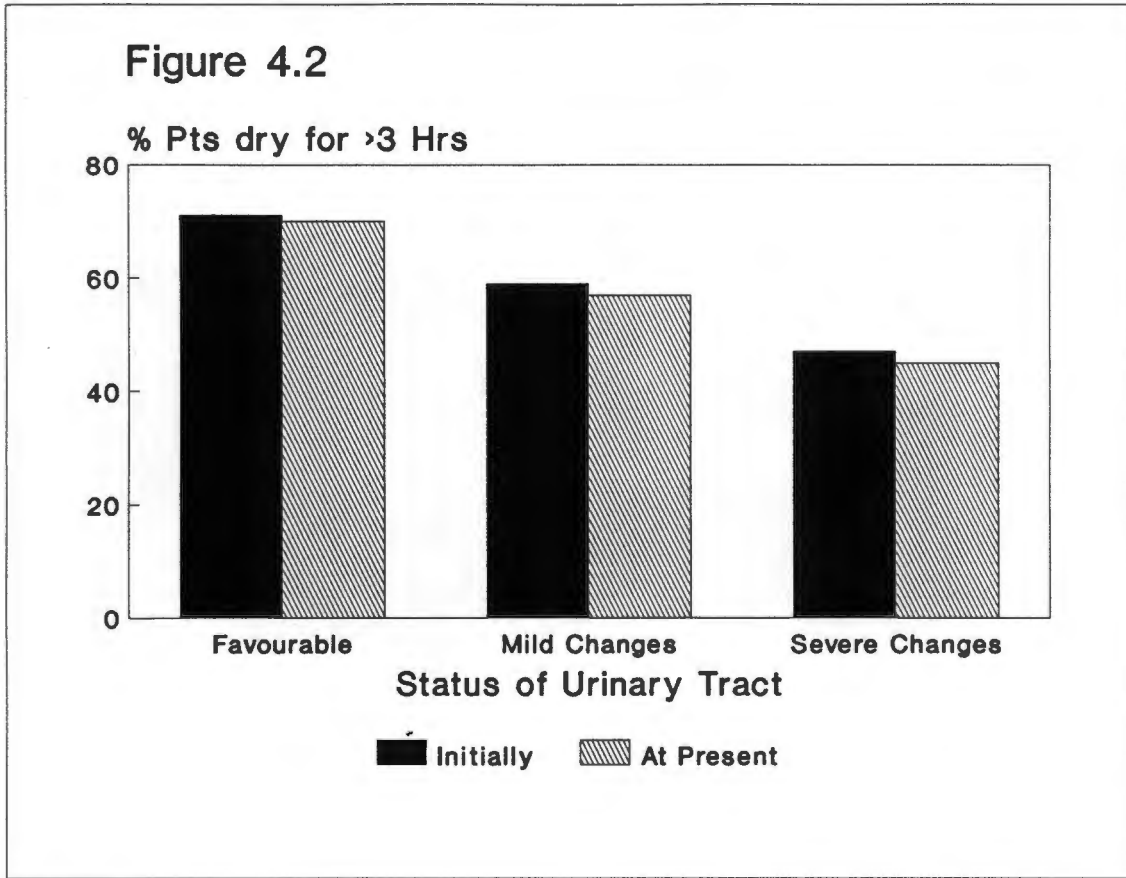


Figure 4.2 Percentage of patients in each urinary tract status group (favourable, mild neuropathic changes, severe neuropathic changes) who are dry for 3 hours or more. Solid columns on left represent urinary tract status at initial presentation. Hatched columns on right represent present urinary tract status.

CHAPTER 5

REFERENCES

Aaronson IA. The AS 800 artificial urinary sphincter in children with myelodysplasia. *S. Afr. Med. J.* 1986;69: 686-688.

Alter M. Anencephalus, hydrocephalus and spina bifida. *Arch. Neurol.* 1962;7: 411-422.

Bauer SB, Hallet M, Khoshbin S, et al. Predictive value of urodynamic evaluation in newborns with myelodysplasia. *JAMA* 1984;252: 650-652.

Brem AS, Martin D, Callaghan J, et al. Long-term renal risk factors in children with meningomyelocele. *J. Paedrics* 1987;110: 51-55.

Brock WA, So EP, Harbach LB, et al. Intermittent catheterization in the management of neurogenic vesical dysfunction in children. *J. Urol.* 1981;125: 391-393.

Carter CO, Evans K. Children of adult survivors with spina bifida cystica. *Lancet* 1973;2: 924-927.

Carter CO. Clues to the aetiology of neural tube malformations. *Dev. Med. Child. Neurol.* 1974;16(Suppl. 32): 3-15.

Cass AS. Urinary tract complications in myelomeningocele patients. *J. Urol.* 1976;115: 102-104

Cass AS, Luxenberg M, Johnson CF, et al. Management of the neurogenic bladder in 413 children. *J. Urol.* 1984;132: 521-525.

Chiaramonte RM, Horowitz EM, Kaplan GW, et al. Implications of hydronephrosis in the newborn with myelodysplasia. *J. Urol.* 1986;136: 427-429.

Connolly B, Fitzgerald RJ, Guiney EJ. Has vesicostomy a role in the neuropathic bladder? *Z Kinderchir.* 1988;43: suppl. II: 17-18.

Cooper DGW. Urinary tract infection in children with myelomeningocele. *Arch. Dis. Childh.* 1967;42: 521-524.

Cornell J, Nelson MM, Beighton P, et al. Neural tube defects in the Cape Town area 1975-1980. *SA Med. J.* 1983;64: 83-84.

Diokno AC, Kass E, Lapidus J. New approach to myelodysplasia. *J. Urol.* 1976;116: 771-772.

Drago JR, Wellner L, Sanford EJ, et al. The role of intermittent catheterization in the management of children with myelomeningoceles. *B. J. Urol.* 1977;118: 92-94.

Duckett JW, Snyder HM. Continent urinary diversion: Variations on the Mitrofanoff principle. *J. Urol.* 1986;136: 58-62.

Dunn M, Roberts JBM, Smith PJB, et al. The long-term results of ileal conduit urinary diversion in children. *Br. J. Urol.* 1979;51: 458-461.

Ehrlich O, Brem AS. A prospective comparison of urinary tract infections in patients treated with either clean intermittent catheterization or urinary diversion. *Paediatrics* 1982;70: 665-669.

French BN. In Youmans JR Ed. *Neurological surgery* Vol. 3 2nd Ed. 1982 WB Sanders Co.

Gardner WJ. The dysraphic states from syringomyelia to anencephaly. *Excerpta Medica* 1973 Amsterdam.

Geraniotis E, Koff SA, Enrile B. The prophylactic use of clean intermittent catheterization in the treatment of infants and young children with myelomeningocele and neurogenic bladder dysfunction. *J. Urol* 1988;139: 85-86.

Goellner MH, Ziegler EE, Fomon SJ. Urination during the first three years of life. *Nephron*. 1981;28: 174-178.

Gonzalez R, Koleilat N, Austin C, et al. The artificial sphincter AS800 in congenital urinary incontinence. *J. Urol*. 1989;142: 512-515.

Goodwin WE, Winter CC. Technique of sigmoidocystoplasty. *Surg. Gyn. & Obs.* 1959;108: 370-372.

Guthkelch AN. Studies in spina bifida cystica III. Seasonal variations in the frequency of spina bifida births. *Br. J. Prevent. Soc. Med.* 1962;16: 159-162.

Haddow JE, Macri JN. Prenatal screening for neural tube defects. *JAMA* 1979;242: 515-516

Hill JT, Ransley PG. The colonic conduit: A better method of urinary diversion? Br. J. Urol. 1983;55: 629-631.

Kass EJ, McHugh T, Diokno AC, et al. Intermittent catheterization in children less than 6 years old. J. Urol. 1979;121: 792-525.

Koff SA. Guidelines to determine the size and shape of intestinal segments used for reconstruction. J. Urol. 1988;140(part 2): 1150-1151.

Kroovand RL. Myelomeningocele in Walsh, PC et al Eds. Campbells Urology. 5th Ed. 1986;2: 2193-2216. WB Saunders Co.

Kyker J, Gregory JG, Shah J, et al. Comparison of intermittent catheterization and supravvesical diversion in children with meningomyelocele. J. Urol. 1977;118: 90-91.

Lapides J, Diokno AC, Silber SJ, et al. Clean, intermittent self catheterization in the treatment of urinary tract disease. J. Urol. 1972;107: 458-461.

Laurence KM. Neural tube defects: A two-pronged approach to primary prevention. Paediatrics 1982;70: 648-650.

Light JK, Pietro T. Alteration in detrusor behaviour and the effect on renal function following insertion of the artificial urinary sphincter. J. Urol. 1986;136: 632-635.

Light K, Van Blerk PJP. Causes of renal deterioration in patients with meningomyeloceles. B. J. Urol. 1977;49: 257-260.

Liptak GS, Bloss JW, Briskin H, et al. The management of children with spinal dysraphism. J. Child. Neurol. 1988;3: 3-20.

Naggan L, MacMahon B. Ethnic differences in the prevalence of anencephaly and spina bifida in Boston, Massachusetts. *NEJM* 1967;277: 1119-1123.

Padgett DH. Neuroschisis and human embryonic maldevelopment: New evidence on anencephaly, spina bifida and diverse mammalian defects. *J. Neuropath. Exp. Neurol.* 1970;29: 192-216.

Patten BM. Overgrowth of the neural tube in young human embryos. *Anat. Rec.* 1952;113: 381-393.

Pitts WR, Muecke EC. A 20-year experience with ileal conduits: The fate of the kidneys. *J. Urol.* 1979;122: 154-157.

Renwick JH. Anencephaly and spina bifida are usually preventable by avoidance of a specific, but unidentified substance present in certain potato tubers. *Br. J. Prev. Soc. Med.* 1972;26: 67-88.

Richards IDG, Roberts CJ, Lloyd S. Area difference in prevalence of neural tube malformations in South Wales. A study of possible demographic determinants. *Br. J. Prev. Soc. Med.* 1972;26: 89-93.

Rowland RG. Continent urinary reservoirs: in: *Surg. Clin. N. America* 1988;68: 891-907.

Scott FB, Bradley WE, Timm GW, et al. Treatment of urinary incontinence by an implantable prosthetic urinary sphincter. *J. Urol.* 1974;112: 75-80.

Scott FB, Fishman IJ, Shabsigh R. The impact of the artificial urinary sphincter in the neurogenic bladder on the upper urinary tracts. *J. Urol.* 1986;136: 636-642.

Shapiro SR, Lebowitz R, Colodny AH. Fate of 90 children with ileal conduit urinary diversion a decade later: Analysis of complications, pyelography, renal function and bacteriology. *J. Urol.* 1975;114: 289-295.

Sidi AA, Dykstra DD, Gonzalez R, et al. The value of urodynamic testing in the management of neonates with myelodysplasia: A prospective study. *J. Urol.* 1986;135: 90-93.

Smithells RW, Sheppards S, Schorah CJ, et al. Possible prevention of neural tube defects by periconceptual vitamin supplementation. *Lancet* 1980;1: 339-340.

Snyder H.McC., Kalichman MA, Charney E, et al. Vesicostomy for neurogenic bladder with spina bifida: Follow-up. *J. Urol.* 1983;130: 724-726.

Spindel MR, Bauer SB, Dyro FM, et al. The changing neurologic lesion in myelodysplasia. *JAMA* 1987;258: 1630-1633.

Strawbridge LR, Kramer SA, Castillo OA, et al. Augmentation cystoplasty and the artificial genitourinary sphincter. *J. Urol.* 1989;142: 297-301.

Thüroff JW, Alken P, Riedmiller H, et al. The Mainz pouch (mixed augmentation ileum and cecum) for bladder augmentation and continent diversion. *J. Urol.* 1986;136: 17-26.

Warkany J. Morphogenesis of spina bifida cystica. In McLaurin RL ed: *Myelomeningocele.* Gruner & Stratton 1977: 31-35 New York.

Webster GW. Personal communication. 1990.