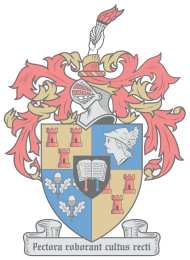
Descriptive review of the health supervision received by children with Down syndrome at Worcester Provincial Hospital from 2010 to 2015.

by Leilah Schoonraad



Thesis submitted in fulfilment of the requirement of the degree of Master of Medicine in the Faculty of Medicine and Health Sciences, at Stellenbosch University

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Declaration

By submitting this thesis electronically, I declare that the entirety of the work contained in this assignment is my original work, that I am the authorship owner thereof (unless to the extent explicitly otherwise stated) and that I have not previously submitted it, in its entirety or in part, at any university for a degree.

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Abstract

Background:

In 2011, the American Academy of Paediatrics (AAP) published revised guidelines for health supervision of children with Down syndrome (DS). In the absence of South African guidelines, we described the health supervision received by children with DS at a regional (level 2) Western Cape Hospital and compared it to the AAP guidelines.

Methods:

This was a 5 year retrospective description of implementation of the 2011 AAP recommendations at the DS clinic at Worcester Provincial Hospital (WPH), specifically related to cardiac, thyroid, hearing and haematological disorders. Data was extracted from patient medical folders and the National Health Laboratory Database. The proportion receiving screening components was compared between the children using WPH as their primary care facility and children referred from peripheral hospitals.

Results:

Sixty-two children received care at WPH DS clinic during the study period. Thirty-six (58%) children lived in Worcester while 26 (42%) were referred from peripheral hospitals. The median age at first clinic visit was 0.5 years (interquartile range (IQR) 0.2-1.2), there was a total of 177 person-years of follow up with a median duration of follow up of 1.8 years (IQR 0.3-4.8) and 2 deaths occurred in the study period. Forty nine children (79%) had a screening echocardiogram performed, the median age at first echocardiogram was 0.8 years (IQR 0.2-1.4). Five (13.9%) children from WPH compared to no children from the peripheral hospitals received the echocardiogram within the first month of life (p =0.056). Those requiring cardiac surgery were operated on at a median age of 2years (IQR 0.9-2.3). Compared to the AAP recommendations, within the first month of life 17 (27.4%) children had a thyroid screen, 20 (32.3%) children had a full blood count and 7 (11.3%) children had a hearing assessment.

Conclusion:

AAP recommendations for health supervision in DS are challenging to achieve within our local health system. The development and advocacy for a South African DS health supervision guideline might improve the care of children with DS.

Opsomming:

Agtergrond:

In 2011 het die Amerikaanse Akademie vir Pediatrie (AAP) gewysigde riglyne oor gesondheidtoesig vir kinders met Down sindroom (DS) gepubliseer. In die afwesigheid van Suid-Afrikaanse riglyne het ons die gesondheidtoesig omskryf wat kinders met DS op streekvlak (vlak 2) by 'n Wes-Kaapse-hospitaal ontvang het en dit met die AAP se riglyne vergelyk.

Metodes:

'n Vyfjaar- retrospektiewe beskrywing van die implementering van die 2011 AAP-aanbevelings by die DS-kliniek van die Worcester Provinsiale Hospitaal (WPH), spesifiek met betrekking tot kardiologiese, tiroïed-, gehoor- en hematologiese versteurings, is gedoen. Data is uit pasiëntlêers en die Databasis van die Nasionale Gesondheidslaboratorium ingewin. Die proporsie van pasiënte wat siftingskomponente ontvang het, is vergelyk tussen die kinders wat WPH as hulle primêresorgfasiliteit gebruik het en kinders wat van perifere hospitale daarheen verwys is.

Resultate:

Twee-en-sestig kinders het tydens die studietydperk sorg by die WPH se DS-kliniek ontvang. Ses-en-dertig (58%) kinders het in Worcester gewoon, terwyl 26 (42%) deur perifere hospitale daarheen verwys is. Die mediaanouderdom by die eerste kliniekbesoek was 0.5 jaar (interkwartielafwyking (IQR) 0.2-1.2), daar was opvolg van altesaam 177 mensjare, met 'n mediaanopvolgduur van 1.8 jaar (IQR 0.3-4.8), terwyl 2 sterftes in die studietydperk voorgekom het. Nege-en-veertig kinders (79%) het 'n siftingseggokardiogram ondergaan, en die mediaanouderdom tydens die eerste eggokardiogram was 0.8 jaar (IQR 0.2-1.4). Vyf (13.9%) kinders van WPH, in vergelyking met geen kinders van perifere hospitale, het die eggokardiogram in hul eerste lewensmaand ontvang (p=0.056). Diegene wat hartoperasies benodig het, is op 'n mediaanouderdom van 2 jaar (IQR 0.9-2.3) geopereer. In vergelyking met die AAP-aanbevelings, het 17 (27.4%) kinders in die eerste lewensmaand 'n tiroïedsifting ondergaan, 20 (32.3%) kinders het 'n volbloedtelling gehad en 7 (11.3%) kinders het 'n gehoortoets ondergaan.

Gevolgtrekking:

Die AAP-aanbevelings vir gesondheidtoesig in DS stel 'n uitdaging vir ons plaaslike gesondheidstelsel om na te kom. Die ontwikkeling van en aanbeveling vir 'n Suid-Afrikaanse DS-gesondheidtoesigriglyn kan moontlik die sorg van kinders met DS verbeter.

Acknowledgements

I would like to express my sincere gratitude to my research supervisors, Dr A Slogrove, Dr A Engelbrecht and Dr M Urban for their continuous support and encouragement throughout this project. I am humbled and inspired by your patience and expert knowledge that have guided me through this journey.

I would also like to thank the staff at Worcester Provincial Hospital (WPH) for without their assistance and approval this research would not have been possible. Thank you to Sr. Zinkfontein who assisted me with compiling a list of Down syndrome clinic attendees from medical archives and finding medical records.

A special thank you to my family and friends for their continuous support and words of encouragement during this project.

Dedication:

I dedicate this thesis to the three mothers in my life, Mariam, Naz and Gale. You have each shown me what it means to keep pushing forward in the face of adversity. You have raised a strong and empowered woman. I am eternally grateful.

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List of Abbreviations

AAP- American Academy of Paediatrics

AIDS- Acquired Immunodeficiency Syndrome

ASD- atrial septal defect

AVSD- atrioventricular septal defect

CD- congenital disorders

CHD- congenital heart defect

CRF- Case Report Form

DS- Down syndrome

ENT- Ear, nose and throat

FT4- Free thyroxine

HREC- Health Research Ethics Committee

HIV- Human Immunodeficiency Virus

IQR- Interquartile range

LSEN- Learners with Special Educational Needs

MDG- Millennium Development Goal

SA – South Africa

SD- standard deviation

TSH- Thyroid stimulating hormone

VSD- ventricular septal defect

WPH- Worcester Provincial Hospital

List of Definitions:

Advanced maternal age: maternal age more than 35 years at time of delivery[15]

Late diagnosis of Down syndrome: diagnosis made after the age of one month[10]

Trisomy 21: 47 chromosomes with a free extra chromosome 21 being present[10]

Translocation: extra chromosomal material as the result of an unbalanced translocation between chromosome 21 and another acrocentric chromosome, usually chromosome 14[10]

Mosaic: a mix of 2 cell lines present in a karyotype, i.e. one normal and the other with trisomy 21[10]

Regular clinic follow up: child presented at least once more after the initial visit and was not lost to follow up

Lost to follow up: failure to present for follow up after more than 24 months had passed

Screening echocardiogram: initial echocardiogram performed in order to determine the presence or absence of an associated cardiac lesion. The screening echocardiogram may be performed whether symptoms of cardiac disease are present or not[11]

Pulmonary hypertension: raised mean pulmonary arterial pressure greater than 25mmHg at rest with no evidence of left atrial hypertension (left atrial mean pressure <15mmHg)[15]

Ostium secundum atrial septal defect: abnormally large opening in the atrial septum at the site of the foramen ovale and the ostium secundum[26]

Ostium primum atrial septal defect: defect in the atrial septum at the level of the tricuspid and mitral valves[26]

Congenital hypothyroidism: Any patient with a high TSH level demonstrated within the newborn period (first 2-28 days of life)[5]

Overt hypothyroidism: A high TSH level and a corresponding low FT4 level (TSH >10µIU /l)[5]

Subclinical hypothyroidism: A high TSH level in the presence of a normal FT4 level (TSH >10µIU /l)[5]

Hyperthyroidism: A low TSH level and a high FT4 level (TSH <0.5 µIU /l)[5]

Microcytic anaemia: haemoglobin less than 2 standard deviations for age and associated with low mean corpuscular volume (MCV<80-100 fl)[25]

Bicytopenia: simultaneous reduction of 2 cell lines in the full blood count[25]

Pancytopenia: simultaneous reduction of all 3 cell lines in the full blood count[25]

Transient myeloproliferative disorder: transient elevation in white blood cell count (>11000mm^3) that may be accompanied by hepatosplenomegaly or pericardial and pleural effusions[24]

Otitis media: inflammation of the middle ear[28]

Chronic suppurative otitis media: perforated tympanic membrane with persistent drainage from the middle ear (i.e. lasting > 6-12 weeks)[28]

Hearing impairment: as determined by pure tone audiometry: mild (26-40dB), moderate (41-55dB), moderately severe (56-70dB), severe (71-90dB), profound (> 90dB)[27]

Symptoms of obstructive sleep apnoea: any symptoms of heavy breathing, snoring, restless sleep, frequent night awakening, daytime sleepiness or apnoeic pauses, or behaviour changes that could be associated with poor sleep[10]

Signs or symptoms of atlantoaxial instability: any symptoms of change in gait or use of arms or hands, change in bladder or bowel function, neck pain, stiff neck, torticollis or weakness[10]

Chapter 1: Introduction and Literature review

South Africa (SA) is in a state of epidemiological transition as childhood deaths from congenital disorders (CDs) increasingly emerge as a leading cause of death in children while infections, particularly HIV/AIDS, decrease. In SA it is estimated that CDs affect 6.8% or one in 15 live births[1]. Despite the lack of empirical data in SA, the previously hidden disease burden of CDs is beginning to emerge through mortality data. In 2013, congenital disorders overtook infection as the third leading cause of death in the early neonatal period[2]. CDs have not yet been addressed in SA as a priority healthcare issue in terms of World Health Resolution (WHA) 63.17 of 2010 that outlined specific actions for commitment and allocation of resources by member states. This recognises the importance of CDs and their contribution to both under- 5 mortality and to the failure to attain Millennium Development Goal (MDG) 4 (MDG 4: to reduce child mortality)[3]. Although CDs are not specifically addressed in the United Nations' Sustainable Development Goals of 2030[4] the recognition and management of co-morbidities associated with Down syndrome will certainly assist in achieving Goal 3 (ensure healthy lives and promote well-being for all at all ages).

1.1 Burden of congenital chromosomal disorders in South Africa

Down Syndrome (DS) is the most common congenital chromosomal abnormality observed in live born infants, and is the most frequent genetic cause of intellectual disability [5]. Studies conducted in SA show a prevalence of DS of 1.8 and 2.09 per 1000 live births in hospital–based studies in urban and rural populations' respectively[6]. To put this into context, the prevalence of HIV in the general infant population in South Africa is 8 per 1000 live births and likely to continue decreasing[7]. This highlights the need for prioritization of services for the care and prevention of CDs as the country's epidemiological transition evolves and the relative contribution of CDs to childhood morbidity and mortality increases.

1.2 Co-morbidities associated with Down syndrome and the current recommendations for screening

The birth of a child with DS has many serious implications including physical and intellectual disability , medical conditions and lifestyle challenges[8]. The value of routine screening tests and genetic counselling has been well established, as they pre-empt the need for targeted therapy, early intervention programmes and support groups that result in better quality of health and significant developmental progress for affected individuals[9]. The South African Human Genetic Policy Guidelines[10] includes a basic list pertaining to the management of DS, rather than a specific protocol. In 2011, the American Academy of Paediatrics (AAP) readdressed the issue of follow up for prevalent medical complications in DS by revising their clinical protocols focusing on improving the level of functioning and quality of life of children with DS[11]. Middle-income countries such as Thailand and South Africa have adopted and adapted these guidelines[8]. The care of children with DS, as recommended by AAP[11], outlines opportunities for health supervision to occur at specific intervals: neonatal and infancy (1 month to 1 year), early childhood (1 to 5 years), late childhood (5 to 13 years) and adolescence (Appendix 2). As the diagnosis and care for DS is largely centred in tertiary services in SA, this will have implications in accessing services and continuity of care for children-later-adults with DS.

1.2.1 Cardiac disease

Optimal screening for congenital cardiac disease requires an echocardiogram that should be done during the immediate neonatal period to exclude a congenital heart defect (CHD)[11]. In fifty per cent of children with DS a significant cardiac lesion will be detected[12]. These patients will then require further review by a paediatric cardiologist if there are any abnormalities on the screening echocardiogram. The AAP recommends a screening echocardiogram in the first month of life and monitoring for signs and symptoms of congestive heart failure at all subsequent visits if a congenital heart lesion is detected[11]. In South Africa, congenital cardiac lesions associated with DS make up 8- 9% of the clinical load of a tertiary referral centre (Red Cross War Memorial Children's Hospital) for the investigations and surgical repair of the CHD[13]. The majority of children with DS and congenital cardiac defects (60%) will have simple defects such as ventricular septal defects, Tetralogy of Fallot or patent arterial ducts. The remaining 40% of patients with DS and a cardiac abnormality will have an atrioventricular septal defect, which is a far more complex lesion. Prompt diagnosis and the treatment of complex cardiac lesions is critical in the care of DS patients since they have a tendency to develop accelerated pulmonary hypertension compared to patients without DS. This accelerated pulmonary hypertension develops in patients with DS due to associated abnormalities such as mid-face hypoplasia and resultant airway obstruction[14].

1.2.2 Thyroid disorders

The AAP recommends doing a TSH during the neonatal period in all DS newborns as there is a 1% risk of congenital hypothyroidism[11]. Thereafter, a TSH should be performed at 6 and 12 months of age, and then annually. The long term consequences of untreated congenital hypothyroidism include severe neurocognitive impairment, growth retardation, decreased physical activity and weight gain that can all compound the long-term challenges experienced by DS children and adults[5].

1.2.3 Ear, Nose and Throat (ENT) disorders

There is a significant (75%) risk of ENT disorders, including serous otitis media, stenotic external auditory canals and hearing loss in children with DS and the AAP recommends brainstem auditory evoked responses or otoacoustic emission testing within the neonatal period[11]. Thereafter an audiology evaluation at 6 months is recommended. If normal hearing is established a behavioural audiogram and tympanometry should be performed 6 monthly in between 1 to 5 years of age until bilateral ear specific testing is possible. Additionally, assessment for obstructive sleep apnoea should occur within the first year and thereafter at all health maintenance visits[11].

1.2.4 Ophthalmological disorders

Newborns with DS carry a 15% risk of congenital cataracts that should be screened for at birth by examining the newborn for a red reflex and repeating this test at all 1 month to 1 year follow ups. Furthermore, ophthalmology referral to exclude strabismus, cataracts and nystagmus should occur within the first year[11].

1.3 Use of the AAP guidelines in the care and follow up of children with Down syndrome in South Africa

In 2011, a study investigating the management of 72 DS patients was conducted to compare the clinical management of DS children in 3 Kwazulu-Natal hospitals in South Africa where the AAP guidelines are implemented. This study observed good adherence to the AAP recommendations for cardiac screening that occurred in 85% of DS patients, but did not provide information about the timing of screening or details about the subsequent management required. This study also showed that the frequency of services provided to screen for hearing (56%), vision (56%) and thyroid dysfunction (18.1%) were suboptimal[15]. These findings suggest that the AAP recommendations for the standardization of health checks in DS may need adaptation within the local South African public health system. However, as it is an evidence-based, comprehensive and widely available guideline it remains an important clinical tool in the follow up care of DS patients in South Africa.

1.4 Study context

Worcester Provincial Hospital (WPH), the setting for this study, is a 296 bed secondary level hospital located in the Boland/Overberg region of the Western Cape. WPH is approximately 110km from Cape Town and the vast majority of patients are from low to very low-income groups. Many people living in the Overberg live in informal housing and most employed people work as farm workers and seasonal labourers. WPH receives referrals from 7 district hospitals and over 87 clinics and provides mainly secondary level care with some primary and tertiary services. It has facilities for computerised tomography scanning, x-rays, an on-site laboratory and some specialist services, such as ENT and ophthalmology, but with the large demographic area catered for at WPH these services are often overloaded. Paediatric echocardiography services are not routinely available. At this rural facility, a DS clinic is conducted once every 3 months by a specialist paediatrician with the aim to ensure the standardisation of follow up care provided to DS patients at WPH, in accordance with the AAP guidelines. The DS clinic has been operating from 2009 and approximately 90 patients from Worcester and the surrounding areas receive their follow up care at this clinic. The tertiary level referral facility, Tygerberg Children's Hospital in Cape Town, performs neurology, cardiology and genetics subspecialist outreach clinics three to four times each year at WPH. The cardiology outreach clinics are performed by the Paediatric Cardiology Service of the Western Cape, which includes cardiologists from Red Cross War Memorial Children's Hospital. Without this essential service children from the WPH drainage area would instead need to travel hundreds of kilometres (for example 264 km from Laingsburg to Cape Town) for regular DS follow up.

1.5 Study aim and objectives:

The study aimed to describe the health supervision received by children with Down syndrome at WPH as compared to American Academy of Paediatrics (AAP) guidelines. The primary objectives sought to determine the proportion of children receiving key components of the AAP guidelines including the following: diagnosis of DS within first month of life, echocardiogram screening before 1 month of age; monitoring for signs of cardiac failure at any follow up visit; thyroid screening before 1 month of age, 6

months, 12 months and then annually; haematologic screening before 1 month of age and then annually; audiology evaluation at 6 months of age; eye exam for cataracts before 12 months of age; assessment for symptoms of obstructive sleep apnoea before 12 months of age; evaluation for symptoms or signs of atlantoaxial instability at any follow up visit. The secondary objectives were to describe the demographic and social background of children with DS in the region, their outcomes including medical co-morbidities and the management thereof. Other secondary objectives were to descrive the duration of follow up and the proportion of children who were lost to follow up and to identify obstacles that may prevent consistency of care and follow up in this rural context.

Chapter 2: Study methods:

2.1 Study design:

A retrospective descriptive study of children aged 1 month to 13 years attending the dedicated specialist run Down syndrome clinic at WPH from 2010 to 2015 was performed.

2.2 Study population:

Children identified by medical archives and the DS clinic register as being in follow up at the WPH DS clinic were included. Children who had congenital disorders other than Down syndrome were excluded as well as those less than one month of age at time of data extraction or with missing hospital records.

2.3 Data collection:

The categorical variables of gender, age and place of primary residence were recorded in order to describe the demographics of the population. Maternal and child date of birth were recorded in order to determine the number of mothers with advanced maternal age and to determine if a late diagnosis was made in a child. Karyotype results were recorded in order to determine the most frequent chromosomal abnormality in the study group. Dates of clinic visits and record of regular clinic attendances were collected in order to determine the rate of loss to follow up. Hospitalisation rates and indications for admission were collected. Study variables and their definitions are detailed in the List of Definitions preceding Chapter 1. Clinical data was sought in the original medical folder and the National Health Laboratory database. Each child was allocated a unique study number for the duration of the study. Data was collected onto a paper based standardized case report form (CRF) (Appendix 1). The form consisted of two parts: the first related to demographic questions about age, gender, primary care hospital and details of the Down syndrome diagnosis. The second part contained questions relating to the recommended healthcare guidelines by the AAP as well as information that could provide guidance about possible obstacles to consistent follow up care. The CRFs were stored in a locked cupboard and could only be accessed by the primary investigator. The data from the paper CRFs were entered into an electronic Excel database. The electronic database was stored on the primary investigators computer and was password protected. Backup copies of the database were regularly made and safely stored.

2.4 Statistical Analysis:

Basic descriptive statistics were calculated, including frequencies for categorical variables and measures of central tendency and variation for continuous variables. Categorical variables and their associations were evaluated using the parametric Chi-squared test. The primary outcomes (echocardiogram screening before 1 month of age, etc.) were categorical variables and their association was evaluated using the parametric Chi-squared test using Stata Version 14 (StataCorp, Texas). To evaluate the association of other categorical variables, the Chi-squared test was used if assumptions were met or the

non-parametric Fishers Exact test when assumptions for the Chi-squared test were not met. For associations with numeric variables the students T-test was used for normally distributed data and the Wilcoxon rank sum test for non-normally distributed numeric data. Statistical significance was interpreted as a 2-sided p-value of <0.05. For selected characteristics comparative analysis was performed between the participants who were identified as using WPH as their primary care facility and those referred from peripheral hospitals.

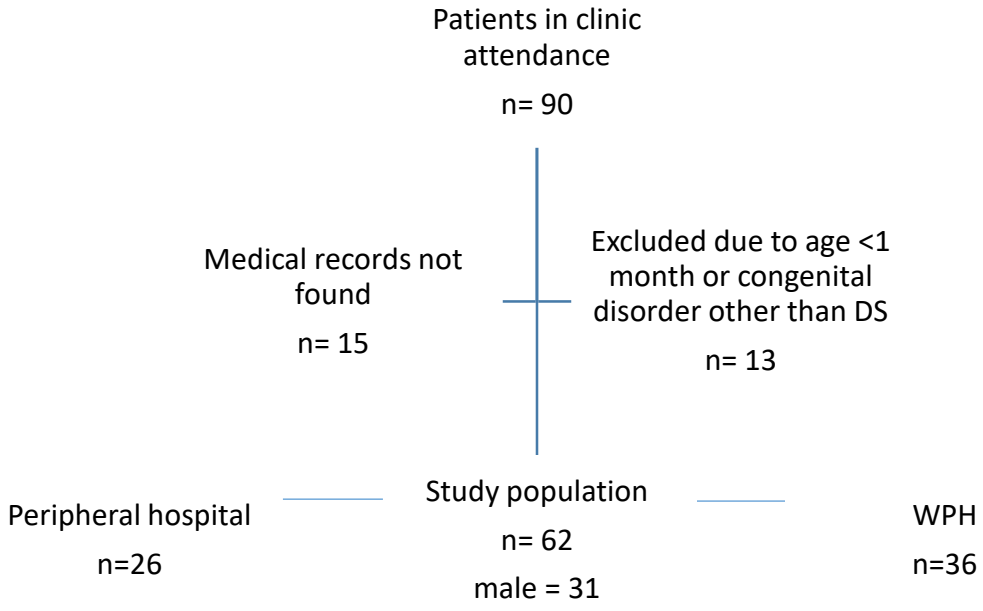
2.5 Ethical considerations

A waiver of individual informed consent was requested from Stellenbosch University Health Research Ethics Committee (HREC) as the study only made use of routinely recorded medical data. No contact with the patient or patient's family was made and there was no influence on the care received. A unique study number was allocated to each medical folder to allow for anonymous data collection, analysis and reporting. All collected data was stored at a secure location in a password protected database using Microsoft Excel so that only the investigator and the supervisor had access to this information. The study received approval from the post graduate committee of the Department of Paediatrics and Child Health, the Stellenbosch University HREC (HREC reference: S15/09/201) and the Provincial Government of the Western Cape Health Impact Assessment Committee (WC_2015RP47_432).

Chapter 3: Results:

From January 2010 to December 2015, a total of 90 children were actively in follow up or had received follow up at the Down syndrome clinic at WPH. Due to missing hospital records 15 children could not be included in the study. A further 13 children were also excluded as they were either under the age of 1 month or had congenital disorders other than Down syndrome and thus 62 children were finally included in the study (Figure 1). The total number of clinic visits in the 62 children was 345 with a total of 177 person-years of observation. The median (interquartile range (IQR)) number of clinic visits was 5 (2-8) visits and the median (IQR) years of follow up was 1.8 (0.3-4.8) years.

Figure 1: Distribution of study sample



DS – Down syndrome, WPH- Worcester Provincial Hospital

There was an equal number of girls and boys with a median (IQR) age of 5.4 (2.2-8.9) years at last follow-up visit. Thirty six children (58%) lived in Worcester while 26 (42%) were referred from the peripheral hospitals: Hermanus (N=3 (4.8%)), Caledon (N=6 (9.7%)), Ceres (N= 5 (8.1%)), Montagu (N= 3 (4.8%)), Robertson (N= 4 (6.5%)), Bredasdorp (N= 2 (3.2%)) and Laingsburg (N= 3 (4.8%)). Forty children (65%) were cared for by a single mother or close family relative. One child lived in a long term care facility and 3 children were in the care of a foster parent.

3.1 Details of diagnosis

Fifty one children (82%) had a karyotype confirmed diagnosis, while 11 children (18%) had no karyotype performed or the result was unknown (Table 1). Overall, the median age (IQR) at the time of diagnosis

was 0.2 (0 - 2.9) months. This includes diagnoses made either by a clinical assessment only or by karyotype analysis. The age range for time of diagnosis was from 0 days (antenatal diagnosis) to the oldest age at time diagnosis of 4 years. The median (IQR) age at time of diagnosis (Table 1) was slightly, but not significantly, older if born at a peripheral hospital compared to WPH (0.5(0- 4.8) months vs 0.1 (0- 1.2) months; p = 0.43). Twenty two children (35.5%) had a late diagnosis made, i.e. after 1 month of life, either by karyotype or clinical assessment, with no difference between children at WPH compared to children diagnosed at peripheral hospitals (36% (13/36) vs. 35% (9/26), p=0.56). One child had an antenatal diagnosis made following amniocentesis. Karyotype results showed that DS was due to trisomy 21 in 86% (44/51), translocation in 11% (6/51) and 1 child had a mosaic karyotype. The mean (standard deviation (SD)) maternal age at time of delivery was 31.7 (8.5) years for the entire population, with a trend toward older maternal age among those born at WPH than those referred from peripheral hospitals (33 (7.1) years vs. 29 (9.9) years; p = 0.06).

3.2 Social support and genetic counselling services

Fifty three (86%) children were offered social support services or genetic counselling at follow up with 52 (84%) children in receipt of the government care dependency grant. Only 5 (5%) children were reviewed by a genetic counsellor and the caregivers of 34 (55%) children had access to a Down syndrome support group. Forty four (71%) children were of school going age and 20 (45%) of these were enrolled in schools for Learners with Special Educational Needs (LSEN), with the remainder being in mainstream schooling.

3.3 Clinic attendance and hospitalisation

The median (IQR) age at first clinic visit was 0.5 (0.2- 1.2) years and the median (IQR) duration of follow up was 1.8 (0.3- 4.8) years. Down syndrome specific growth charts were used for all children at follow up. Nineteen (31%) children were lost to follow-up, 12/36 (33%) children from Worcester compared to 7/26 (27%) children from peripheral hospitals (p=0.59). In the children lost to follow up the median (IQR) age at last clinic visit was 1.8 (0.5- 5.6) years and the median (IQR) age at time of diagnosis of those lost to follow up was 1.7 (0- 5.4) years.

Factors that hindered consistent follow up care were identified from the records of twelve (19%) children with failure to access hospital transport (6/12, 50%) being the most frequent reason. Financial insecurity (2/12, 17%) and lack of information given about importance of screening tests (2/12, 17%) were noted as other factors that deterred regular follow up. No medical specialist available for consultation on the day of the clinic visit resulted in 5 (8%) children not being referred for screening investigations. This problem occurred most often for DS children requiring ophthalmological screening.

Forty (65%) children required hospitalisation at some stage during their follow up care with bronchopneumonia (56%) being the most frequent reason for admission (Table 1), followed by congestive cardiac failure (16%), acute gastroenteritis (7%), meningitis (5%) and seizures (1%). Two children (3%) died during follow up; one death was related to an infectious complication of staphylococcal septicaemia in a child living in a long term care facility. The second death occurred in a 21 month old child due to pulmonary hypertension and a congenital cardiac defect.

Table 1: Details of diagnosis, follow up and hospitalisations

	Total (N=62)
Median (IQR) age at time of diagnosis (months)	0.2 (0-2.9)
Late diagnosis (%)	22 (35.5)
Mean (SD) maternal age in years	31.6 (8.5)
Karyotype: N=62 Trisomy 21 (%)	44 (71.0)
Mosaicism (%)	1 (1.6)
Translocation (%)	6 (9.7)
Unknown (%)	11 (17.7)
Number of children lost to follow up (%)	19 (30.6)
Number of children with at least one hospitalisation (%)	40 (64.5)
Reasons for hospitalisation (N=75)	
Bronchopneumonia (%)	42 (56.0)
Congestive cardiac failure (%)	12 (16.0)
Acute gastroenteritis (%)	7 (9.3)
Meningitis (%)	5 (6.7)
Seizures (%)	1 (1.3)
Other/unknown (%)	8 (10.6)

3.4 Cardiac co-morbidity

Forty nine (79%) children had a screening echocardiogram at some stage during their follow up to assess for associated cardiac lesions (Table 2). Five (14%) children from within the WPH group received the echocardiogram within the first month of life, while none of the children from the peripheral hospitals were screened before 1 month of age (p= 0.056). Overall, the median age at first echocardiogram screen was 0.8 years (IQR 0.2- 1.4 years). In children with regular clinic attendance 44/49 (89%) had an echocardiogram compared to those lost to follow up in whom 8/13 (62%) had an echocardiogram (p≤0.001).

Fifty five percent of children with an echocardiogram (27/49) were found to have cardiac lesions with the most frequent cardiac lesions being atrial septal defect (ASD) (9/27; 33%), ventricular septal defect (VSD) (7/27; 26%) and atrioventricular septal defect (AVSD) (7/27; 26%) (Table 2). Two children (2/49; 4%) were found to have pulmonary hypertension on either a screening or follow up echocardiogram. Twenty two (36%) children required at least one hospitalisation for a primary cardiac cause with a mean number of 1.4 admissions per child and a median (IQR) age of 6 (2- 18) months at the time of first hospitalisation. Among the 27 children with cardiac lesions, one child known with an AVSD and pulmonary hypertension had died due to cardiac failure with an inoperable lesion (further details presented below 'Cardiac mortality case'). Fifty six percent (15/27) of children with a cardiac lesion required some form of management for the cardiac disease with all 15 children receiving medical management (anti-failure treatment), 52% (14/27) of children underwent a cardiac catheterisation

procedure and 44% (12/27) of children required cardiac surgery. The median (IQR) age at first echocardiogram for those receiving cardiac surgery was 0.3 (0.2-1.3) years, none having their initial screening echocardiogram under the age of 1 month. The median (IQR) age at the time of cardiac surgery was 2 (0.9- 2.3) years. All children were monitored for clinical signs or symptoms of cardiac failure at each DS clinic visit.

3.5 Cardiac mortality case:

This death occurred in a 21 month old female patient. She was diagnosed with DS at a peripheral hospital at 5 weeks of age and presented for the first time to WPH at the age of 3 months when she was admitted for a lower respiratory tract infection. She was reviewed at the DS clinic 6 months after the hospitalisation and was referred for an echocardiogram to be performed at the next available elective date. This investigation was performed at the age of 13 months and 3 weeks and it revealed an atrioventricular septal defect and established pulmonary hypertension. She had 5 subsequent clinic visits, including visits to Red Cross Children's Hospital, however due to the presence of irreversible pulmonary hypertension her cardiac defect was deemed inoperable.

Table 2: Cardiac co-morbidities

	Total N=62
Screening echocardiogram performed- N (%)	49 (79.0)
Age (years) at time of echocardiogram - median (IQR)	0.8 (0.2-1.4)
Echocardiogram performed <1 month- N (%)	5 (8.1)
Cardiac lesion on screening echocardiogram – N (%)	27 (43.5)
Echocardiogram findings: N=27	
Atrial septal defect (%)	9 (33.3)
Ventricular septal defect (%)	7 (25.9)
Atrioventricular septal defect (%)	7 (25.9)
Patent ductus arteriosus (%)	1 (3.7)
Valvular lesion (%)	1 (3.7)
Pulmonary hypertension (%)	2 (7.4)
Hospitalized at least once for a primary cardiac reason – N (%)	22 (35.5)
Age at time of primary cardiac hospitalization in months – median (IQR)	6 (2-17.9)
Management of cardiac lesion: N=27	
Medical management (%)	15 (55.6)
Cardiac catheterization ± intervention (%)	14 (51.9)
Cardiac surgery (%)	12 (44.4)
Age at time of cardiac surgery in years – median (IQR)	2.0 (0.9-2.3)
CCF monitoring at each visit (%)	62 (100)

3.6 Other medical co-morbidities: Thyroid, haematological, ENT, ophthalmological disorders and atlantoaxial instability.

Thyroid disorders

Seventeen (27%) children had a thyroid function screen performed within the first month of life, as recommended by the AAP (Table 3). The mean (SD) age at first thyroid screen was 2.3 (3.8) months. Thirty three (53%) children were appropriately screened at the recommended age 3-9 month clinic visit as well as 35 (59%) children were screened at the recommended age 9-15 month clinic visit. Twenty eight (57%) children over the age of 2 years continued to receive annual thyroid function screening in accordance with the AAP and while repeat thyroid function tests were performed in all remaining children they were done at inconsistent intervals. Twenty one (34%) children were found to have evidence of thyroid dysfunction with subclinical hypothyroidism (15/21; 71%) being the most frequently detected abnormality; 5 (24%) children were overtly hypothyroid and required hormone supplementation. One (5%) child was found to have hyperthyroidism.

Haematological disorders

Twenty (32%) children had a screening haemoglobin test or full blood count performed within the first month of life, as is recommended by the AAP, and only 2 (4%) children of those over the age of 2 years had a haemoglobin screen performed annually (Table 3). Haematological disorders were detected in 17 children with microcytic anaemia (12/17; 71%) the most frequent abnormality detected; three children (18%) had a bicytopenia; one (6%) child had a transient myeloproliferative disorder and one (6%) child had a pancytopenia.

ENT disorders

Seven (11%) children had a hearing screen performed within the first month of life, as recommended by the AAP, while a further 16 (26%) children were later screened at age 3-9 month clinic visit. All patients were routinely referred to an ENT surgeon for screening at the recommended age groups (under one month and at 3-9 months) and also at the time of presentation with an acute infection or concerns of hearing impairment. Forty seven (76%) children, evaluated by an ENT surgeon, were found to have an ENT disorder with infective complications with otitis media (18/47; 38%) and chronic suppurative otitis media (22/47; 47%) being the most frequent. Twelve (26%) children of those with an ENT disorder had hearing impairment. Forty one (66%) children were reviewed for upper airway obstruction, with 9/41 (22%) having symptoms of obstructive sleep apnoea and 13/41 (32%) had adenoidal hypertrophy. The insertion of grommets (27%) and adenoidectomies (13%) was required as a surgical management procedure for some patients diagnosed with ENT disorders during follow up.

Ophthalmological disorders

All children were examined for possible signs of cataracts (absent red reflex) by the clinic paediatrician, however only 9 (15%) children were reviewed by an ophthalmologist for signs of strabismus, cataracts, and nystagmus under the age of 1 year as recommended by the AAP. Refractory error was the most frequent disorder (44%) detected in those diagnosed with ophthalmological disorders.

Atlantoaxial instability

Seventeen (27%) children were documented to have been screened for signs or symptoms of atlantoaxial instability. It was unclear from the records how many of the children in follow up received a cervical spine x-ray for formal assessment.

Table 3: Other medical co-morbidities: Thyroid disorders, Haematological disorders and ENT disorders

Thyroid disorders	**Total N=62**
Appropriately screened at:	
<1 month – N (%)	17/62 (27.4)
3-9 months – N (%)	33/62 (53.2)
9-15 months – N (%)	35/59 (59.0)
Annually – N (%)	28/49 (57.0)
Any thyroid disorder on screening – N (%)	21/62 (33.9)
Type of thyroid disorder detected: (N=21)	
Subclinical hypothyroidism – N (%)	15 (71.4)
Overt hypothyroidism – N (%)	5 (23.8)
Hyperthyroidism – N (%)	1 (4.8)
Haematological disorders	
Appropriately screened at:	
<1 month – N (%)	20/62 (32.3)
Hb annually – N (%)	2/52 (3.8)
Any haematological disorder on screening – N (%)	17/62 (27.4)
Haematological disorders detected: (N=17)	
Microcytic anaemia – N (%)	12 (70.6)
Transient myeloproliferative disorder – N (%)	1 (5.9)
Bicytopaenia – N (%)	3 (17.6)
Pancytopaenia – N (%)	1 (5.9)
ENT disorders	
Appropriately screened at:	
<1 month – N (%)	7/62 (11.3)
3-9 months – N (%)	16/62 (25.8)
Any ENT disorder on screening – N (%)	47/62 (75.8)
ENT disorders detected: (N=47)	
Otitis media – N (%)	18 (38.3)
Chronic suppurative otitis media – N (%)	22 (46.8)
Hearing impairment – N (%)	12 (25.5)
Obstructive sleep apnoea (symptoms) – N (%)	9 (19.1)
Adenoid hypertrophy – N (%)	13 (27.7)
Other – N (%)	10 (21.2)

Table 4: Summary of key screening tests performed in accordance with the AAP recommendations

(The shaded blocks are intended to indicate an age group where the screening opportunity was not appropriate)

Cardiac disorders	**Total N=62**	**Birth – 1 month**	**1 month – 1 year**	**1 year – 5 year**
Echocardiogram <1 month	5/62	8.1%		
Monitor for symptoms of cardiac failure	62/62		100%	
Thyroid disorders				
TSH <1 month	17/62	27.4%		
TSH at 6 months	33/62		53.2%	
TSH at 12 months	35/59		59.0%	
TSH annually	28/49			57.0%
Haematological disorders				
Haemoglobin/Full Blood Count < 1 month	20/62	32.3%		
Haemoglobin annually	2/52			3.8%
ENT disorders				
Newborn hearing screen	7/62	11.3%		
Audiology evaluation at 6 months	16/62		25.8%	
Assess for obstructive sleep apnoea symptoms	41/62		66.1%	
Ophthalmological disorders				
Eye exam for cataracts	62/62		100%	
Ophthalmology referral to assess for strabismus, cataracts, and nystagmus	9/62		14.5%	
Atlantoaxial instability				
Assessment of atlantoaxial instability	17/62			27.4%

Chapter 4: Discussion

DS is the most common chromosomal disorder in newborns, with a birth prevalence of approximately 2/1000 live births in South Africa[10,16]. In a population of children with DS followed up at a level 2 regional hospital (WPH), our study aimed to evaluate the implementation of the 2011 AAP recommendations for health supervision for children with DS over a 5 year period. In this cohort of children with DS followed up at the regional level WPH we observed that the majority of children were diagnosed with DS within the first month of life, but few received the screening tests recommended by the AAP within the first month of life. Screening tests for cardiac defects were performed more often (79%) owing to their frequent occurrence and cause of morbidity and mortality in DS. Screening tests at later age groups also lagged and genetic counselling services were not readily available. This is in keeping with other studies in middle/low income countries reviewing the adherence to the AAP guidelines [9,15].

In the current SA health care system, tertiary facilities such as Tygerberg Hospital Genetic Services, remain primarily responsible for the initial care and co-ordination of follow up services for children with DS. These facilities are overburdened and accessing them often entails a great travelling distance for children coming from rural areas that makes consistent care and follow up challenging. Within the Western Cape, WPH is the only secondary level facility, that offers a specialist run DS clinic to enable children with DS to be cared for in a community setting and allow closer to home referral for specialist services when necessary.

The co-morbidities and other congenital abnormalities associated with DS make early diagnosis important in the care of children with the disorder in order to prevent missed opportunities for early intervention. In South Africa the diagnosis of DS is often delayed or missed. This was shown in a recent study from Kwa Zulu-Natal (KZN) in which medical practitioners and nursing staff had difficulty in making an accurate clinical diagnoses of DS and only suspected DS 55% of the time[17]. Earlier studies in Gauteng and Limpopo provinces in 1997 found that more than half of the patients with DS attending a genetics clinic were diagnosed after 7 months of age[18]. In comparison the median age of diagnosis of DS in our study was 2 weeks of age in both the WPH and the peripheral hospital group suggesting that diagnostic abilities within our local health services may be adequate, although our study did not set out to specifically identify missed diagnoses. Thirty five percent of our cohort still had a late diagnosis, after the first month of life, and it is concerning that 18% had no karyotype performed or the result was unknown. Considering that the majority of children in our cohort were born to mothers without advanced maternal age (>37years), one of the major risk factors for DS, karyotype analysis would be crucial to understand the nature of the genetic defect associated with the case of DS. There was a relatively high number of children with DS secondary to Robertsonian translocations (9.7%). Such defects can occur in women of any age and are usually reported to account for only 3% of cases in a population, but unlike trisomy 21 due to meiotic non-dysjunction, translocations are not associated with older maternal age[19]. Thus in our study, the relatively high proportion of cases due to Robertsonian translocation may therefore reflect a relatively low average maternal age. If a parent carries a balanced translocation this has a higher risk of recurrence in future pregnancies and other family members as well

as a higher rate of miscarriage[19]. Ten percent of cases of DS in our study were secondary to translocations, higher than the 3% generally reported[19]. The need for genetic counselling in this setting is thus crucial so that families can make informed decisions regarding future pregnancies.

It was reassuring that the government care dependency grant was received for more than 80% of children in in our study. Financial insecurity however, was still cited as a factor deterring regular follow up visits in 17% of children. It was no surprise that only 5 children were reviewed by a genetic counsellor as there is no genetic counsellor or nurse available for WPH, reflective of extreme shortages in the government employment of genetic nurses or counsellors in South Africa[3]. Currently there are only 22 genetic counsellors registered with the Health Professions Counsel of South Africa, this is in stark contrast to the Department of Health's Human Genetics Policy Guidelines for the management and prevention of genetic disorders , birth defects and disabilities that recommends 300 genetic counsellors/genetic nurse counsellors as proposed by developed world recommendations[10].

Twenty children of school going age (20/44 (45%)) were enrolled in schools for Learners with Special Educational Needs (LSEN), with the remainder being in mainstream schooling. The optimal schooling option for children with DS in SA in unclear. Internationally there has been increased move toward inclusive education (attending a mainstream school with remedial facilities) for children with DS. The benefits of inclusive education for children with DS have been shown in gains in spoken language skills, reading and writing ability, math skills, general knowledge and social independence[18]. In the rural Western Cape, LSEN schools are often not readily accessible to children with DS as they are available in only a few larger towns, requiring that children commute long distances or are enrolled in boarding facilities. Inclusion in mainstream schooling is an attractive option in rural areas, but to be effective it requires that remedial classes or teacher assistants are available to cater for the particular needs of children with DS.

Hospitalisation occurred commonly as 65% of children required admission at some stage during their follow up. The reasons for hospitalisation were in keeping with the common high burden diseases in young children in South Africa, with pneumonia the most frequent reason for admission[21]. The high burden of infection related diseases in the community was reflected in this cohort of children with DS with gastroenteritis and meningitis being other important causes for hospitalisation. Two deaths were recorded in the folders of children reviewed over the 5 year period, however it is unknown if any deaths occurred amongst the 19 children whom were lost to follow up.

Also of note is the relatively late age at time of diagnosis of children whom were lost to follow up compared to those who continued to have regular follow-up. Late diagnosis may be associated with family, social or health care system challenges that could similarly increase the risk of being lost to follow up.

Almost 80% of children in our study received screening echocardiograms at some stage. However, less than 10% received screening echocardiograms before 1 month of age, and all those who did were born at WPH, with none of the children born at peripheral hospitals receiving this screening within the first month of life. It is concerning that despite the diagnosis of DS being made at a median age of 2 weeks,

first echocardiogram occurred at a median age of 9 months. We were unable in this study to determine the reason for this delay. We postulate though that this is due to a combination of echocardiograms being performed on an elective basis at the quarterly cardiology outreach clinic when this specialist service is available as well as social and transport logistical challenges for families in remote areas to access this service when available. As expected, the children whom were lost to follow up had less opportunity for a screening echocardiogram to be done, while 89% of those whom continued to have regular clinic attendance were ultimately screened. In keeping with what has been described ASD, VSD and AVSD were the most common cardiac lesions detected amongst the children in our study[20]. Children with DS and associated cardiac lesions requiring intervention, either cardiac catheterisation or surgery, received this at a median age of 2 years of age. Although there may be imprecision in this age estimate as we did not have access to clinical records from Red Cross Children's Hospital where all interventional procedures would have been performed, this finding suggests that accessing specialist tertiary care services is challenging for children in rural and remote areas. Although only a single case, the death of a patient with an AVSD and pulmonary hypertension in our study group may present a modifiable factor as the late age of initial echocardiogram would directly impact on all management decisions in her care. Ideally children with an AVSD should be operated before the first year of life or irreversible pulmonary vascular changes will ensue[22].

In the domains of thyroid function testing, ophthalmology and haematological testing our study showed substantial deviation from the AAP guidelines in the observed frequencies of tests and services performed at the DS clinic. The first thyroid screen was often performed beyond the first month of life and thereafter it was performed in only 54-59% of children at the recommended age intervals, however all children in follow-up did receive periodic thyroid screening. Our study showed a similar spectrum of thyroid dysfunction to local and international cohorts, with subclinical hypothyroidism being the most common problem encountered[5]. Difficulty with access to a specialist ophthalmology service as in our study is also experienced at tertiary facilities such as Tygerberg Hospital. Haematological screening was poorly performed in our study and this may reflect either a prioritisation of services to conditions with more associated co-morbidity (cardiac and thyroid screening) or lack of clinician awareness of the comprehensive AAP protocol.

Audiology screening showed a great number of children with hearing impairment, however this also includes children who failed an initial hearing screen but were then subsequently retested. Current recommendations suggest a sleep study should be performed in all children with DS at 4 years of age to document obstructive sleep apnoea, however this is not feasible in our current healthcare facilities[23].

4.1 Strengths and limitations

Our study describes the management of a common chromosomal abnormality in a unique decentralised setting. WPH is the only regional level 2 hospital with a specialist run and dedicated DS clinic. Furthermore, evaluation of this service against an internationally accepted norm for healthcare supervision of children with DS, the AAP guidelines provides much needed insight into the successes as well as challenges of providing comprehensive care for children with DS at a regional level that will be valuable in informing future locally appropriate guidelines.

This was a retrospective study with the inherent limitations of retrospective data collection from medical records that may be incomplete or unstandardized. We had limited detail on the cardiac co-morbidities and their management, however the primary focus of this study was on evaluating the implementation of comprehensive healthcare supervision and screening for early identification of comorbidities in children with DS and not necessarily the long term management of specific co-morbidities. We also did not collect information on referral to neurodevelopmental and allied health services that often enable earlier referral to other services such as audiometry.

4.2 Conclusion and recommendations

Within the United States, comprehensive and evidence based guidelines from the AAP have enabled medical professionals to better care for children with DS and for their families in the spheres of both medical and social development[11]. Regular screening for associated comorbidity in conditions such as DS, improves outcomes and allows children to achieve their highest possible functional status. The challenges facing children with DS and their families are immense in any context. Additional financial, educational and nutritional insecurity and the high prevalence of infectious diseases and malnutrition in the overall childhood population in SA makes the follow up care for children with conditions such as DS far more complex and challenging.

From our study and others performed in SA, it is evident that a local and resource appropriate guideline is needed. The development of a SA DS health care supervision guideline should take into account resources available to different facilities and thereby enable screening to be performed at both clinic and hospital levels. A 'Health Supervision Protocol for individuals with Down syndrome' has recently been drafted in the Western Cape but has not yet been published (Appendix 3 and 4). In conjunction with such guidance a patient held DS healthcare card could contain information relating to the patients' health care requirements as well as results of prior medical investigations. This would serve to both empower care givers with knowledge of their child's health care needs and provide health care professionals with a check list of what health related concerns have been addressed and what may still be required. Furthermore, we strongly recommend the realisation of the Department of Health's Human Genetics Policy Guidelines with regards to investment in genetic counsellors and nurses to support the decentralised care of children with DS, as has successfully been achieved for children with HIV- infection.

In conclusion, this study demonstrates that even though the implementation of the AAP guidelines was not complete at the WPH DS clinic, it is possible to provide reasonable care to children with DS outside of a tertiary referral centre and to retain a large number in follow-up in order to help children with DS reach their highest possible functional and wellness status.

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Appendices

Case Report Form:

Details of each study participant to be completed on a separate form

1). Patient details and demographic data: (1a)

Study no	Participant DOB (dd/mon/yy)	Wt (Z score on DS chart)	Maternal DOB (dd/mon/yy)

1b) Gender:

Male	(1)	
Female	(2)	

1c) Primary care hospital- demographic data:

Worcester	(1)	
Hermanus	(2)	
Caledon	(3)	
Ceres	(4)	
Montagu	(5)	
Robertson	(6)	
Bredasdorp	(7)	
Laingsburg	(8)	
Other/unknown	(99)	

2). Details of diagnosis: (2a)

Date of first clinical assessment confirming DS	Date of karyotype specimen collection	Date of diagnosis
(ND= not done/unknown)	(ND= not done/unknown)	(ND= not done/unknown)

2b) Karyotype result:

Trisomy	(1)	
Mosaicism	(2)	
Translocation	(3)	
Other/unknown	(99)	

2c) Was a late diagnosis made (>1 month of age)?

Yes	(1)	
No	(2)	

3). Clinics follow up care and hospitalisations:

3a) Has the patient received regular clinic follow up?

Yes	(1)	
No	(2)	

3b)

Date of clinic visit:	Type of clinic attended: (see below)			Wt(kg)
	Down syndrome	(1)		
	Neurology	(2)		
	Asthma	(3)		
	Cardiology	(4)		
	Dermatology	(5)		
	ENT/audiology	(6)		
	General Paeds OPD	(7)		
	Other	(99)		

3c) Has the patient been lost to follow up?

Yes	(1)	
No	(2)	

3d)Total number of Down syndrome clinic visits:

3e) Hospitalisation for any cause:

3f) Has the patient been hospitalised for any cause?

Yes	(1)	
No	(2)	

Date of hospitalisation:	Reason for hospitalisation:		
	BPN (bronchopneumonia)	(1)	
	CCF (congestive cardiac failure)	(2)	
	AGE (gastroenteritis)	(3)	
	Meningitis	(4)	
	Seizures	(5)	
	Other/unknown	(99)	
	Never admitted	(100)	

3f)Total number of hospitalisations:

4). Cardiology follow up and management:

4a) Has the patient received a screening echocardiogram?

Yes	(1)	
No	(2)	

4b) Was the initial screening echocardiogram done before 1 month of age:

Yes	(1)	
No	(2)	
Unknown	(99)	
Never done	(100)	

4c)

Date echocardiogram was performed:	Echocardiogram findings (see below)		
	ASD	(1)	
	VSD	(2)	
	AVSD	(3)	
	PDA	(4)	
	Tetralogy of Fallot	(5)	
	Valvular lesion	(6)	
	Pulmonary Hypertension	(7)	
	Co-arctation of the Aorta	(8)	
	Normal heart	(9)	
	Other/unknown	(99)	
	Never done	(100)	

Cardiac morbidity and mortality:

(*complete this section only if child is known with a cardiac lesion*)

4d) Has the patient been hospitalised for a primary cardiac cause?

Yes	(1)	
No	(2)	

4e) Hospitalisation:

(for a primary cardiac cause)

Date of hospitalisation	Reason for admission	
	CCF	(1)
	LRTI	(2)
	Growth Failure	(3)
	Infective endocarditis	(4)
	Never admitted	(100)

4f) If the patient has died, was the death as a consequence of a cardiac related event/illness:

Yes	(1)	

Not applicable (patient still alive)	(2)	
Other (non-cardiac related cause of death)	(99)	

4g) Was medical/surgical management of cardiac lesion required:

Yes	(1)	
No	(2)	
Other/unknown	(99)	
Not applicable	(100)	

4h) Type of management required :

Dates of medical/surgical management procedures:	Medical/surgical management procedure:	
	Started on diuretic therapy	(1)
	Cardiac catheterisation (therapeutic)	(2)
	Cardiac catheterisation (diagnostic)	(3)
	Cardiac surgery	(4)
	Other/unknown	(99)
	Not applicable	(100)

4l) Was the patient monitored for signs and symptoms of CCF at each follow up visit?

Yes	(1)	
No	(2)	
Other/unknown	(99)	

5). Thyroid disorder: screening and identification of disorders

5a)

Dates of thyroid screen:	Result of thyroid function tests:	Thyroid disorder detected:		
		Congenital hypothyroidism	(1)	
		Subclinical hypothyroidism	(2)	
		Overt hypothyroidism	(3)	
		Hyperthyroidism	(4)	
		Normal thyroid function	(5)	

		Other/Unknown	(99)	
		Never done	(100)	

TSH screening:

5c) Screened before 1 month of age:

Yes	(1)	
No	(2)	
Not applicable	(3)	

5d) Screened between 3-9 months of age:

Yes	(1)	
No	(2)	
Not applicable	(3)	

5e) Screened between 9-15 months of age:

Yes	(1)	
No	(2)	
Not applicable	(3)	

5f) Screened annually after first birthday :

Yes	(1)	
No	(2)	
Not applicable	(3)	

6). Haematogical disorders: screening and identification of disorders

6a) Has the patient had a screening Hb/FBC:

Yes	(1)	
No	(2)	

6b)

Haematological disorders detected		
Normal FBC	(1)	
Iron deficiency anaemia	(2)	
Transient myeloproliferative disorder	(3)	
Bicytopenia	(4)	
Pancytopenia	(5)	
Other/unknown	(99)	
Never screened	(100)	

6c) Haematological screen (FBC) done before 1 month to rule out transient myeloproliferative disorder, polycythaemia:

Yes	(1)	
No	(2)	
Not applicable	(3)	

6d) Hb done annually from age 1 year to 13 years:

Yes	(1)	
No	(2)	
Not applicable (pt not yet >1yr)	(3)	

7). ENT disorders: identification of disorders

7a)

Dates of screening	ENT disorders detected:			Management requirements:		
(ND= screening not done)	Otitis Media	(1)		Antibiotics	(1)	
	Chronic Supp OM	(2)		Aural lavage/wicking	(2)	
	Hearing Impairment	(3)		Grommets	(3)	
	OSA (symptoms)	(4)		Steroid nasal spray	(4)	
	Adenoid hypertrophy	(5)		Adenoidectomy	(5)	
	Other/unknown	(99)		Audiology referral	(6)	
	Never screened	(100)		Not applicable	(7)	

7b) Newborn hearing screen done before 1 month of age:

Yes	(1)	
No	(2)	
Not applicable	(3)	

7c) Audiology evaluation at 3-9 months of age:

Yes	(1)	
No	(2)	
Not applicable	(3)	

8). Ophthalmological disorders:

8a)

Dates of screening	Ophthalmological disorder detected: (see below)	
(ND= screening not done)	Refractory error	(1)
	Cataract	(2)
	Other	(99)
	Never screened	(100)

8b) Eye exam for cataracts done within first year of life:

Yes	(1)	
No	(2)	
Not applicable	(3)	

9). **Atlanto-axial instability (AAI): screening evaluation for signs and symptoms**

9a) Was the patient monitored for signs and symptoms of AAI at any follow up visit?

Yes	(1)	

No	(2)	

10). Social support services and genetic counselling:

10a) Was genetic counselling and social support services offered to this patient at any of the follow up visits/hospitalisations?

Yes	(1)	
No	(2)	

10b) If yes, indicate the type of service offered:

Genetic Counsellor	(1)	
Referral for CDG	(2)	
Referral to DS support group	(3)	
Other/unknown	(99)	
Not offered	(100)	

10c) Does the patient attend special schooling?

Yes	(1)	
No	(2)	
Not applicable (too young/old)	(100)	

11). Obstacles that may prevent continuity of care:

11a) Were social/financial/medical issues identified that may prevent continuity of follow up visits/hospitalisations?

Yes	(1)	
No	(2)	

11b) Type of Obstacle to continuity of care

Patient related factor			Health institution related factor		
Financial insecurity	(1)		No specialist service available	(1)	
Poor medical beliefs	(2)		Not referred to available specialist	(2)	
Failure to access transport	(3)		Medical equipment/facility not available	(3)	
Other	(99)		Other	(99)	
None	(100)		None	(100)	

POOR MEDICAL BELIEFS
*(poor understanding of condition/
Expressed lack of confidence in medical intervention)

American Academy of Pediatrics (AAP) Guidelines for Health Supervision for children with Down syndrome

APPENDIX 1 Health Supervision for Children With Down Syndrome

	Prenatal	Birth–1 mo	1 mo–1 y	1–5 y	5–13 y	13–21 y
Counseling regarding prenatal screening test & imaging results						
Plan for delivery						
Referral to geneticist						
Parent-to-parent contact, support groups, current books and pamphlets						
Physical exam for evidence of trisomy 21						
Chromosomal analysis to confirm dx						
Discuss risk of recurrence of Down syndrome						
Echocardiogram						
Radiographic swallowing assessment if marked hypotonia, slow feeding, choking with feeds, recurrent or persistent respiratory sx, FTT						
Eye exam for cataracts						
Newborn hearing screen and follow-up						
Hx and PE assessment for duodenal or anorectal atresia						
Reassure parents delayed and irregular dental eruption, hypodontia are common						
If constipation, evaluate for limited diet or fluids, hypotonia, hypothyroidism, GI malformation, Hirschsprung		Any visit				
CBC to R/O transient myeloproliferative disorder, polycythemia						
Hb annually; CRP & ferritin or CHr if possible risk iron deficiency or Hb <11 g.				Annually		
Hemoglobin						Annually
TSH (may be part of newborn screening)			6 and 12 mo	Annually		
Discuss risk of respiratory infection						
If cardiac surgery or hypotonic: evaluate apnea, bradycardia, or oxygen desaturation in car seat before discharge						
Discuss complementary & alternative therapies		All health maint. visits				
Discuss cervical spine positioning, especially for anesthesia or surgical or radiologic procedures		All health maint. visits				
Review signs and symptoms of myopathy		All health maint. visits				
If myopathic signs or symptoms: obtain neutral position spine films and, if normal, obtain flexion & extension films & refer to pediatric neurosurgeon or orthopedic surgeon with expertise in evaluating and treating atlanto-axial instability		Any visit				
Instruct to contact physician for change in gait, change in use of arms or hands, change in bowel or bladder function, neck pain, head tilt, torticollis, or new-onset weakness				Biennially		
Advise risk of some contact sports, trampolines				All health maint. visits		
Audiology evaluation at 6 mo						
If normal hearing established, behavioral audiogram and tympanometry until bilateral ear specific testing possible. Refer child with abnormal hearing to ot				Every 6 mo		
If normal ear-specific hearing established, behavioral audiogram				Annually		
Assess for obstructive sleep apnea Sx				All health maint. visits		
Sleep study by age 4 years						
Ophthalmology referral to assess for strabismus, cataracts, and nystagmus						
Refer to pediatric ophthalmologist or ophthalmologist with experience with Down syndrome				Annually	Every 2 y	Every 3 y
If congenital heart disease, monitor for signs & Sx of Congestive heart failure		All visits				
Assess the emotional status of parents and intrafamilial relationships		All health maint. visits				
Check for Sx of celiac disease; if Sx present, obtain tissue transglutaminase IgA & quantitative IgA				All health maint. visits		
Early intervention: physical, occupational, and speech therapy				Health maint. visits		
At 30 months, discuss transition to preschool and development of IEP						
Discuss behavioral and social progress				Health maint. visits		
Discuss self-help skills, ADHD, OCD, wandering off, transition to middle school					Health maint. visits	
If chronic cardiac or pulmonary disease, 23-valent pneumococcal vaccine at age >2 y						
Reassure regarding delayed and irregular dental eruption						
Establish optimal dietary and physical exercise patterns				Health maint. visits		
Discuss dermatologic issues with parents						
Discuss physical and psychosocial changes though puberty, need for gynecologic care in the pubescent female						
Facilitate transition: guardianship, financial planning, behavioral problems, school placement, vocational training, independence with hygiene and self-care, group homes, work settings						Health maint. visits
Discuss sexual development and behaviors, contraception, sexually transmitted diseases, recurrence risk for offspring						Health maint. visits
		Do once at this age				
		Do if not done previously				
		Repeat at indicated intervals				

Maint. indicates maintenance; dx, diagnosis; sx, symptoms; FTT, failure to thrive; Hx, history; PE, physician examination; GI, gastrointestinal; CBC, complete blood count; R/O, rule out; Hb, hemoglobin; ot, occupational therapy; CHr, reticulocyte hemoglobin; IgA, immunoglobulin A; IEP, Individualized Education Plan; ADHD, attention-deficit/hyperactivity disorder; OCD, obsessive compulsive disorder.

Health supervision protocol for individuals with Down Syndrome *(Newborn – 6 yrs)*

Screen for: *specific investigation	**Newborn or at diagnosis** (2 visits in first year)			**Infancy (1-3 yr)** (1 visit per year)			**Pre-school (4-6 yr)** (1 visit in first year)		
	Primary	**Secondary**	**Tertiary**	**Primary**	**Secondary**	**Tertiary**	**Primary**	**Secondary**	**Tertiary**
	·Suspected: **REFER** ·Confirmed: **REFER** to support groups, social work (CDG)	·*Karyotype ·Counselling +recurrence risk info **REFER** for Genetic counselling	Genetic counselling						
Congenital anomalies		·Duodenal atresia **REFER** for echo 6/52-3m **REFER** if ?Hirschsprung's dis	·Cardiac anomaly * Echo		**REFER** if ?Hirschsprung's disease				
Growth	·FTT ·Feeding issues			·FTT ·Obesity *BMI			·Obesity *BMI		
Thyroid		*TSH **REFER** if hypothyroid			*TSH Annual and if concern (poor growth, slower development)			*TSH only if concern (poor growth, slower development, obesity, constipation)	
Eye/ Vision		·No red reflex **REFER** for ?cataracts ·strabismus after 6 months **REFER**			·Strabismus ·Refractive errors	*Formal Eye and vision screen		·Strabismus ·Refractive errors	*Formal preschool refraction

Hearing and upper airway obstruction	* Hearing screening (OAE) if available in setting, if not available **REFER** by 3 months	* Hearing screening (OAE) if not available at primary level by 3 months			*Formal Hearing test ·CSOM ·Recurrent respiratory infection ·Symptoms of Obstructive sleep apnoea (OSA)			·CSOM ·Hearing ·OSA symptoms	
Neuro development	·Early intervention (Physiotherapy)			·Early intervention (OT, SLT, Physio)				*School placement assessment (age 5y); neurodevelopmental assessment	
Other specific	·Immunizations	Anaemia or HSM - * FBC + film for Myelodysplasia		·Immunizations	·Anaemia or HSM - * FBC + film for Myelodysplasia/ Leukaemia ·Auto-immune symptoms eg coeliac		Immunizations	·Auto-immune symptoms eg coeliac disease	

Recommended health checks, however check at any time when clinical or parental concerns.

Health supervision protocol for individuals with Down Syndrome *(School age - Adult)*

Screen for: *specific investigation	**School-age and Adolescence (7-18y)** (every 2nd year)			**Adult** (every 2nd year)		
	Primary	**Secondary**	**Tertiary**	**Primary**	**Secondary**	**Tertiary**
Growth	·Obesity *BMI			·Obesity *BMI		
Thyroid		*TSH only if concern (poor growth, slow development, obesity, constipation)			*TSH only if concern (Regression, depression)	
Eye/ Vision	School nurse screen for: Visual Acuity	·Strabismus ·Refractive errors				
Hearing and upper airway obstruction		·CSOM ·Hearing ·OSA symptoms				
Neuro development	School nurse/ teacher screen for symptoms and refer: Attention Behavioural issues Mood disorders/anxiety				·Developmental regression ·Psychiatric condition e.g. mood disorders, anxiety disorders	
Other specific	·Fertility and contraception	·Diabetes symptom check ·Auto-immune symptoms e.g. coeliac disease		·*Diabetes ·Hypertension ·Fertility and contraception	·Auto-immune symptoms e.g. coeliac disease	

Recommended health checks, however check at any time when clinical or parental concerns

Summary of Levels of care and follow-up responsibilities:

• Primary level:	Can monitor growth, coordinate intervention therapies and psychological support. Administer immunizations, contraception. School nurse can do specific health screening and refer appropriately. Promote links with community support groups
• Secondary level: (either at secondary hospital or Genetic clinic/outreach)	Diagnosis Can manage most of care and screening. Develop specific Case Management Plan. School placement can be facilitated by paediatricians, supported where possible by OTs and SLTs. Region specific services will be identified.
• Tertiary level:	Only complicated cases with multiple chronic health problems *Recommend minimum of at least 1 visit with genetic specialist service*