

Development of bladder control in a population
that is potty-trained early

A follow-up study in Vietnamese children

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*“Này con yêu ơi, con biết không? Mẹ yêu con, yêu con biết bao!
Hãy cứ đi, Mẹ luôn bên con, dõi theo con từng bước chân...”*

Nhật kí của mẹ - Nguyễn Văn Chung

ABSTRACT

The overall purpose of this thesis was to advance the knowledge of bladder function development in children with the focus on early onset of potty training.

Specific aims:

- To describe, longitudinally, the development of the micturition pattern in healthy children who are potty trained early, from birth to the age of three (Papers I and III)
- To describe mothers' experiences of an ongoing potty training process in healthy children and how children communicate their needs (Paper II)
- To compare, longitudinally, the voiding pattern and emptying ability of healthy children who are potty trained early with children who are potty trained late (Paper III)
- To investigate if potty training already from infancy can affect bladder dysfunction in boys with posterior urethra valves (PUV) (Paper IV)

Participants: Papers I-III. Forty-seven healthy children, 0-3 years of age, were followed longitudinally every 3 months. Paper IV. Seventeen children born with (PUV), 0-4 years of age, 18 months follow-up.

Methods: Quantitative follow-up using 4-hour voiding observation and qualitative interviews. Comparisons are made between age groups and between healthy children and children with PUV.

Results: Infants in Vietnam rarely used diapers; daily potty training was applied to most of them from the age of 3 months and daily to all the children at the age of 12 months. Compared with the Swedish children, none had started potty training at that age (Papers I and III). By the age of 24 months, potty training had been completed for 98%. In the Swedish group, 5% had started daily potty training by the age of 24 months and by the age of 36 months 55% had completed potty training. The difference was significant ($p < 0.001$). Potty training performed daily affected the emptying ability positively: at the age of 9 months, no residual urine was found in the healthy children. These results differ significantly from the group of Swedish children. The frequency of voiding was lower in the Vietnamese children than in the Swedish group. Bladder volumes increased by age in both groups, but in the Vietnamese children it was significantly lower than in the Swedish children. The potty-training process showed communication developing between the mother and child (Paper II). In the child's first months of life, the mothers tried to recognize signs of the need to urinate. The mothers supported these signs using a whistling sound at certain times as a reminder. Furthermore, findings from the 4-hour voiding observation showed few signs of dysfunctional bladder in the Vietnamese boys with PUV, including residual urine even if there were significant more of dysfunction compared with the healthy Vietnamese boys (Paper IV).

Conclusions: It is possible to perform potty training in infant children by learning to communicate needs. Potty training performed daily affected the emptying ability positively in all children including the boys with PUV: at the age of 9 months, no residual urine was found in healthy children. The frequency of voiding and the bladder volumes were lower in the Vietnamese children than in the Swedish group. Early potty training reduced the symptoms of bladder dysfunction in boys with PUV.

Key words: Bladder, children, communication, content analysis development, potty training, reference values, signs urethra valves, urination

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LIST OF ORIGINAL PAPERS

This thesis is based on the following papers, identified in the text by their Roman numerals:

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Submitted

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DEFINITIONS AND ABBREVIATIONS

Clean intermittent catheterization (CIC)	A technique to empty the bladder by inserting a catheter in the urinary bladder 4-5 times a day
Dry	When a child is perceived by the surrounding people as being able to control his or her bladder in order not to get wet
Highest bladder volume	Maximum sum of highest voided volume and post-void residual urine volume
Healthy child	No history of urinary tract infection, no malformation of the urinary tract that could affect bladder function
Post-void residual (PVR)	Urine volume in the bladder measured less than five minutes after voiding
Interrupted voiding	Interrupted voiding is defined as two voidings within a period of ten minutes, with the highest volume at the first voiding
Potty training	Activities by parents or caregivers for the purpose of making the child dry
Potty-trained	Complete and independent dryness day and night
Posterior urethra valves (PUV)	A posterior urethral valve is an obstructing membrane in the posterior male urethra
Toilet trained	In this thesis it is synonymous with potty-trained
Vesico-ureteral-reflux	Reflux of urine from the urinary bladder to the ureters, grading I-V depending on severity

INTRODUCTION

Bladder control from the aspect of not wetting clothes and the bed is an important issue for children, parents, and the surroundings. Becoming “dry” is a process that usually takes place at home and does not normally cause any problem, but sometimes parents need advice and support. In health care service and nursing care the pediatric nurse plays a role of an observer, teacher and coach. In pediatric nursing you are expected to be able to guide parents in how to potty-train when needed. To manage this in children you need knowledge about bladder control and how it affects bladder function in a caring perspective.

There has previously only been general interest in whether children have bladder control, in other words, if they are “dry”. However, interest in bladder function during infancy and in small children before they have bladder control has increased during the last decades. Recent knowledge has stressed that bladder dysfunction can be recognized in infants with non-neurogenic malformation [1]. One example is boys born with posterior urethral valves, i.e., an obstruction in the urethra often accompanied by the congenital high-grade reflux and dilatation [2]. To be able to design a treatment program for an individual child in order to promote an optimal urinary bladder function and this way also preserve the kidney function, the normal function needs to be imitated and practiced.

There is still a lack of knowledge about normal bladder function and how children really achieve bladder control. During the last decades, we have seen that children use diapers longer, and daily potty training begins around the age of 3 years [3, 4]. In many non-Western and developing countries, by tradition or when diapers are not available, children seem to be potty-trained already as infants [5]. How these differences affect bladder function has not yet been studied.

BACKGROUND

Health and children's development of skills

Children's health can be regarded as the extent to which individual children or groups of children are able or enabled to develop and realize their potential, satisfy their needs, and develop the capacities that allow them to interact successfully with their biological, physical, and social environment [6, 7]. Health and health influences interact throughout childhood and into adulthood and different elements make children feel healthy or well. In a study from the UK, almost all the children confirmed that healthy foods, sports, physical activities, good hygiene, and sleep were the most important health factors. In Kenya, children aged from 10 to 15 years considered wellbeing to include being happy, healthy, physically active, and having good personal hygiene [8]. Children express different needs at different ages [9]. For younger children /infants wellbeing means sleep, food and bonding [10-13].

Children's physical and psychological development is related to health and wellbeing [11]. Parents generally try to understand, encourage, and support their child's health and wellbeing. Development can be seen as a process of maturation, education, environmental and cultural adaptation. In small children, development is shown by their behavior and signs, depending on the situation. However, these signs have to be communicated and interpreted by caregivers in order to support the development. Factors relevant to children's health and development in critical and sensitive periods need to be taken into consideration. Many factors affect the development and growth of the child, such as family lifestyle, socio-economic status, politics, quality of food, education, media, genetics, and the intrauterine environment [14, 15]. Achieving bladder control at an expected age is important for the health of each individual and the family [16]. In children's development, social and family relations are the most important factors [11].

Children's health is of global interest, and the United Nations has supported children's rights for decades. Child, according to the definition of the UN Convention [17], is a human being below the age of 18. Furthermore, every child has the inherent right to life and shall be ensured, to the maximum extent possible, survival and good development (The Child Convention, Article 6). Articles 12 and 23 express children's rights to make their voice heard, and include mentally and physically disabled children. Moreover, all children should enjoy a full and decent life, to ensure dignity and promote self-reliance in society [17]. Article 24 recognizes the right of the child to the highest attainable standard of health and to treatment of illness and rehabilitation of health. The rights of the Convention provide for needs to protect against exploitation and discrimination, and the child's participation in decision-making.

The development of our personality is described by Erikson in terms of eight life stages [18]. The first three stages are relevant to the development of bladder control. The first stage takes place between the birth and one and a half years of age. During this stage, the basic trust is established through the quality of care given by the parents. The second stage takes place during the period from one to three years of age, when

the psychosocial progression concentrates on developing a sense of personal control. In Erikson's view, potty training is an important part of this advancement. A feeling of control and a sense of independence is achieved by learning to control one's body function. The child will feel confident and secure if he or she successfully completes this stage. During the third stage, which takes place between three and five years of age, the child learns intensively. The child will achieve a sense of initiative if he or she successfully accomplishes what the parents expect. If not, the child will experience a sense of guilt and feelings of anxiety and fear. The parents are the most important influence according to the theory by Erikson, and they must be confident enough to support their child during the achievement of bladder control. Sometimes parents need some support from health care professionals to help their child become dry.

Potty-training methods and affecting factors

The importance of achieving bladder control concerns both the child and parents. Toilet or potty training usually starts in order to get the child dry, but the age when it starts differs. The potty-training procedure is usually conducted by the parents or caregivers and performed at home. However, several factors influence the timing, such as the lifestyle of the family and the community, welfare, culture and tradition, and the personality of the child [3, 5, 19, 20].

Before super-absorbent diapers and washing machines became widely available, there had been a practical and important reason to avoid urine and feces on the clothes and the bed. At that time, potty training in the Western countries was often started as soon as the child was able to sit on a potty. Being a good mother was often associated with having the child potty-trained early. Up to the 1950s, almost all mothers stayed at home taking care of their house and family. A common attitude, according to the old tradition, was that adults and, particularly, the man of the house were important persons that had to be honored. The child, on the other hand, was supposed to be silent and thus show respect to older people. A well-mannered child was supposed to do what his or her parents told him to. This attitude was stressful for both children and mothers with respect to the successful potty training. At that time, it was allowed to physically punish and embarrass children; it was not legally forbidden in Sweden until 1979 [21].

A child-oriented approach to toilet training was first highlighted in the 1960s, and the recommendation was to wait until the child was able to achieve bladder and bowel control naturally [22, 23]. In 1962, Brazelton demonstrated the success of a child-oriented model in which the parents were recommended to give their child a "potty chair" around the age of 12 months and to tell the child what it would be used for. As a second step, the mother would ask her child to sit on the potty chair with all his or her clothes on. At this time, the mother would sit with her child and do something nice like read a fairy tale or give the child a cookie. After a week or more, the diapers would be taken off before sitting down. The child was then encouraged and reminded to go to the toilet chair by him- or herself when needed [24].

Foxx and Azrin described a method of toilet training in 1972 that let the child practice on a doll. The doll was filled with water so it could urinate and then the child per-

formed all the steps of toilet training with this doll, including using the potty chair. This technique was practiced until the child had learned all the components of the toilet-training procedure. Finally, the child applied the technique to him- or herself: he or she went to the potty chair, pulled down his or her pants and sat on the potty chair until he or she had finished voiding; the child then stood up and pulled up his or her pants again [25].

In East Africa in 1977, the Digo mothers helped their children to control the bladder and bowels by observing the child's body language already from the newborn age. They responded to signs of a need to urinate in order to strengthen this communication. The signs of elimination could be crying, grimaces, or grunts. After one month, the siblings took over responsibility for the training process. The children were expected to be "dry" at 5 months, but not all fulfilled this goal [5].

According to the recommendation by the American Academy of Paediatrics, parents are advised to look for signs of readiness in their child before starting toilet training. Such signs could include that the child stayed dry for at least 2 hours, the child followed simple instructions, asked to use the potty or wanted to wear underwear instead of diapers. The parents are advised to use easy and understandable words for the procedure and outcomes in the conversation with the child, pick a potty chair together with special books and toys, discuss signs of need with the child, and make trips to the potty regularly [26].

In Sweden, the "wait and see" method has been practiced more or less for 40 years. A potty-training method based on Brazelton's advice was first recommended in 2001 [27]. This method recommended that the parents start potty training at the age of 18 months if the family's life situation was calm and appropriate for changes. The potty was introduced and the child told the reason for using the potty. The diaper was supposed to be removed as often as possible at home and the best way to succeed was to put the child on the potty after sleep or meal. The diaper was supposed to be removed as soon as the child woke up in the morning in order to avoid the child emptying the night urine in the diaper. It was suggested that the child understood that everyone, including parents and siblings, performed toilet matters. Parents would have to be positive, allowing an accident now and then, and remember that potty training should be fun.

Common potty-training methods stress that the child has to be mature enough for the transition from diapers to underpants. Parents and caregivers are still advised to look for signs of readiness before they start potty training [28]. In a study from Belgium, parents and daycare workers were asked which toilet training methods they used for the children. The most common activity for both parents and daycare workers was putting the child on the potty and encouraging the child to void until he or she had been successful. They regularly reminded the child to use the potty and repeatedly demonstrated the process to the child. They also removed the diapers, offered extra drinks, and encouraged the child to express his or her needs. The child liked to copy the behavior and actions of parents or caregivers [28]. Nowadays, in most Western countries, including Sweden, parents often work outside the home and children stay at daycare centers. Until now, the tradition has been that potty training is the parents'

responsibility and should be conducted at home. This means that the policy at most daycare centers has been that the staff change diapers when necessary but do not conduct any potty training. Perhaps the time has come to change this tradition due to the time children spend at daycare centers. Anyway, many daycare centers and preschools used to help children achieve bladder control. In the newly published study from Belgium mentioned before, 82% of the staff in daycare centers declared that they spent more than one hour a day on potty training. All the parents and respondents reported that they had good communication concerning the potty-training process and no conflicts with the toilet-training methods, except that it was time-consuming [28].

Different cultures have different expectations, but the habit of using diapers makes sense. Economic factors may also affect potty training: parents in low-income countries cannot afford diapers for everyday use. Cold weather is another factor contributing to making it difficult to practice potty training without diapers. Warm weather during the summer season makes it a good time to start potty training. The child can then wear underpants or be naked instead of wearing diapers [3]. Some children are more interested than others in learning to control their bladder and bowel and this does, of course, influence the time spent on the potty-training process.

Vietnamese culture and history

Vietnam is a country under communistic dictatorship. It has got an area of 331 sq. km. and is situated in the Southeast Asia, bordering with China, Laos, and Cambodia. Its size is similar to that of Sweden, but the population is ten times higher at approximately 91.5 million (2012) [29], of which 28.8% lives in the cities (2010). Fifty per cent of the population is younger than 30. Following the tradition, women get married at around 23 and men at around 26 years of age, and they are legally not allowed to live together without marriage. In Vietnam, there has been a two-child policy since 1994. This recommendation was due to a huge increase of the population after the American War. In Vietnam, children account for 36% of the population [29]. In Sweden, it is 20%, according to the statistics of the National Board of Health and Welfare [30]. The children benefit from the country's economic achievements. Vietnam is undergoing strong development, particularly in health care and education. Mortality in infants below the age of one has decreased from 44.2 per 1,000 live births in 1992 to 18.0 per 1,000 live births in 2004. The maternal mortality rate per 100,000 live births is 59, while the global rate is 210. Eighty-four per cent of all births in Vietnam are attended by skilled health care personnel. Mortality in children below the age of five has decreased significantly in the last two decades, and it is now 23 per 1,000 live births compared with the global average of 57 [31]. Other difficulties the country faces include high risks of major infectious diseases, environmental issues, such as deforestation, water pollution, and industry related problems in urban areas [32].

When people get married in Vietnam, they often live together with the husband's parents, and, when children arrive, the grandparents take care of them until they start preschool at around the age of two. At the time of this study the maternal leave was four months for women working for the government (since May 2013, 6 months). Mothers are supposed to be responsible for the household, including the economy, family, and children. According to the old tradition, mothers potty-train their children

already at infancy and Vietnamese children do not use diapers to the same extent as children in the Western countries.

The children in the present project were recruited from the National Hospital of Pediatrics (NHP), which has been located in Hanoi since 1969. During a bombing raid in 1972, most of the hospital was damaged, but it was built up again and finished in 1981 with the funds provided by the Swedish government. Before 1997, the hospital was called the “Vietnam-Sweden Children’s Hospital” and “The Olof Palme Pediatric Institute” because of the cooperation with Sweden. The collaboration has been active for 40 years, and the core of the relationship is improvement work in Vietnam, though it is now becoming more of a mutual exchange [33]. Today, there is still much room for improvement in the health care system. There are not enough staff or hospital beds available in the country, and the standard of health care is sometimes poor and inadequate.

Normal function of the urinary bladder

It has been a general belief that during infancy children use diapers and eliminate without telling anyone beforehand. In old textbooks, you can read that the micturition process is an automatic, controlled action emptying the bladder at a certain level. The studies by Jansson and Yeung have emphasized that bladder function in infants is a conscious action [34, 35].

The urinary bladder (detrusor) is a smooth muscle sac with a mucous layer covering the inside. The function of the bladder is to store urine from the kidneys and to get emptied when appropriate. The bladder should be filled to an adequate level and emptied completely, periodically, and voluntarily [35]. It is unknown what initiates a micturition during infancy, but a large variation in voided volumes and arousal before urination indicate awareness of when it is time to empty the bladder [34]. When the children become older, the large variation could be due to social behavior as well as urgent need. The studies by Mattsson show that children of school age go to the toilet when they want to and not necessarily when the bladder is full [36].

The bladder should remain relaxed and compliant during filling. When it is time to empty, the detrusor muscle contracts and the increased pressure helps the bladder to empty. To facilitate emptying in one portion during an acceptable period of time, the pelvic floor muscle and urethra sphincters have to be relaxed at the same time. This co-ordination is related to the nerves fibres in the pelvic nerve (mainly parasympathic innervation) and the pudental nerve (mainly somatic innervation) interconnected on spinal cord level and modulated by the brain. Sympathetic innervation has also been shown to be involved in urethral function, beside its function in the bladder storing phase. It is mainly the parasympathetic cholinergic innervation of the detrusor that is responsible for the emptying phase of the bladder.

Development of bladder control - earlier research

The way bladder function develops and children achieve bladder control has been studied during the last decades to gain knowledge about normality, and some very

interesting characteristics of bladder function have been identified. This knowledge is of importance to addressing correctly what is abnormal in bladder function of the above mentioned conditions. Studies have shown that when children are toilet trained, the physiological conditions included in the voiding cycle change. There are some immature characteristics during the first couple of years, of which dyscoordination between the bladder and the sphincter at voiding is the most apparent. This lack of normal and complete coordination at voiding means that the emptying of the bladder is often incomplete, with an increase in residual urine [34, 37]. After achieving bladder control, the bladder capacity increases, the coordination between the bladder and the sphincter apparatus improves, and the emptying of the bladder is complete [35, 38, 39]. Whether this improvement in emptying the bladder only depends on maturation of the coordination between the sphincter and the bladder associated with age, or if it is also due to the fact that the child, when toilet trained, empties the bladder as a voluntarily and consciously initiated act is not known. However, from studies in girls aged 6 and 10 years, it is known that a sitting position during micturition facilitates relaxation of the pelvic floor muscles leading to complete emptying of the urinary bladder [40].

In a longitudinal study in healthy Swedish children, the development of the micturition pattern from the age of three months to six years was followed [34, 38]. The results showed that the frequency of voiding decreased over time, voided volumes increased, and post-residual urine decreased marginally until the age when bladder control was achieved. However, there was great variation in voided volumes in the individual child, indicating that bladder emptying is not an automatic function without influences from the brain, as was previously thought. The study also showed that if the child was asleep, he or she would wake up or show signs of arousal when it was time to void, which also supports the theory that the brain influences bladder function already in infants [34, 38, 41]. These findings also confirm a previous study performed in Hong Kong using a combination of electroencephalography (EEG) and cystometric registration of voiding [35].

In the Western World, the age for bladder control has gradually increased and, in recent studies, it has been shown to be between three and five years for 80% of children [38, 42, 43]. During the last 50 years, the median age to be toilet trained has increased by one year, however the time to apply daily toilet training has increased by 2.5 years [19, 22-24, 38, 42, 43]. In many non-Western and developing countries, by tradition or when diapers are not available for the families, children seem to achieve bladder control already in early infancy [5]. This means that in Western countries, the period of using diapers and not having bladder control is much longer than in developing countries. These findings may have implications regarding children's health, due to the prolonged period of dyscoordination and residual urine [44]. However, there is a lack of studies.

Urinary bladder dysfunction

Most children achieve urinary bladder control without any problem, but not all. In paediatric urology and paediatric urology care, the bladder function is important in many aspects. A severe dysfunction, including incomplete and high-pressure empty-

ing, creates a high risk of urinary tract infections (UTI) and pyelonephritis, with renal damage as a consequence of infection [45].

Different kinds and severities of bladder dysfunction are seen in children. Functional disturbance, with urgency and urinary incontinence as the main symptoms, is the most common condition in young children, though most will outgrow it. However, these symptoms are not seen during infancy or before potty-training age [35, 38]. When children in Sweden start school, at around the age of seven years, three to seven percent suffer from urine incontinence [46-49], but as many as 26 percent have a sign of bladder dysfunction, mostly reported as urgency [48]. Emptying difficulties are rare, one percent, at this age [36, 48].

There are dysfunctions that are induced by different congenital abnormalities, with incontinence as one of the symptoms, but combined with high intravesical pressure and poor emptying, it is a life-threatening condition due to the affected renal function if it is not treated. In boys with posterior urethral valve (PUV), this used to be a serious condition [1]. In children born with dilation of the ureters and/or high-grade reflux of different origins, this may also lead to a high risk of UTI [44]. UTI during infancy is usually regarded as pyelonephritis, with a risk of renal scarring due to the sensitive growing kidney.

Posterior urethra valves (PUV)

Posterior urethral valves (PUV) are the most common cause of lower urinary tract obstruction in male infants. The incidence of this congenital anomaly in our setting is unknown, although reports from the United States and Europe in 2011 indicate that it occurs with an estimated incidence of 1 in 8,000 infant males to 1 per 25,000 live births [50, 51]. The corresponding numbers in Vietnam are not available due to lack of screening. Technically, the membrane is easy to resect, but the secondary pathology can be severe with detrusor hypertrophy of the bladder, hydronephrosis, vesicoureteral reflux, and early renal impairment. Furthermore, one-third of boys with PUV will develop end-stage renal failure. Of boys with PUV, 75% have a persisting bladder dysfunction after ablation of the valves during infancy. This could be a negative predictive factor for the renal deterioration seen in these boys during growing up [1].

Bladder dysfunction during infancy in boys with PUV has been shown to be characterized by a hypercontractile pattern, and in more than half of the cases low compliance. Even after ablation of the valve, there are sometimes signs of urethral obstruction during the first year of life, due to the fact that the detrusor hypertrophy influences the bladder outlet. The cornerstones of bladder treatment are urotherapy, including potty training and a bladder regimen with frequently timed voidings and nocturnal emptying, if needed, also pharmacological treatment [52]. Anti-cholinergic drugs are used to decrease bladder pressure and abolish instability and alpha blockers to enhance bladder emptying. For severe bladder emptying problems, clean intermittent catheterization (CIC) could be the treatment of choice, but it is difficult to accomplish due to a sensitive and abnormal anatomy of the proximal urethra with a prominent bladder neck barrier. Whether early potty training during the first years of life can affect bladder dysfunction, has to our knowledge, not yet been tested.

PURPOSE

The overall purpose of this thesis was to advance the knowledge of bladder function development in children with the focus on early onset of potty training.

Specific aims

- To describe, longitudinally, the development of the micturition pattern in healthy children who are potty-trained early, from birth to the age of three (Papers I and III)
- To describe mothers' experiences of an ongoing potty-training process in healthy children and how children communicate their needs (Paper II)
- To compare longitudinally the voiding pattern and emptying ability of healthy children who are potty-trained early with children who are potty-trained late (Paper III)
- To investigate if potty training already from infancy can affect bladder dysfunction in boys with posterior urethra valves (PUV) (Paper IV)

PARTICIPANTS AND METHOD

Participants

The parents of 76 healthy newborn infants in Vietnam were informed about the study and asked to participate when attending health check-ups for their children at the National Hospital of Paediatrics (NHP) (Papers I, II and III). After informed consent, 47 agreed to participate. The inclusion criteria were that the child was younger than 2 weeks and healthy; meaning no illness or malformation affecting the urinary tract. The participants in Papers I, II, and III were from the same population of children (n=47). In Paper IV, parents of children born with posterior urethra valves (PUV) seeking medical check-ups at NHP were asked to participate. Seventeen children were included in the study. The inclusion criteria were consecutively chosen boys, 0-4 years old, treated with valve resection and who had a uni- or bilaterally dilated upper urinary tract at the time of diagnosis (Table 1).

Table 1. Overview of the design of the thesis

	Subjects	Design	Analysis
<i>Paper I</i>	47 healthy Vietnamese children 26 boys, 21 girls, Ages 0 – 1 year	Follow-up, quantitative study	Descriptive statistics
<i>Paper II</i>	47 Vietnamese mothers of 47 healthy Vietnamese children	Follow-up, qualitative interviews	Content analysis
<i>Paper III</i>	47 healthy Vietnamese children 26 boys, 21 girls Ages 3 months – 3 years 57 healthy Swedish children (published data) 23 boys, 34 girls Ages 3 months – 3 years	Follow-up, quantitative study	Descriptive/ comparative statistics
<i>Paper IV</i>	17 Vietnamese boys with PUV Ages 0 – 4 years 26 Vietnamese healthy boys (data paper III) Ages 0 – 3 years	Quantitative, follow-up study	Descriptive / comparative statistics

* 4-hour observations were used in papers I, III, IV

Methods, interviews, and instruments

4-hour voiding observation

The healthy participating children (Papers I and III) were investigated at the National Hospital of Paediatrics (NHP), following the study protocol, starting when the children were around 2 weeks of age and then at 3, 6, 9, 12, 18, 24, 30, and 36 months of

age. The investigation included mapping of the micturition pattern through the 4-hour micturition observation method, during which the child and parents/caregivers had to stay at the hospital [53]. The child's daily routines were followed as far as possible. If the child normally used diapers, he or she used a pre-weighed one during the observation. When the child passed water, the diaper was weighed and the residual urine was estimated. Children who did not usually wear diapers passed water in a potty or on a pre-weighed protective pad. Voided volumes were measured in ml or mg. Ultrasound (Toshiba Nemio XG) was used to measure post-residual urine following each voiding [53]. The study protocol has been validated in previous studies [34, 38]. If the child was sleeping, eating, or crying, this was also registered in the protocol (see Appendix). These recordings were made every ten minutes for four hours, but the child had to be under constant observation throughout this period. Post-residual urine, reported in ml, was estimated by considering the bladder as a rectangular box and all three dimensions as variables: width, height, and depth were multiplied to obtain the actual bladder volume [53]. During the 4-hour observation, we aimed for a friendly and "being-together" atmosphere with play and drinks, and we offered health check-ups and advice when requested. In Paper IV, the 4-hour voiding observation was also used. After inclusion, the children were investigated 3, 6, 9, 12, and 18 months after surgery and for the older boys they followed the same protocol after inclusion. Investigations at 3 and 18 months are reported in paper IV.

Creatinine(s)

Creatinine was taken as a vein blood sample. The normal value during the first month is 40 ± 4 micromol/l. Below 2 years of age it is 35-40 micromol/l, at the age 2-6 years old it is 40-60 micromol/l (Paper IV). Creatinine is a chemical degradation of the muscle metabolism produced from creatine, a molecule that is important in the creation of energy. Nearly 2% of the creatine in the body is converted into creatinine every day. Creatinine is transported in the blood to the kidneys. Kidneys filter creatinine and its excretion in the urine. The kidneys maintain the creatinine levels in the normal range in the blood. Creatinine is a reliable quality in the assessment of renal function. If the renal function is abnormal, creatinine levels in the blood will increase, because less creatinine is released through the urine. Serum creatinine is therefore an important routine test to assess renal function. The creatinine test was performed at each investigation in the study (3, 6, 9, 12, and 18 months after surgery or after inclusion for older children).

Interviews

The parents were interviewed and the children observed (notes) on each visit (3, 6, 9, 12, 18, 24, 30, and 36 months) (Papers I and II). Qualitative interviews: parents were asked to talk about their experiences of potty training to achieve bladder control (Paper II). The interviewee was encouraged to speak freely, like a conversation, without interruption (Mishler EG, 1986). The interviews (Paper II) started with a single open question: "*Could you tell me how you manage your child's pee and poo?*" and "*How does your child manage them?*"

Quantitative short questions were asked at the same time as the interviews concerning health, eating, and potty and diaper use.

Analysis

Statistical analysis

For the quantitative variables, descriptive statistics were used, including mean, median, standard deviation, and range (Papers I, III, and IV). Variables were reported using descriptive statistics [8]. For comparisons between two groups (Papers III and IV), the Mann-Whitney U-test was used for continuous variables and the Mantel-Haenszel Chi² test for ordered categorical variables. All significance tests were two-tailed and conducted at the 5% significant level [54]. Analyses were conducted using the SPSS 18 statistical software (SPSS Inc, Chicago, Ill, USA) and SAS software version 9.2.

Content analysis

To analyze the interview text, a qualitative content analysis was conducted using the technique supported by Krippendorff [55]. This method was chosen based on the aim of the study and the nature of the data collected. Content analysis is defined as a research technique for making replicable and valid inferences from texts to the context of their use. The interviews were put together in a single text, arranged by age. Following the prescribed steps, the text was read and reread to gain a sense of its entirety. Meaningful units were identified and extracted from the text according to the aim of the study. The meaning units were sorted and coded. After several processes of coding, sub-categories were identified and categories created. The process of identifying categories included an alteration between the text as a whole and its parts. The analysis was carried out individually and in cooperation until agreement was reached between the authors. The analysis is described in steps, ensuring reliability together with quotations to support the findings (Paper II).

ETHICS

This thesis follows the ethical rules according to the Declaration of Helsinki [56]. Voluntary participation and informed consent from the parents were a requirement of inclusion in the study. The benefits of this study exceed the risks in our judgment. Permission from the head of the hospital and the ethical committee at the National Hospital of Pediatrics (NHP) in Hanoi were obtained. The data used for the comparison studies have been published previously and no further approval was needed.

Participating in a study like this is time-consuming for the family. To facilitate this in connection with the study, we offered health check-ups and advice, if requested, as well as small gifts to the children. The participants also received payment for traveling expenses.

RESULTS

The results of the papers are presented as a summary of the important findings from each study.

Summary Paper I and Paper III

The first paper describes, in quantitative terms, the micturition pattern longitudinally in healthy children who were potty trained early, from new-born up to the age of 12 months. In Paper III, similar data from the age of 3 months up to the age of 36 months are compared with data of Swedish children who were potty trained late. The children were investigated every third month, from new-born to the age of one year and after that every 6 months up to the age of 3 years (Figure 1).

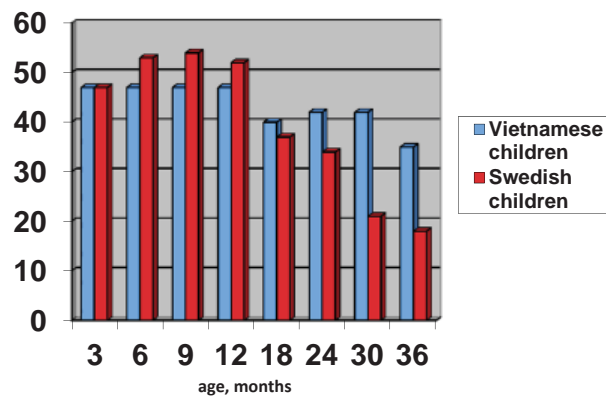


Figure 1. Participation rates for the healthy children from 3 months to 3 years of age in the Vietnamese group and the Swedish group

The studies were performed in Vietnam and included 47 children (Figure 1). None of the children became ill in a way that affected the urinary tract function. The number of Swedish children in the control group was 57 (Paper III). Compared with children in Western countries, the infants in Vietnam rarely used diapers, and daily potty training was applied to most of them already from the age of 3 months (Paper I). This habit improved emptying of the urinary bladder, and the dyscoordination seen in non-toilet-trained children, recognized as interrupted voiding and increased residual urine, disappeared. In the Vietnamese group, daily potty training was applied to all the children at the age of 12 months compared with the Swedish children, none of whom had started potty training at that age (Papers I and III). By the age of 24 months, potty training had been completed for 98% of the Vietnamese group. In the Swedish group, 5% had started daily potty training by the age of 24 months and by the age of 36 months 55% had completed potty training. To get 100% potty trained children, we had to wait until 4.5 years of age [38]. The difference was significant ($p < 0.001$).

The frequency of voiding decreased over time. The Vietnamese group had significantly fewer voidings below the age of 12 months ($p < .0001$) and lower voided volumes than the Swedish group (see Table 2, Paper III). The voided volumes increased according to age in both group. Post-residual urine decreased according to age and, in the Vietnamese children, already at the age of 9 months, bladder emptying could be regarded as complete, compared with the Swedish group, which first showed complete emptying at the age of 36 months ($p < 0.0001$) (Papers I and III).

Summary Paper II

Forty-seven Vietnamese mothers, the same population as in Papers I and III, were interviewed and followed from the time their children were new-born to 24 months of age. The study aimed to describe mothers' experiences of the potty-training process (i.e., how wetting clothes and beds is avoided) and how children communicate their needs to their parents. From the analysis, we found two categories: patience in communication needs and on-going development of the child's ability. These categories were created from two to five subcategories found for the different ages (see Table 1, Paper II).

The potty-training process showed communication developing between the mother and child. During the child's first months of life, the mothers tried to recognize signs of the need to urinate. The mothers supported these signs using a whistling sound at certain times as a reminder. According to tradition, to be a good mother, potty training should be conducted and diapers rarely used. The process advanced and, at the age of 6 months, two-way communication was developed between the mother and child and, by the age of 9 months, there were already more successes than failures. Once the communication worked like a routine, at around the age of 12 months, the mothers started to practice independency, step by step. The mothers felt happy and confident helping their children to establish good habits. By the age of 18 months, the children kept dry most of the time despite not being reminded, and at 24 months they had independent bladder control (Paper II, Table 2).

Summary Paper IV

Seventeen Vietnamese boys born with PUV, aged from 3 months to 4 years, were included in the study. The boys had to be potty trained from new-born. For comparison of the findings we used data from a previously published study consisted of 26 healthy Vietnamese boys longitudinally followed from the age of 3 months to 3 years of age. These boys had been potty trained since infancy (Papers I and III). Micturition studies with 4-hour voiding observations were reported at 3 and 18 months after inclusion.

Findings from the 4-hour voiding observation showed that the emptying can be regarded as complete during the first year in both the PUV boys and the healthy boys. However, the boys with PUV had a higher amount of residual urine in the age groups 1-2 and 2-4 years ($P < 0.001$) (Table 3, Paper IV). These boys also had less interrupted voiding as a sign that dyscoordination had disappeared (Figure 2, Paper IV).

The voided volumes increased according to age in all groups. When comparing the boys with PUV with healthy boys, a significant difference was showed with lower volumes in the age groups 0-1 year (Table 3, Paper IV). The healthy Vietnamese boys showed an even lower number of voidings. This was statistically significant for the Vietnamese PUV compared with the healthy Vietnamese boys at the age of 1-2 years and 2-4 years ($P < 0.01$) (Figure 1, Paper IV).

DISCUSSION

Method discussion

The 4-hour voiding observation method is a non-invasive examination that is well-suited to follow a natural course of the urinary bladder function and development. Voiding volumes and post-void residual urine can be mapped, and these findings can be seen in relation to time intervals, intakes, sleeping, and activities that may affect outcomes. The method has been used before in similar studies and also in our group [2, 34, 38, 41, 53]. When comparing the groups of patients, it has been an advantage that the same method was used for the investigations.

Conducting research in two different cultures requires an open mind in order to recognize and understand the differences and to be careful when interpreting the data. Being a member of a research group with much experience has been a help when discussing confounding factors. For the follow-up interviews, the content analysis technique described by Krippendorff was used for the analysis, and it was found to be useful for this kind of subject. With regard to the content of the interview questions, this topic was not shown to be sensitive during infancy and toddler age. The interviews were performed in Vietnamese (by HTD) and translated into English (HTD) before the analysis. It was an advantage to be aware that according to Vietnamese culture, to be good mother you have to potty train early and that diapers were not an option for most of the families. In the analysis, awareness and pre-understanding of the cultural differences helped to gain a wider and deeper understanding of the mothers' experiences.

Result discussion

The purpose of this thesis has been to advance the knowledge of bladder function development in children, with the focus on early onset of potty training. The four papers contributed to this by 1) longitudinally studying the process of potty training in a population of healthy children that usually starts potty training very early and 2) investigating children with posterior urethra valves (PUV) who were potty trained since infancy concerning their urinary bladder function, and comparing these findings with other groups of children [34]. The thesis includes qualitative and quantitative methods in order to capture the potty training process.

Findings from this thesis show that potty training with good outcomes is possible already from infancy in healthy children as well as boys with PUV. Vietnamese mothers usually start to potty-train already from infancy by looking for signs to communicate needs (Paper II). This method is also mentioned in the study by deVries [5]. In the thesis, the development of skill is described by age. The children were able to remain "dry" already from the age of 6-9 months, an age when children do not usually have words to communicate or the ability to walk by themselves to a potty. In this situation they were of course dependent on their parents' attention and interest in potty training. In the study, one girl aged about one year was diagnosed with autism and difficulties with communication skills. This girl was later, compared with the others.

Her mother performed daily potty training with her; however, the girl emptied her bladder completely at the same age as the other children. In the Swedish group, all the children wore good quality diapers and nobody asked them if they had any need to eliminate. In these cases, no communication of needs to eliminate was developed. Most of the Swedish mothers did not apply daily potty training until the age of 3 years [3]. One reason that facilitated communication between the Vietnamese children and their mothers was that the children did not use diapers. Elimination could be recognized immediately by both the child and the parent. To succeed with potty training, an ability and willingness to communicate are needed (Papers I and II). This thesis has shown that infant children have this competence seldom used in the Western world. Elimination is a need that can be satisfied and responded to even in infants. The thesis illuminates a cultural difference where children who are potty trained from early infancy are encouraged to communicate their needs whilst children potty trained late have to ignore this ability and use diapers for elimination until the time when potty training starts.

One of the factors affecting the communication development is bonding, which is also an important health factor in infants [57]. In this thesis we can see how the interaction between the child and parent affects maturation of the bladder control process. According to the general health considerations and development of skill, control of urine and faces is related to health and wellbeing [6, 7, 18]. The aim was not to investigate health aspects in general, but it is well known that being unable to control elimination affects self-esteem, and hence health and wellbeing in older children [58]. However, there is lack of studies on this aspect in preschool children.

An important finding from the thesis is that emptying of the bladder improves significantly with early potty training. In our study, interrupted voiding as a sign of dyscoordination between the bladder and the sphincter system was rarely seen in the healthy Vietnamese children or the boys with PUV (Figure 2, Paper IV). In a study of Swedish boys with PUV interrupted voiding were seen in more than 65% in all age groups and was still common at the age of 5 years [2]. This phenomenon has been demonstrated in between 43 and 60% of healthy infants before toilet training [34, 37, 41]. The findings indicate that early potty training has a positive effect on dyscoordination, which is usually seen before potty training.

As a consequence, post-residual urine decreased according to age for daily potty training in both Vietnamese children and Swedish children. In the Vietnamese healthy children, bladder emptying could be regarded as complete at the age of 9 months, compared with the Swedish healthy children who first showed complete emptying at the age of 36 months ($p < 0.0001$) (Papers I and III). It was stated earlier that healthy infants do not empty their bladder completely at each voiding, but these findings were related to children who were not yet potty trained [37, 39, 59, 60]. A micturition that is started voluntarily seems to allow complete emptying of the bladder compared with a micturition when using diapers. Studies by Wennergren show that the best position for girls, aged 6-10 years, to empty their bladder is to sit with support for their legs and feet. This position makes the pelvic floor muscles relax [40]. Children described in this thesis used a sitting position, but after the age of 2 the boys used to stand up.

The frequency of voiding decreased according to age in the groups of healthy Vietnamese children as well as in the Swedish children, however, the Vietnamese group had significantly fewer voiding below the age of 12 months ($p < .0001$) and lower voided volumes than the Swedish group (Table 2, Paper III). This result could be explained by Swedish children being bigger than Vietnamese children, but in fact no significant correlation has been found between body size and voided volumes (Paper III). These findings may be related to the habit of encouraging the child to void once per hour to once every two hours (Paper II). Findings before potty training with more frequent voidings are in accordance with a study by Gladh who found a voiding frequency of 1-7 times per 4 hours and Goellner who reported a frequency of 20 times per 24 hours in new-born children [37, 59].

Voided volumes increased slightly over time in all groups before potty training and increased rapidly after potty training (Papers I, II, and IV). This has previously been demonstrated in the study by Muellner, 1960 [22, 38]. The voided volumes were lower in the Vietnamese groups of children than in the Swedish children. This difference may be explained by Vietnamese people not drinking as much, and due to the pollution, drinking water not being available except when bought.

This is a pilot study and first attempt to investigate the benefits of early potty training in boys with PUV. Findings from 17 boys with PUV are compared with those of healthy Vietnamese boys (Paper IV). The number of boys investigated was low, but included boys with severe valves (Table 1, Paper IV). There were few signs of bladder dysfunction in the boys with PUV. The emptying was almost complete. Compared with the healthy Vietnamese boys however, there were differences indicating abnormalities. The number of voidings and interrupted voidings was higher in boys with PUV than in healthy infants, as confirmed by the results of earlier studies by Holmdahl [1, 2, 52]. With regard to the voided volumes, the differences were significant at the age of 0-1 year. The differences could be explained by the hypercontractile pattern of the bladder that is often seen in boys with PUV [2]. An earlier published study from Sweden, which included 23 boys with PUV followed with the 4-hour observation method, showed a higher number of voidings, more interrupted voidings, and higher post-void residual urine than in the present study of Vietnamese boys with PUV [2].

The findings indicate that the habit to prompt a child to void at 1-2 hour intervals already from infancy can improve bladder function to empty the bladder, including for children with poor emptying. This prompting may induce the micturition reflex to be released voluntarily from the brain earlier than is the case of children who are potty-trained late. Daily potty training already from infancy seems to facilitate the development of good bladder habits also in boys with PUV. The sitting position when urinating may also be beneficial for complete emptying. The potty training procedure used in Vietnamese children is coherent with the standard therapy recommended by the International Children Continence Society (ICCS) for children with dysfunctional bladder disturbances [63]. This therapy is aimed at calming down an over-active bladder and improves emptying in children who are already potty trained. However, we need more research on this topic to evaluate if early potty training does prevent post-natal bladder dysfunction.

CONCLUSIONS

It is possible to perform potty training in infant children by learning to communicate needs (Papers I, II, III, and IV). Avoiding using diapers may help in the potty training procedure (Papers I, II, III, and IV).

Early potty training already from infancy is beneficial for emptying the urinary bladder, also in boys with PUV (Papers I, III, and IV). Residual urine significantly decreases and interrupted voiding disappears (Papers I, III, and IV). No residual urine was shown in healthy children after the age of 9 months (Papers I and III).

When children had been potty trained, the number of voiding decreased and bladder volume increased (Papers I, III, and IV).

Early potty training reduced the symptoms of bladder dysfunction in boys with PUV (Paper IV).

CLINICAL IMPLICATIONS

Early potty training can be recommended in children with emptying problems and signs of bladder dysfunction.

The potty training method described can be a support to parents and health care professionals when potty training start.

Updated guidelines for potty training need to be discussed and created to support parents, health care centers, and preschools to meet individual needs.

FURTHER RESEARCH

Further studies have to be conducted to confirm the findings of the thesis.

Randomized follow-up studies have to be conducted to investigate the outcomes of early potty training in children with emptying difficulties and bladder dysfunction and also whether there are any benefits for the kidney function.

Further, impacts on wellbeing, quality of life, and self-esteem in late and early potty training need to be studied as well as the impacts on constipation and bladder dysfunction.

SVENSK SAMMANFATTNING

Avhandlingens övergripande syfte var att öka kunskapen om utvecklingen av blåsfunktion hos barn med fokus på tidig pottränning.

Specifika syften:

- Att beskriva, longitudinellt, utvecklingen av miktionsmönstret hos friska barn 0-3 år, som är pottränade tidigt (delarbete I och III).
- Att beskriva mammors erfarenhet i en pågående potträningsprocess och hur friska barn kommunicerar sina behov (delarbete II).
- Att jämföra longitudinellt, miktionsmönstret inklusive tömningsförmågan hos friska barn som är pottränade tidigt med barn som är pottränade sent (delarbete III).
- Att undersöka om pottränning redan från spädbarnsåldern kan påverka blåsdysfunktion hos pojkar med posterior urethra valvel (PUV)(delarbete IV).

Deltagare: Delarbete I-III. Fyrtiosju friska barn, ålder 0-3 år, följdes longitudinellt var 3:e månad. Delarbete IV. Sjutton barn födda med PUV, ålder 0-4 år, uppföljning efter 18 månader.

Metod: Kvantitativ uppföljning med 4-timmars miktionsobservation tillsammans med kvalitativa intervjuer av mammor. Jämförelser är gjorda mellan olika åldersgrupper av friska barn och en grupp av pojkar med PUV.

Resultat: Små barn i Vietnam använder sällan blöjor; de flesta pottränades dagligen från att de var 3 månader och alla barn från 12 månaders ålder. När det gäller svenska barn så hade ingen startat vid den åldern (delarbete I och III). Vid 24 månaders ålder hade 98% av de vietnamesiska barnen kunnat avsluta träningen. I jämförelse med den svenska gruppen så hade 5% startat daglig pottränning vid den åldern och vid 36 månader hade 55% kunnat avsluta träningen. Skillnaden var signifikant ($P < 0.001$). Daglig pottränning påverkade tömningen positivt; vid 9 månaders ålder fanns ingen residualurin hos de friska vietnamesiska barnen. Dessa resultat skiljer sig signifikant från den svenska gruppen av barn. Miktionsfrekvensen var lägre hos de vietnamesiska barnen jämfört med de svenska. Blåsvolymen ökade med ålder hos båda grupperna, men hos de vietnamesiska barnen var den signifikant lägre jämfört med de svenska barnen. Potträningsprocessen visade på hur kommunikationen mellan mamma och barn utvecklades (delarbete II). Redan under den första levnadsmånaden försökte mammorna känna igen tecken på att deras barn behövde kissa. Mammorna stödde sedan dessa tecken genom ett speciellt visselljud som hon också använde vid speciella tillfällen för att påminna. Vidare, resultaten från 4-timmars miktionsobservation visade få tecken på dysfunktionell blåsa hos de vietnamesiska barnen med PUV (delarbete IV). Men i jämförelse med friska vietnamesiska barn så fanns det signifikant fler tecken på blåsdysfunktion i gruppen med PUV.

Konklusion: Det är möjligt att potträna också små barn genom att lära att kommunicera dessa behov. Daglig pottränning påverkade tömningsförmågan positivt hos alla barn, inkluderande pojkar med PUV; vid 9 månaders ålder kunde man inte finna någon residualurin hos de vietnamesiska friska barnen. Miktionsfrekvensen och blåsvolymen var lägre hos de vietnamesiska barnen än de svenska. Tidig pottränning reducerade tecken på blåsdysfunktion hos pojkar med PUV.

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REFERENCES

1. Holmdahl, G., et al., *The changing urodynamic pattern in valve bladders during infancy*. J Urol, 1995. 153(2): p. 463-7.
2. Holmdahl, G., et al., *Four-hour voiding observation in young boys with posterior urethral valves*. J Urol, 1998. 160(4): p. 1477-81.
3. Jansson, U.B., E. Danielson, and A.L. Hellstrom, *Parents' experiences of their children achieving bladder control*. J Pediatr Nurs, 2008. 23(6): p. 471-8.
4. Mota, D.M. and A.J. Barros, *Toilet training: situation at 2 years of age in a birth cohort*. J Pediatr (Rio J), 2008. 84(5): p. 455-62.
5. deVries, M.W. and M.R. deVries, *Cultural relativity of toilet training readiness: a perspective from East Africa*. Pediatrics, 1977. 60(2): p. 170-7.
6. JW, K., *Philosophical and theoretical perspectives for advanced nursing practice*. 3. ed. Sudbury, Mass: Jones and Bartlett; 2002.
7. Stein, R.E., *Children's Health, the Nation's Wealth: Assessing and Improving Child Health*. Ambul Pediatr, 2005. 5(3): p. 131-3.
8. Onyango-Ouma, W., J. Aagaard-Hansen, and B.B. Jensen, *Changing concepts of health and illness among children of primary school age in Western Kenya*. Health Educ Res, 2004. 19(3): p. 326-39.
9. Pridmore P, B.G., *Images of health: Exploring beliefs of children using the "draw-and-write" technique*. Health Education Journal 1995: p. 54, 473-488.
10. Baret, H., *Parents and children: facts and fallacies about attachment theory*. J Fam Health Care, 2006. 16(1): p. 3-4.
11. Ebba Kostmann, L.N., *Children's perspective on health: What makes children feel good according to themselves*. International Journal of Education, 2012. ISSN 1948-5476, Vol.4, No. 1.
12. Owens, J.A. and C. Jones, *Parental knowledge of healthy sleep in young children: results of a primary care clinic survey*. J Dev Behav Pediatr, 2011. 32(6): p. 447-53.
13. Vereijken, C.M., H. Weenen, and M.M. Hetherington, *Feeding infants and young children. From guidelines to practice-conclusions and future directions*. Appetite, 2011. 57(3): p. 839-43.
14. Hockenberry ML, W.D., Winkelstein ML, Kline NE., *Wong's Nursing Care of Infants and Children*. Seventh ed, 2003. Seventh ed. S.T Lois: Mosby.
15. Betz CL, H.M., Wright S, *Family-centered nursing care of children* 1994. Second ed. Philadelphia: W.B. Saunders.
16. Stein, M.T., S.D. Dixon, and C. Cowan, *A two-year-old boy with language regression and unusual social interactions*. J Dev Behav Pediatr, 2000. 21(4): p. 285-90.
17. Fact sheet: A summary of the rights under the convention of the rights of the child. Available at: www.unicef.org/crc/files/Rights_overview.pdf. Accessed 2013-01-10.

18. Erikson, E.H., in *The life Cycle completed: A Review* 1982, New York: W.W. Norton: <http://www.psychology.iastate.edu>.
19. Bakker, E. and J.J. Wyndaele, *Changes in the toilet training of children during the last 60 years: the cause of an increase in lower urinary tract dysfunction?* BJU Int, 2000. 86(3): p. 248-52.
20. Hauck, M.R., *Mothers' descriptions of the toilet-training process: a phenomenologic study.* J Pediatr Nurs, 1991. 6(2): p. 80-6.
21. *Foraldrabalken 6 kap., 1 §.*, 1979. Available at: http://www.riksdagen.se/sv/Dokument-Lagar/Lagar/Svenskforfattningssamling/Foraldrabalk-1949381_sfs-1949-381/ - K13. Accessed 2013-06-14.
22. Muellner, S.R., *Development of urinary control in children: some aspects of the cause and treatment of primary enuresis.* J Am Med Assoc, 1960. 172: p. 1256-61.
23. Klackenbergh, G., *Expectations and reality concerning toilet training.* Acta Paediatr Scand, 1971: p. suppl, 224: 85.
24. Brazelton, T.B., *A child-oriented approach to toilet training.* Pediatrics, 1962. 29: p. 121-8.
25. Foxx, R.M. and N.H. Azrin, *Restitution: a method of eliminating aggressive-disruptive behavior of retarded and brain damaged patients.* Behav Res Ther, 1972. 10(1): p. 15-27.
26. Stadler, A.C., P.A. Gorski, and T.B. Brazelton, *Toilet training methods, clinical interventions, and recommendations.* American Academy of Pediatrics. Pediatrics, 1999. 103(6 Pt 2): p. 1359-68.
27. Hellstrom, A.L. and U. Sillen., *Early potty training advantageous in bladder dysfunction. Decreases the risk of urinary infection.* Lakartidningen, 2001. 98(28-29): p. 3216-9.
28. Kaerts, N., et al., *Toilet training in daycare centers in Flanders, Belgium.* Eur J Pediatr, 2012. 171(6): p. 955-61.
29. Vietnam Demographics Profile 2012. Available at: http://www.indexmundi.com/vietnam/demographics_profile.html. Accessed 2013-01-10.
30. The National Board of Health and Welfare, befolkningsstatistik. Available at: <http://www.socialstyrelsen.se/> Accessed 2013-01-08.
31. World Health Organization. Vietnam: Health Profile. 2012. Available at: <http://www.who.int/gho/countries/vnm.pdf> . Accessed 2012-10-01.
32. The World Factbook. Vietnam. 2012. Available at: <https://www.cia.gov/library/publications/the-world-factbook/geos/vm.html> . Accessed 2013-01-06.
33. National hospital of pediatrics. About us – National Hospital of Pediatrics. Available at: <http://www.nhp.org.vn/list.aspx?cat=001002>. Accessed 2012-12-12.
34. Jansson, U.B., et al., *Voiding pattern in healthy children 0 to 3 years old: a longitudinal study.* J Urol, 2000. 164(6): p. 2050-4.
35. Yeung, C.K., et al., *Natural filling cystometry in infants and children.* Br J Urol, 1995. 75(4): p. 531-7.

36. Mattsson, S.H., *Voiding frequency, volumes and intervals in healthy schoolchildren*. Scand J Urol Nephrol, 1994. 28(1): p. 1-11.
37. Gladh, G., et al., *Voiding pattern in healthy newborns*. Neurourol Urodyn, 2000. 19(2): p. 177-84.
38. Jansson, U.B., et al., *Voiding pattern and acquisition of bladder control from birth to age 6 years--a longitudinal study*. J Urol, 2005. 174(1): p. 289-93.
39. Roberts, D.S. and B. Rendell, *Postmicturition residual bladder volumes in healthy babies*. Arch Dis Child, 1989. 64(6): p. 825-8.
40. Wennergren, H.M., B.E. Oberg, and P. Sandstedt, *The importance of leg support for relaxation of the pelvic floor muscles. A surface electromyograph study in healthy girls*. Scand J Urol Nephrol, 1991. 25(3): p. 205-13.
41. Sillen, U., et al., *The voiding pattern of healthy preterm neonates*. J Urol, 2000. 163(1): p. 278-81.
42. Blum, N.J., B. Taubman, and N. Nemeth, *During toilet training, constipation occurs before stool toileting refusal*. Pediatrics, 2004. 113(6): p. e520-2.
43. Largo, R.H. and W. Stutzle, *Longitudinal study of bowel and bladder control by day and at night in the first six years of life. II: The role of potty training and the child's initiative*. Dev Med Child Neurol, 1977. 19(5): p. 607-13.
44. Sillen, U., *Bladder dysfunction in children with vesico-ureteric reflux*. Acta Paediatr Suppl, 1999. 88(431): p. 40-7.
45. Hansson, S., et al., *Urinary tract infections in children below two years of age: a quality assurance project in Sweden. The Swedish Pediatric Nephrology Association*. Acta Paediatr, 1999. 88(3): p. 270-4.
46. Lee, S.D., et al., *An epidemiological study of enuresis in Korean children*. BJU Int, 2000. 85(7): p. 869-73.
47. Bloom, D.A., et al., *Toilet habits and continence in children: an opportunity sampling in search of normal parameters*. J Urol, 1993. 149(5): p. 1087-90.
48. Hellstrom, A.L., et al., *Micturition habits and incontinence in 7-year-old Swedish school entrants*. Eur J Pediatr, 1990. 149(6): p. 434-7.
49. Jarvelin, M.R., et al., *Enuresis in seven-year-old children*. Acta Paediatr Scand, 1988. 77(1): p. 148-53.
50. *"Posterior urethral valves - Disease Information"*. Children's hospital, Boston. Retrieved January 31, 2011. Available at: <http://www.childrenshospital.org/az/Site1471/mainpageS1471P0.html>. Accessed 2013-05-06.
51. *Posterior urethral valves*. Available at: http://en.wikipedia.org/wiki/Posterior_urethral_valve. Accessed 2013-05-07.
52. Holmdahl, G., et al., *Natural filling cystometry in small boys with posterior urethral valves: unstable valve bladders become stable during sleep*. J Urol, 1997. 158(3 Pt 2): p. 1017-21.

53. Holmdahl, G., et al., *Four-hour voiding observation in healthy infants*. J Urol, 1996. 156(5): p. 1809-12.
54. Mantel, N. and W. Haenszel, *Statistical aspects of the analysis of data from retrospective studies of disease*. J Natl Cancer Inst, 1959. 22(4): p. 719-48.
55. Krippendorff, K., *Content analysis: an introduction to its methodology*. 2. ed2004, Thousand Oaks, Calif.: Sage. xxiii, 413 s.
56. *Declaration of Helsinki*. Available at: [http://www.wma.net/en/30publications/10policies/b3/index.html.pdf?print-media-type&footer-right_page\]/\[toPage\]](http://www.wma.net/en/30publications/10policies/b3/index.html.pdf?print-media-type&footer-right_page]/[toPage]). Accessed 2013-06-20.
57. Lynch, L. and S. Bemrose, *It's good to talk: pre- and post-birth interaction*. Pract Midwife, 2005. 8(3): p. 17-20.
58. Hagglof, B., et al., *Self-esteem in children with nocturnal enuresis and urinary incontinence: improvement of self-esteem after treatment*. Eur Urol, 1998. 33 Suppl 3: p. 16-9.
59. Goellner, M.H., E.E. Ziegler, and S.J. Fomon, *Urination during the first three years of life*. Nephron, 1981. 28(4): p. 174-8.
60. Hjalmas, K., *Micturition in infants and children with normal lower urinary tract. A urodynamic study*. Scand J Urol Nephrol, 1976. Suppl 37: p. 1-106.
61. Abrams, P.H., et al., *The results of prostatectomy: a symptomatic and urodynamic analysis of 152 patients*. J Urol, 1979. 121(5): p. 640-2.
62. Speakman, M.J., et al., *Cystometric, physiological and morphological studies after relief of bladder outflow obstruction in the pig*. Br J Urol, 1991. 68(3): p. 243-7.
63. Neveus, T., et al., *The standardization of terminology of lower urinary tract function in children and adolescents: report from the Standardisation Committee of the International Children's Continence Society*. J Urol, 2006. 176(1): p. 314-24.

APPENDIX

Bladder volume 27 ml at start, time: 8⁰⁰ am

Last meal: 7⁰⁰ am

Time	Void vol	Res urine	Eating (ml)	Asleep	Awake	Crying	Obs
8 ¹⁰					X		
20					X		
30	28	0		X			
40				X			
50				X			
9 ⁰⁰				X			
10				X			
20			40 ml milk	X			
30				X			
40				X			
50	27	3			X		
10 ⁰⁰					X		
10					X		
20			breast feeding		X		
30					X		
40	34	0			X		
50					X		
11 ⁰⁰					X		
10					X		
20					X		
30	30	0			X		
40					X		
50					X		
12 ⁰⁰					X		

4hr voiding obs

Highest bladder volume : 34 ml
 Voiding frequency : 4
 Highest/lowest residual urine : 3/0
 Interrupted voidings : 0