HIV risk exposure among young children

A study of 2–9 year olds served by public health facilities in the Free State, South Africa

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FOREWORD

In 2002, the Nelson Mandela Foundation (NMF), together with a consortium of donors, commissioned the Human Sciences Research Council (HSRC) to conduct the *Nelson Mandela/HSRC study of HIV/AIDS*. The study was the first of its kind to use household and community surveys to determine HIV prevalence and assess behavioral risk. The Foundation publicised and disseminated its findings with the intention of stimulating dialogue and informing policy development around HIV/AIDS locally and internationally. One question that arose from the study was around the unusually high rates of infection in the 2–14 age group.

The NMF commissioned the HSRC to urgently investigate the reasons for these high rates. This report is in response to that request. This study enjoyed the enthusiastic participation of and co-funding by the Free State government and the Nelson Mandela Children's Fund. Researchers who partnered in this process included the HSRC, the University of Stellenbosch, the Medical Research Council and Centre for AIDS Research and Development. This demonstrates how donors, researchers and policy-makers can work together to tackle a critical research question.

The information coming out of this study is indeed groundbreaking, and we trust that you will read the report to gain insights into its richness and depth. We have discovered that while most of the HIV infections were found to be associated with mother's HIV-positive status, there is the potential for transmission of HIV to children by women breastfeeding children who are not their own. The socio-cultural practice that allows children to be breastfed by women who are not their biological mothers has major implications in a country where communicable diseases are highly prevalent.

Infant feeding practices that inadvertently expose children to receiving HIV-contaminated milk is another route of HIV infection among children. This is of serious concern in view of the findings that nearly a third of the breast milk expressed, which is destined for feeding hospitalised breastfed children has evidence of HIV viral load.

Evidence generated from this study suggests there is a need to reduce the potential for HIV transmission in dental, maternity and paediatric facilities. The study found that tested instruments demonstrate evidence of visible and microscopic amounts of blood on equipment used to diagnose or treat patients. Health care-acquired infections are completely avoidable. The solutions lie not only with policymakers, to ensure that there are policies and guidelines for infection control, and that these guidelines are rigorously implemented, but that patients are educated to demand that health workers wash their hands, wear and change gloves and use sterile equipment. Well-informed patients are best placed to monitor weaknesses in infection control.

We applaud the decision of the Free State Department of Health to conduct an investigation to determine the source of HIV infection in the seven HIV positive children whose mothers were HIV negative. We would encourage them to share their findings so that we can avoid health care facilities compromising the health of our children.

John Samuel
Chief Executive
Nelson Mandela Foundation

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ACRONYMS

AIDS	Acquired Immune Deficiency Syndrome
ANRS	*Agence Nationale de Recherche sur le Sida*
BBV	Blood-borne virus
CADRE	Centre for Aids Development, Research and Evaluation
CHC	Community health centres
CIET	*Centro de Investigación de Enfermedades Tropicales*
DHS	Demographic and Health Survey
DNA	Deoxyribonucleic acid
EBM	Expressed breast milk
ELISA	Enzyme-linked immunosorbent assay
HIV	Human Immunodeficiency Virus
HSRC	Human Sciences Research Council
IC	Infection control
LE	Lejweleputswa
MO	Motheo
MRC	Medical Research Council
MTCT	Mother-to-child transmission
NF	Northern Free State
NNU	Neo-natal unit
OR	Odds ratio
PMTCT	Prevention of mother-to-child transmission
RNA	Ribonucleic acid
RR	Relative risk
SSD	Sterilisation services division
TBA	Traditional birth attendant
TM	Thabo Mofutsanyane
UNAIDS	Joint United Nations Programme on HIV/AIDS
VCT	Voluntary counselling and testing
WHO	World Health Organization
XH	Xhariep

Executive summary

In 2002, a population-based study of HIV prevalence in South Africa was conducted by a research consortium consisting of the HSRC, MRC, CADRE and ANRS. A key finding of the study was that the epidemic seriously affects South African children aged 2–14 years, with an overall HIV prevalence among 2 350 children of 5.6% (95% CI: 3,7%–7.4%) (Nelson Mandela/HSRC Study of HIV/AIDS 2002). This was much higher than expected and could not be adequately explained by the data at hand.

Following presentation of the data, both Mr Nelson Mandela and the Free State Department of Health expressed interest in addressing the question: 'Why were so many children infected with HIV?' A research study was therefore designed to investigate all possible routes of HIV transmission among 2–9 year old children, and the research area selected was public health services in the Free State. The aim of this study was to identify risk factors among children aged 2–9 years old, other than those associated with vertical transmission from their mothers. The objectives of the study were:

- To estimate the proportion of HIV-positive children aged 2–9 years whose biological mother was known to be HIV-negative;
- To estimate the prevalence of HIV infection among children aged 2–9 years served by public health services in the Free State;
- To assess exposure to risk for HIV infection in children aged 2–9 years inside and outside these facilities;
- To identify the risk factors in the Free State public health sector for acquiring HIV in children aged 2–9 years whose mothers were known to be HIV-negative;
- To identify the breaks in infection control (IC) practices that could lead to the transmission of HIV in the health care services;
- To identify practices in traditional and social settings which may facilitate the transmission of HIV.

Methodology

A cross-sectional study with a nested case-control sub-study was used to investigate these objectives in all public hospitals excluding psychiatric hospitals. Selected community health centres (CHC) and primary care satellite clinics feeding into these hospitals were also included. Forty-three Free State-based professionally registered nurses, most of whom were retired, were trained to carry out voluntary counselling and testing (VCT), administer questionnaires and collect data.

For the cross-sectional study, mothers (and children) who agreed to participate after being counselled were recruited and informed consent was obtained. A physical examination was performed on the child to check signs of scarification. This was followed by HIV testing in the mother or caregiver's presence. Mothers and their children were tested for HIV using the Abbott (screening) and Unigold (confirmatory) rapid tests. Indeterminate samples (first rapid test positive and second rapid test negative) were tested by HIV ELISA (Abbott HIV-1/2 Axsym EIA test). DNA tests on blood from the mother and child confirmed their biological maternal relationship.

A questionnaire designed to ascertain the child's current health status, his/her use of health care services, history of hospitalisation, possible exposure to blood, injections and traditional practices was completed after an interview with the mother or caregiver. The questionnaires obtained data on risk factors prior to HIV testing. Fieldworkers and participants were blind to HIV status at the time of data collection. For ethical and legal reasons, no data on sexual abuse was obtained. Mothers and children found to be HIV-positive were referred to health care facilities for further assistance, support and counselling. Those identified as discordant pairs (mother HIV-negative, child HIV-positive) were studied in detail as part of a case-control study.

A facility-based study, which investigated IC practices in dental, maternity, neo-natal and paediatric facilities, was conducted in parallel without exchange of information with either of the aforementioned studies.

IC provision in all available in-patient maternity and paediatric facilities, and dental facilities was based on the following:

- Assessing knowledge of IC among health care workers (hospital and dental) using a questionnaire;
- Observing IC provision in maternity and paediatric units as well as dental facilities;
- Observing clinical practice and compliance with IC practice in these units;
- Detecting the presence of visible and occult blood on clinical equipment and in the environment;
- The presence of visible and occult blood (OBTI test), which was used as a surrogate marker for inadequate IC practice and possible risk of blood-borne virus (BBV) transmission;
- Documenting procedures for preparation, labelling and distribution of milk, both formula and expressed breast milk (EBM), for babies in hospitals. Random samples of both formula and EBM were sent for viral load determination. The possible risk of BBV transmission was considered where EBM may have been inadvertently given to the wrong baby.

The results of the dental facility study, maternity and paediatric study, detection of occult blood (included in dental and maternity sub-studies) and milk processing and distribution studies are presented in this report.

Further evidence was gathered from focus group discussions with traditional healers and birth attendants. Focus group discussions among traditional healers and traditional birth attendants were conducted to document their knowledge of HIV prevention and document practices that might have the potential for transferring HIV between clients.

Data analysis on the cross-sectional study was carried out using SPSS™ and STATA.

The Ethics Committee of the University of Stellenbosch and the HSRC (for the milk room study) approved the research project.

The findings are summarised below.

Profile of HIV status of children attending public health services in the Free State

- The HIV prevalence of children attending public health services in the Free State was 14.8%. The prevalence was higher among hospitalised patients (21.5%)

compared to patients attending out-patient facilities (13.7%). These figures suggest a substantial burden of paediatric HIV/AIDS on public hospitals.

- Age was found not to be related to HIV status. Children aged 2–5 years old had a similar HIV prevalence (14.9%) to children aged 6–9 years (14.6%). When data were analysed by single years from age 2–9 years, there was no clear trend.
- Children attending public health services who lived in the city had a higher HIV prevalence (22.9%) than children who lived on farms (19.1%) or those who lived in rural areas (12.5%).
- There were major differences in HIV prevalence among patients served in the different health districts. The patients living in the mining district of Lejweleputswa had the highest HIV prevalence of 26.7%, while those living in Thabo Mofutswanyana district had the lowest HIV prevalence at 10.5%.

Risk exposure for HIV infection among children

- The study found that 29.1% of mothers were HIV-positive. The overwhelming majority of them (92.3%) breastfed their children, 86.4% beyond six months, and 60% longer than one year.
- The overwhelming majority of children who were HIV-positive had HIV-positive mothers (98.6%). Only 1.4% of HIV-positive children had HIV-negative mothers; thus mother-to-child transmission is the dominant mode of HIV infection among children in the Free State. But it also indicates that at least 1.4% of the children could have been infected through non-vertical transmission; possibly through nosocomial transmission.
- Odds ratios (OR) were reported as follows: among all children, HIV seropositive status was associated with breastfeeding by a non-biological mother (OR:16.9), blood transfusion (OR:2.6), history of prior hospitalisation (OR:2.3), number of injections had in the previous 12 months (OR:1.6), vaccination at public health facilities (OR:1.4), receiving milk from a milk room (OR: 2.0), scarifications (OR:2.0), and visits to a traditional healer (OR:1.8).
  All statistically significant exposure factors identified in the bivariate analysis were entered as explanatory factors into a multiple regression model to obtain adjusted odds ratios. Blood transfusion, vaccination at public health facilities and receiving milk from a milk room were no longer significantly associated with HIV status of the child in the full model. Having been breastfed by a non-biological mother remained highly associated with a child's HIV status. The odds of having been breastfed by a non-biological mother were 17 times greater in HIV-positive children compared to the odds in HIV-negative children. Having a prior hospital admission, having seen a traditional healer and being scarified also remained statistically significant after controlling for age, sex and other exposure factors.

HIV acquisition in children born to HIV-negative mothers: a nested case-control study

- Seven children were HIV-positive but their biological mother HIV-negative. These seven children constituted the cases in this matched case-control study. Six (86%) of the seven cases were girls compared to 15 (43%) of HIV-positive controls ($p = 0.07$) and 16 (46%) of HIV-negative controls ($p = 0.08$). Cases came from only two districts whereas controls came from all five districts. There were no significant differences between cases and controls except in the number of dental visits (OR: 41), receiving milk from a milk room (OR: 13) and being breastfed by a non-biological mother (OR: 17).

Evidence of potential for nosocomial transmission of HIV

- The potential for nosocomial HIV transmission in the Free State was evident in maternity, paediatric and dental facilities.
- Exposure to HIV-contaminated milk was observed and 29.7% of the sample of breast milk destined for feeding children tested positive for HIV viral RNA.
- In testing various items to be used on patients for clinical care, it was found that 47% were positive for occult blood and 25% of items that come into direct contact with the patient tested positive for occult blood.
- In testing items or instruments that come in direct contact with the mouth and gums of patients and were ready to be used for next patients, 24.6% were found to be positive for occult blood.

New finding

- A new finding was the practice of shared breastfeeding, where 1.7% of the children were reported to have been breastfed by a non-biological mother. The odds of having been breastfed by a non-biological mother were 17 times greater in HIV-positive children compared to the odds in HIV-negative children. These findings were identical in both the cross-sectional analysis and the case-control study. Even when all the other risk factors such as age, sex, hospital admission, dental injections, visit to traditional healers, vaccination, scarifications and being fed with milk from the milk room were controlled for, being breastfed by a non-biological mother remained as an independent risk factor. This mode of transmission of HIV has not previously been reported in South Africa.

SECTION 1. INTRODUCTION

In 2002, the *Nelson Mandela/HSRC Study of HIV/AIDS* found that HIV prevalence was high among South African children. HIV prevalence, based on the testing of 2 350 children aged 2–14 years, was found to be 5.6% (CI 95%: 3.7–7.4). A further report drawing on this data found that among a subset of 1 377 children, HIV prevalence was 6.2% (CI 95%: 4.2–9.0%) (Brookes, Shisana, & Richter, 2004). This was the first time in South Africa that a national population-based HIV-prevalence study was conducted, assessing the HIV status of children at a national level. It was thus the first time that data were available to suggest that HIV prevalence among South African children was high.

These two reports highlighted the urgent need for improved understanding of HIV prevalence among children. The findings could not readily be explained with the data at hand, and further research was necessary into possible modes of HIV infection among children. This study was therefore designed to explore a range of non-vertical modes of HIV infection including nosocomial infection (healthcare-acquired infections) and cultural practices among the 2–9 year old age group, taking into account vertical HIV transmission.

1.1 Literature review

1.1.1 Vertical transmission

The most frequently identified mode of HIV infection among children is vertical transmission from mother to child. Such infection may occur prior to birth, during delivery or through breastfeeding. In South Africa, during 2003, 96 228 babies were estimated to have been infected through vertical transmission (Department of Health, 2003). It has also been found that 52.5% were likely to have died within two years (Newell, Coovadia, Cortina-Borja & Rollins 2004). In 2002 it was found that HIV prevalence among children aged 2–14 was 5.6%. This translates to 704 829 South African children living with HIV in 2002. UNAIDS (2004) offers an alternate estimate of 230 000 children younger than 15 years living with HIV by the end of 2003. UNAIDS estimates are based on a model that uses data from antenatal surveys and includes modelling formulae incorporating ratios of vertical transmission and child survival. This approach differs from the direct approach taken within population-based studies – here estimates are derived directly from a national sample. UNAIDS estimates include children of all ages and high death rates are assumed.

1.1.2 Nosocomial infections (healthcare-acquired infections)

Applying standard precautions to risk prone procedures and safe waste disposal (e.g. injections and medical sharps) are recognised practices for reducing nosocomial infections. Lack of infection control (IC) systems may play a role in the transmission of HIV in health care settings in South Africa. A recent survey found that IC mechanisms were weak in public and private health care facilities (Shisana, Hall & Maluleke 2003). It was found that only 65% of all health care facilities had an adequate supply of sterilising equipment 75–100 % of the time. Thirty per cent of public sector primary health care facilities never stocked sterilising equipment while 6.2% never stocked disinfectants. About 17% of private health care facilities never stocked disinfectants. Lack of sterilising equipment and disinfectants suggests that patients may be at risk of contracting nosocomial infections through the use of poorly sterilised or unsterilised equipment.

In South Africa a register of HIV-positive children with HIV-negative mothers was recently established at Tygerberg Academic Hospital. The register, which was instituted in August 2003, listed 18 cases by October 2004. Further cases have since been reported. Case investigations suggest that transmission through child abuse or early sexual activity was likely in only two cases and that nosocomial transmission was suspected in all others (Cotton 2001). These cases indicate the need to investigate the role of the health care system in transmitting HIV to patients, particularly children.

1.1.3 Cultural practices

Possible sources of HIV transmission to infants and children may be associated with cultural practices that involve the use of shared instruments and non-sterile equipment by traditional healers for group circumcision and scarification (Hardy 1987). Since these practices result in exposure to blood, they present opportunities for the transmission of HIV to practitioners and to their clients.

There is considerable evidence that scarification involving shared instruments is probably the commonest practice among African societies who value specific forms of bodily mutilation as a mark of membership to a particular cultural group (Helman 2000; Marck 1997). Moreover, it is recognised that scarification results in bleeding, and that group scarification therefore has implications for HIV transmission especially when a single instrument is used (Orubuloye, Caldwell & Caldwell 1995). Various forms of scarification are carried out at different ages throughout childhood with puberty being the significant stage.

1.1.4 Sexual abuse

Sexual abuse of children, both female and male, is believed to be widespread in South Africa. A report by the Child Protection Unit of the South African Police Services noted that 21 000 cases of rape and attempted rape of children under the age of 17 were reported in 2000. In a report to the Parliamentary Task Group on the Sexual Abuse of Children (Parliament of South Africa 2002), Childline stated that they had experienced an increase of 400% in sexual abuse over the past decade. Decreases in the average age of sexually assaulted children, decreases in the age of the sexual offenders and an escalation in the use of brute force were also observed. The National Democratic Lawyers' Association noted that 41% of rapes or attempted rapes in 2001 were of persons under the age of 18 and that 50% of these involved children under the age of 11. CIET Africa reported a 6% prevalence of 'forced sex' among both males and females aged 12–21, with greater prevalence in rural areas (Madu & Peltzer 2000). The 1998 DHS found that 2.9% of 15–19 year olds reported childhood sexual abuse (rape). Of all women aged 15–49 who reported childhood rape, the majority (85.4%) had experienced abuse when they were 10–14 years old. When instances of rape were analysed according to perpetrator, it showed that the perpetrators were likely to be teachers (32.8%), strangers/recent acquaintances (20.2%), relatives (11.3%), family friends/ lodgers (11.1%), boyfriends (8.3%), fathers (5.1%) and brothers (4.8%) (Department of Health 1998).

Although no statistics are available for the commercial sexual exploitation of children, a number of non-governmental organisations deal with child victims. Such exploitation includes actions by community members, caretakers and family members and extends to trafficking (Fox 2003; Gisselquist, Rothenberg, Potterat & Drucker 2002). The myth that AIDS can be cured by sex with a virgin has been attributed by various sources to be a causal factor in high rates of baby rape. However, this has been disputed by Jewkes and others (Jewkes, Penn-Kekana, Levin, Ratsaka & Schrieber 2001).

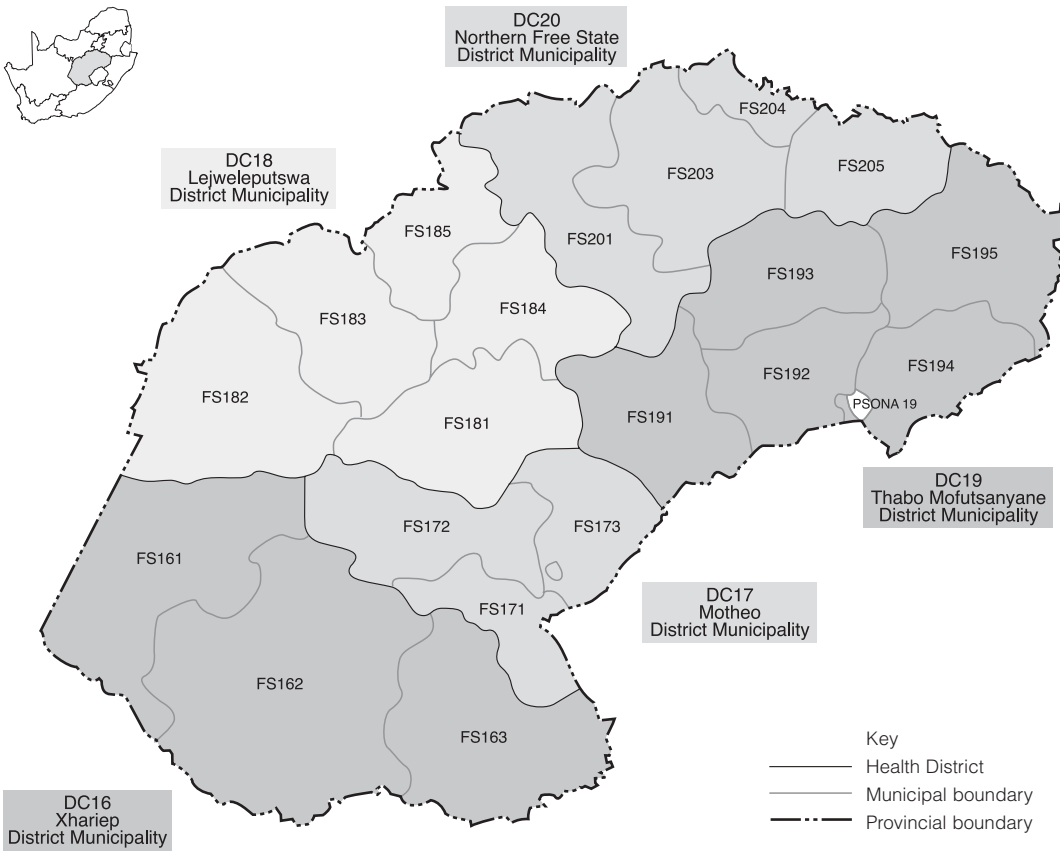
1.2 Research setting

The study was undertaken in the Free State province, the third largest province in South Africa. It has a total GDP of R23 688 million, which is about 6.19% of the National GDP. It has a population of 2 706 million, 19% of whom are under the age of 10 (Statistics South Africa 2003). The main language spoken is Sesotho (64%), followed by Afrikaans (12%) and Xhosa (9%). Some 16% of people aged 20 years or older have had no schooling and 17.6% are unemployed. The Free State is ranked the third most urbanised province in the country with 71% of the population living in urban areas. The population density in the province is 22 per km, and the average household size is 4.4 persons.

1.2.1 Health districts of the Free State

The province has five health districts, i.e. Motheo, Xhariep, Thabo Mofutsanyana, Lejweleputswa and Northern Free State (Figure 1). Health planning in the province is based on a health district model. The health districts are also economic districts and coincide with the political boundaries used for election purposes.

Figure 1: Map of Free State, showing the 5 health districts



1.2.2 Description of the five health districts

- Motheo (DC17) is the most urbanised district. A functional economic corridor along adequate road networks strengthens trade relations with Lesotho and other provinces. There is also a good manufacturing infrastructure. This district is the best served regarding access to health services.

- Xhariep (DC16) is predominantly an agricultural area where mining has been localised and activity has greatly declined. The community is largely rural. Poor road conditions and inadequate public transport infrastructure make access to health care problematic. This district is the most underserved area in so far as health services are concerned.

- Thabo Mofutsanyana (DC 19) is mountainous with a large proportion of fertile rural areas. The terrain limits access to health services. It has cross-border trade relations with Lesotho and other provinces. Most of the population lives in two former apartheid-established townships Phuthaditjhaba and Tshiame.

- Lejweleputswa (DC18) is a major mining area. The district has a well-established infrastructure and roads network, with limited agricultural activity.

- Northern Free State (DC20) has natural resources in the form of coal deposits, which support the largest petrochemical industry in the country. There is stable agricultural production. Because of its strategic location, the district has economic links with Gauteng.

1.2.3 Health indicators

The Free State ranks second lowest in the country regarding access to sanitation, which places it at high risk for communicable diseases. The province has a high teenage pregnancy rate of 14.8% among 15–19 year olds (Department of Health, 1998). Based on antenatal data, Free State had an HIV prevalence of 30.1% among pregnant women in 2003. The 2002 national population-based HIV survey found that the Free State had an HIV prevalence of 14.9% among persons aged 2 years and older in comparison to 11.4% for the country as a whole. This rate was the highest of all provinces, although the confidence intervals overlapped with Mpumalanga, Gauteng and KwaZulu-Natal. HIV prevalence among 15–49 year olds was 19.4% in comparison to 15.6% for the country as a whole (Nelson Mandela/HSRC Study of HIV/AIDS 2002). The three leading causes of death in 2001 in the Free State are respiratory conditions (196.4 per 100 000), infectious and parasitic diseases (176.4 per 100 000) and circulatory diseases (126.9 per 100 000) (Free State Department of Health 2003).

The infant mortality rate per 100 000 live births has increased rapidly from 33.82 in 2000, 52.74 in 2001, and 65.74 in 2002, to 68.27 in 2003. The top five causes of infant mortality are preterm delivery (21.9% of all reported cases), unspecified pneumonia (13.1%), broncho-pneumonia (12.1%), diarrhoea and gastroenteritis (11.2%) and ill-defined and unspecified causes (8.4%). Infections associated with HIV cannot be ruled out. Immunisation coverage under 1 year is 85.7% (Free State Department of Health 2003).

The Free State has 234 primary health care facilities, which consist of clinics and community health centres. The province also has 31 hospitals (of which one is a psychiatric hospital). The doctor ratio per 1 000 people is 0.14.

1.3 Aim and objectives

The aim of this study was to identify risk factors among children aged 2–9 years old, other than those who had acquired HIV via vertical transmission from their mothers.

The objectives of this study were:

- To estimate the proportion of HIV-positive children aged 2–9 years whose biological mother was known to be HIV-negative;
- To estimate the prevalence of HIV infection among children aged 2–9 years, served by public health services in the Free State;
- To assess exposure to risk for HIV infection in children aged 2–9 years inside and outside these facilities;
- To identify the risk factors in the Free State public health sector for acquiring HIV in children aged 2–9 years whose mothers were known to be HIV-negative;
- To identify the breaks in IC practices that could lead to the transmission of HIV in the health care services;
- To identify practices in traditional and social settings which may facilitate the transmission of HIV.

SECTION 2.
METHODS

This section addresses definitions used in the study as well as various methodological approaches used in the four components of the research. The research methods included individual interviews, testing of biological specimens and milk, observations, and focus group discussions. Both qualitative and quantitative data were collected as supporting evidence. The different methods were used to triangulate the findings in order to increase their reliability and validity.

2.1 Definitions

Discordant mother/child pair

An HIV discordant mother/child pair is defined as a mother and child where the child is HIV-positive but the biological mother is HIV-negative at the time of testing.

Indeterminate sample

First rapid test positive and second rapid test negative.

HIV infection

For the purposes of this study, a person was considered to be HIV-positive if he or she had been found to be HIV-positive with:

- both a screening and confirmatory rapid HIV test; or
- one positive rapid HIV test and a positive laboratory HIV ELISA test result.

Milk room

Hospital room where baby milk is prepared.

Nosocomial infection

Health care-aquired infection.

Occult blood

The presence of microscopic amounts of blood which are invisible to the naked eye and can only be detected by appropriate tests.

2.2 Study components

In addition to the objectives and methods, the study consisted of four components which are summarised in Table 1.

Table 1: Components of the study and their respective objectives

Study component	Objective	Methods
Study A: Cross-sectional study of children served by Free State public health services and their mothers with nested case-control study	• To estimate the prevalence of HIV infection among children aged 2–9 years served in the Free State public health sector • To estimate the prevalence of discordant mother/child pairs among children served in the Free State public health sector • To assess exposure to risk for HIV infection in children aged 2–9 years old	Voluntary counselling and testing (VCT) of children and their mothers
	Identify risk factors for HIV infection with discordant mother/child status	Compare HIV-infected children with discordant mother/child status with: • HIV-infected children with concordant mother/child status; • and with HIV-negative children
Study B: Investigation of cases of HIV-positive children with an HIV-negative biological mother	Identify potential sources of infection among HIV-positive children with an HIV-negative biological mother	• In-depth questionnaires investigating exposures to health care settings and traditional healers • Investigation of multiple factors of potential infection
Study C: A quantitative assessment of IC practices in formal health care facilities	Estimate the proportion of health care facilities that have full implementation of universal/standard precautions	Interviews and structured observations in health care facilities and dental practices
Study D: A qualitative assessment of IC practices among traditional healers	Identify selected traditional practices that may expose children to blood-borne pathogens	Focus groups with traditional healers

2.3 Study design

In the cross-sectional study, data was collected between April and July 2004. Mothers or caregivers (where the mother was not present) were interviewed about their children's experiences that might have exposed them to HIV infection.

2.3.1 Study population

The study population consisted of all children aged 2–9 years who were served in 25 public hospitals, three community health care centres and 54 primary health care clinics.

2.3.2 Sample size calculations

The sample size was based on estimations of the proportion of HIV children whose mothers were HIV-negative and generating sufficient cases for a nested case-control study. If the proportion of discordant mother and child pairs (mother negative and child positive) is assumed to be 5% among HIV-infected children, a sample size of 203 is required to estimate this proportion to within 3% with a probability of 95%. If a design effect of 2 is assumed as well as an 80% response rate, the effective sample size of HIV-positive children is 500. However, for the case-control analysis, 46 cases and five controls per case are needed, and thus, the sample size was doubled to identify a sufficient number of discordant children. This was expected to provide additional precision of the estimate of discordance.

During data collection, it became obvious that we had underestimated the number of children needed to investigate this objective. A decision was therefore taken to extend enrolment until 4 000 mother-child or caregiver-child pairs were obtained. In addition, generating more numbers would help to study in greater detail the relative contribution of risk factors for HIV in children.

2.3.3 Sampling

All in-patient and out-patient children at public hospitals and selected primary and community health care centres during the period April to July 2004, who met the inclusion criteria, were approached to participate in the study. Public health clinics were selected based on the following four criteria:

- Busy clinics seeing a large number of children 2–9;
- Location in geographic areas near hospital facilities;
- Clinics visited by doctors; and
- Clinics having a private room for voluntary counselling and testing (VCT).

In total, 3 530 mother-child pairs participated in the study and an additional 583 caregivers provided information about the children they brought to health facilities. There were 4 113 completed questionnaires; HIV test specimens were collected from 4086 children; and 3 530 specimens were collected from biological mothers. The caregivers who participated were not required to be tested for HIV status.

2.3.4 Exclusion criteria

Only fixed clinics were included in the study as mobile clinics would have been difficult to sample. Psychiatric hospitals were also excluded. A mental or psychiatric condition that would preclude the mother from understanding or providing informed consent was also a reason for exclusion. Children whose mothers' refused to allow them to participate were excluded. Where the child refused to give a specimen, the child was not tested.

2.3.5 Recruitment of participants

All mothers of children aged 2–9 years visiting their hospitalised children in public hospitals or primary health care clinics were asked to participate and to answer questions about their children. Caregivers who were accompanying 2–9 year old children for medical care at a primary health care facility were asked to answer questions about the children.

Mothers who consented to both counselling and testing for HIV and DNA were included in the study. The number of mothers who refused to participate as well as their reasons for refusal were documented.

2.3.6 Focus groups

Four focus groups were conducted in the Free State to document some of the practices that traditional health practitioners follow in pregnancy care, delivery of babies and treatment of children. Two of the focus groups were conducted with traditional healers and the other two were conducted with TBAs.

2.4 Organisation of the fieldwork

The study employed 43 registered professional nurses to conduct interviews, conduct physical examinations of the children, conduct VCT and collect blood specimens from mothers and children. They were trained by the HSRC to conduct interviews with mothers about their children, and by the MRC to take blood specimens safely for HIV testing and to collect samples for DNA analysis from both mother and child. Safe blood sampling equipment and safety boxes for disposing of waste were provided. There were two teams of field workers in each of the three regions. These teams comprised a supervisor (who was also a driver) and four fieldworkers. Each team spent a day at each facility to complete all the interviews and tests. There was one supervisor in charge of each of the five health districts.

2.4.1 Statistical methodology

The outcome measure for the cross-sectional study was HIV-positive status of the child. Initial descriptive analyses of all variables provided a basic overview of socio-demographic characteristics, breastfeeding, morbidity, utilisation of health services, number and type of injections and other procedures, as well as exposure to other potential risk factors, i.e. scarification. Numerical data such as duration of hospitalisation or number of injections were analysed both as continuous and categorical data, depending on the frequency distribution and reliability of the variable. Factors associated with HIV status were assessed in bivariate analysis using chi-square tests and Fisher's exact tests for categorical variables. To determine variables that were independently associated with HIV status, all variables found to be crudely associated with HIV status were entered into a logistic regression model.

Odds ratios (OR) were reported, bearing in mind that temporal sequencing cannot be established in a cross-sectional study: for example, whether hospitalisation is a potential risk factor for HIV infection or whether it is a result of the infection.

2.4.2 Data collection for cross-sectional and case-control studies

Questionnaires

Multi-lingual registered professional nurses were trained to collect the data. The nurses explained the purpose of the interview along with potential risks and benefits of participation and ensured the confidentiality of the results. They were also trained in ethics and methods to anonymously link questionnaires to HIV and DNA test results. For all study participants, interviewers collected information on demographic characteristics and various factors related to health-care and environment including:

- Birth settings, presence of health care workers, umbilical cord care;
- Health care: chronic diseases, exposure to body fluids (blood, breast milk from a non-biological mother), open wounds;
- Number of visits to health-care settings, number of days hospitalised;
- Health facility-based percutaneous and permucosal procedures;
- Blood transfusion;

- History of living and/or caring for a person with an HIV/AIDS-related illness;
- Exposure to improperly disposed medical sharps and clinical waste.

Questionnaires were translated into Sesotho. A pilot study was conducted to pre-test the questionnaire and findings were incorporated into the final questionnaire.
Detailed guidelines for interviewers and supervisors were provided along with relevant training.

Each child was physically examined to assess scarification. The whole body including the following areas were checked:

- Head and neck area: forehead, sides of the face just around the ears, the earlobes for earring piercing, the front and back (over the spine) of the neck especially between the collarbones (clavicles);
- The chest: particularly over the middle of the chest and over the spine;
- Abdomen: the umbilicus, the lower part of the abdomen and groin area as well as lower back;
- Upper limbs: the shoulder, elbow and wrist joint areas;
- Lower limbs: the knee joints and ankles.

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Among the sources of HIV infection, we identified sexual abuse as an important variable to study. However, after consulting with experts in child sexual abuse and trauma in the study of sexual abuse and HIV infection in children, it became clear that there was no suitable non-invasive, non-traumatic method that could be used to study the prevalence of sexual abuse and possibly link this to HIV infection among the sample of children. Ethics precluded directly asking if a child had been sexually abused.

Determining HIV status of mother and child

Once the participants had been identified, the researcher asked permission from a visiting mother or caregiver to participate in the study. If the mother or caregiver agreed, she or he was asked to sign a written informed consent form prior to counselling and HIV testing of the child and herself.

A separate VCT area was identified where the mother would be interviewed and tested in privacy. The mother was interviewed first and underwent pre- and post-test counselling according to the Free State VCT protocol. Mothers who consented to both counselling and testing for HIV as well as DNA testing were included in the study.

After pre-test counselling, a rapid HIV test ('Determine' by Abbott) was done for the screening of the mother and the child. A second rapid HIV test ('Unigold' by Trinity Biotech) was performed only if either the child or mother tested positive in the initial test. Discordant samples (first rapid test positive and second rapid test negative) were tested by HIV ELISA (Abbott HIV-1/2 Axsym EIA test). The standard operating procedures (SOP) for the Abbott 'Determinine' test conducted are presented in Appendix 1.

A physical examination was performed on the child to check for signs of scarification. This was followed by HIV testing in the mother or caregiver's presence. The HIV results of both mother and child were communicated immediately. The nurses would then ask

for the child's case record from the hospital staff to complete the additional information on the child which the mother/caregiver might not know e.g. type of operation performed, number of injections given, history of hospitalisation, etc.

DNA testing

DNA tests were conducted on all HIV discordant mother/child pairs to confirm that the putative mother was indeed the biological mother. One 5ml whole blood specimen was obtained from each child and mother in an EDTA tube (mauve-capped Vacutainer) and labelled with the barcode only for the sero-discordant pairs. The ethnic group of the mother was needed for the probability of maternity determination. Further details on blood collection for the DNA testing process are provided in Appendix 2.

2.5 Ethical clearance

The study as a whole was approved by the ethics committee of Stellenbosch University. The milk preparation sub-study, which formed part of Study C, was approved by the ethics committee of the HSRC. Informed consent was obtained from all mothers or caregivers who participated in the study. Participation was voluntary. There was no incentive given to increase participation. The results of the HIV test were immediately disclosed to the mother.

SECTION 3.
RESULTS

Each set of results will be presented as a separate sub-study as follows:

- Cross-sectional study (study A)
- Nested case-control study (study B)
- Facility-based study (study C)
  - Dental sub-study (C1)
  - Maternity and paediatric sub-study (C2)
  - Occult blood sub-study (C3)
  - Milk preparation sub-study (C4)
- Traditional healer study (study D)

3.1 Cross-sectional study (study A)

Twenty five hospitals in the Free State (except the psychiatric hospitals), 58 public sector primary health care clinics and three community health care centres agreed to participate in the study.

Of the 3 570 mothers asked to participate in the study, 3 510 (98.4%) agreed to be tested and 60 refused; 583 caregivers were interviewed but not tested for HIV. Among the 4 113 children whose mothers agreed to their participation, 4 086 (99.3%) children agreed, while 26 refused. The analysis is based on 3 510 mother-child pairs. Regarding exposure to risk, all 4 113 children are included in the analysis. This high level of acceptance of HIV testing indicates that women are interested in knowing their own and their child's HIV status.

3.1.1 Demographic characteristics of the sample

In Table 2 we present the demographic characteristics of the children included in the survey. Most of the children were ambulatory, coming from clinics and out-patient departments of hospitals. Most of the children surveyed came from Northern Free State, Thabo Mofutsanyana, Motheo and Lejweleputswa health districts, with fewer coming from Xhariep. The latter district is medically underserved.

Table 2: Demographic characteristics of the children surveyed, Free State 2004

	Number	Percentage
Out-patient	3560	86.6
In-patient	553	13.4
Total	4113	100.0
Health district		
Motheo	924	22.5
Xhariep	289	7.0
Thabo Mofutsanyana	1008	24.5
Lejweleputswa	855	20.8
Northern Free State	1037	25.2
Total	4113	100.0
Sex of the child		
Male	2057	50.0
Female	2019	49.1
Not recorded	37	0.9
Total	4113	100.0

	Number	Percentage
Race		
Asian	13	0.3
African/black	3955	96.2
Coloured	94	2.3
White	12	0.3
Not given	39	0.9
Total	4113	100.0
Main source of income		
Salary taxed	1201	29.2
Contributions by adults and relatives	307	7.5
Contributions by younger family members/relatives	60	1.5
Government pension/grants	1890	46.0
Grants/donations by private welfare	33	0.8
Other sources of income	68	1.7
No income	102	2.5
Not stated	452	11.0
Total	4113	100.0
Area where the child lived		
City	154	3.7
Town	2917	70.9
Rural village	856	20.8
Farm	118	2.9
Not indicated	68	1.7
Total	4113	100.0

There was an equal distribution between boys and girls who participated in the study. Africans dominated the sample; based on the 2001 census overall, 88% of the population of the Free State is African, 9% white, 3% coloured and 0.1% Asian. In this study more African patients attended public health services compared with a very small proportion of whites. The proportion of coloureds found was similar to that found in the general population of the province.

Half of the children came from homes where the household received a social grant; nearly a third came from homes where parents earned a taxed salary; and 9% received income from other family members. This suggests that the majority of children attending public health services in the Free State are economically disadvantaged. The public health service was the dominant source of health delivery, particularly for hospital care. However, in primary care, 47.3% of these children had a history of using a private general practitioner.

The majority of the children resided in towns, with few from rural areas and farms. The 74.5% urban sample found in this study was slightly higher than the 71% Free State proportion of the urban population.

3.1.2 HIV status by various demographic and background characteristics of study children

Hospital data were representative of the population of children using these facilities and represented all the hospitals in the province. The data for the primary health care facilities was based on 54 primary care facilities and three community health centres out of 490 primary health care facilities in the province – this was not necessarily representative of all primary health care facilities in the Free State.

The prevalence of HIV infection among children aged 2–9 years served in public health services in the Free State was based on 4 086 children tested for HIV status. Of these 605 or 14.8% (95% CI: 13.7–16.1) tested HIV-positive. The HIV prevalence was higher among hospitalised children compared to ambulatory paediatric patients namely 21.5% (95% CI: 18.1–25.8) compared to 13.7%, (95% CI: 12.6–14.9). Further analysis was done by various demographic variables such as sex of the respondent, race, age and geographic location.

Table 3 presents HIV prevalence by sex, race, age of the child and residential locality. Based on a sample of 4 049 completed results, the HIV prevalence among boys aged 2–9 years was 14.3% and among girls it was 15.3%. These differences were not statistically significant ($p = 0.844$).

Table 3: HIV prevalence by sex, race and age, Free State public health facilities, 2004

	Sex of child		
	Male	Female	Total
Child HIV-positive	293	306	599
	(14.3%)	(15.3%)	
	CI (12.8–16.1)	CI (13.7–17.1)	
Total	2045	2004	4049

	Race of child				
	Asian	African/black	Coloured	White	Total
Child HIV- positive	3	579	13	1	596
	(23.0%)	(14.7%)	(14.1%)	(8.3%)	
	CI (0.1–51.9)	CI (13.6–15.9)	CI (6.1–20.83)	CI (0–6.7)	
Total	13	3930	92	12	4047

	Age-group of child		
	2–5 year olds	6–9 year old	Total
Child HIV-positive	408	197	605
	(14.9%)	(14.6%)	
	CI (13.6–16.5)	CI (12.7–16.8)	
Total	2737	1347	4084

Locality type					
	City	Town	Rural[1]	Farm[2]	Total
Child HIV-positive	35	431	106	22	594
	(22.9%)	(14.8%)	(12.5%)	(19.1%)	
	CI (16.2–31.3)	CI (13.5–16.3)	CI (10.3–15.0)	CI (11.9–27.8)	
Total	153	2905	845	115	4018

Notes: 1 The word 'rural' was translated to respondents into Sesotho as 'mahabeng'
2 The word 'farm' was translated as 'mapolasing'

Analysis was also done by race of the child. However, there were very few children who were Asian, coloured or white attending public health services. Analysis of HIV prevalence based on prevalence by age group showed no significant differences in HIV prevalence among younger children (2–5 years) and older children (6–9 years).

In Table 4 data are presented by HIV prevalence in single age years. The highest HIV prevalence was observed among the 7–year olds, followed by the 2–year olds and then the 4–year olds. The 6–year olds had a higher HIV prevalence than the 5–year olds. This analysis suggests there is no discernible trend in HIV prevalence by age among the children served by public health facilities in the Free State.

Table 4: HIV prevalence by age of the children, among hospital and primary healthcare patients in the Free State, 2004

Age of child	2	3	4	5	6	7	8	9
N	99	131	102	76	58	63	41	35
Percentage	(17.1%)	(14.4%)	(14.9%)	(13.5%)	(14.4%)	(18.8%)	(13.0%)	(11.9%)
CI	(14.0–20.7)	(12.1–17.0)	(12.2–18.0)	(10.7–16.7)	(10.9–18.4)	(14.6–23.9)	(9.3–17.2)	(8.2–16.1)
Total	580	908	684	565	402	335	316	294

Since the Free State government uses a district-health planning model, data was analysed by district (see Table 5). The results show marked differences in HIV prevalence by health district. Lejweleputswa health district, which is an urban and mining community, had the highest HIV prevalence at 26.7%. Thabo Mofutsanyana had the lowest prevalence at 10.5%.

Further in-depth analysis revealed an extremely high HIV prevalence (39.4%) in the in-patient sample from Lejweleputswa district, followed by Northern Free State (25.9%) and Motheo district (23.3%). Lejweleputswa also showed the highest HIV prevalence among out-patients (25.1%). Health districts serving rural and farm communities, i.e. Thabo Mofutsanyana and Xhariep, had the lowest HIV prevalence among out-patients (10.3 and 9.1% respectively) and among in-patients (10.3 and 11.2% respectively).

3.1.3 Association between maternal HIV status and child HIV status

In this section, we only include those mother-child pairs with known HIV status. Caregiver-child pairs have been excluded. Of the 4 113 parent/caregivers, 3 530 are biological mothers and of these, HIV results were obtained for 3 471 mother-child pairs. The relation between maternal HIV status and child HIV status is given in Table 6.

Table 6 shows that, of the 2 457 HIV-negative mothers, 7 (0.3%) had HIV-positive children and 2 450 (99.7%) had HIV-negative children. Of the 1 014 HIV-positive mothers, 477 (47%) had HIV-positive children. There is an overwhelming association between HIV positive status of the child and the mother's positive status. Only 1.4% of all HIV-positive children had HIV-negative mothers.

Table 5: HIV prevalence by patient status and health district, Free State 2004

	Health district					
	MO	XH	TM	LE	NF	Total
Child HIV-positive	116	32	104	228	125	
	(12.6%)	(11.1%)	(10.5%)	(26.7%)	(12.1%)	
	CI (10.5–15.0)	CI (7.5–15.1)	CI (8.6–12.6)	CI (23.7–30.6)	CI (10.1–14.3)	
Total	919	288	991	853	1035	
In-patients Child HIV-positive	30	1	21	37	30	119
	(23.3%)	(9.1%)	(10.3%)	(39.4%)	(25.9%)	
	CI (15.9–32.7)	CI (0–27.7)	CI (6.1–14.9)	CI (29.5–54.5)	CI (17.9–36.3)	
Total	124	11	198	93	115	541
Out-patients Child HIV-positive	86	31	83	191	95	486
	(10.8%)	(11.2%)	(10.3%)	(25.1%)	(10.3%)	
	CI (8.6–13.2)	CI (7.5–15.4)	CI (8.2–12.6)	CI (22.0–29.1)	CI (8.3–12.5)	
Total	795	277	793	760	920	3545

Note: LE=Lejweleputswa, NF = Northern Free State, XH = Xhariep, MO = Motheo, TM = Thabo Mofutsanyana

Table 6: The association between maternal HIV status and child HIV status, Free State 2004

	Child's HIV status		
Mother's HIV status	Positive	Negative	Total
Positive	477	537	1 014
Negative	7	2 450	2 457
Total	484	2 987	3 471

The relative risk (RR) for an HIV-positive mother having an HIV-positive child in comparison to an HIV-negative mother is:

RR (477/1 014) / (7/2 457) = 165

3.1.4 Bivariate analysis of factors associated with HIV status of child

Bivariate analysis was used to study the relationship of exposure factors and HIV status. However, it must be noted that, due to the cross-sectional nature of the study, it is not possible to determine the sequence of events that have led to the child's HIV infection. The child may have been infected by the biological mother or as a result of exposure to other risk factors.

In this study 92.3% of the children were breastfed at birth by their biological mother. Ten per cent (10.1%) of the 4 113 children were breastfed for 0–3 months, 8% for 3–6 months, 14.8% for 6–12 months; and 60.9% beyond one year. The proportion of HIV-positive mothers breastfeeding their children was similar to that of HIV-negative mothers. The study found that 94.2% of HIV-positive mothers breastfed their children: 86.4% breastfed for 6–12 months and 62.8% breastfed beyond one year.

Table 7 presents risk exposure associated with breastfeeding in the HIV-positive and HIV-negative children. A very strong association between breastfeeding by a non-biological mother and HIV status of the baby was found. The odds of being breastfed by a non-biological mother were 16.9 times greater for an HIV-positive child than for an HIV-negative child.

For hospital admissions the odds of having a history of hospitalisation were 2.3 times greater for an HIV-positive child than for an HIV-negative child. Similarly blood transfusion was also significantly related to HIV status of the child (OR: 2.6). Table 7 shows that there was a positive association between the number of injections children received and HIV status. The odds of having had any type of injection were 1.6 times greater for HIV-positive than for HIV-negative children. Vaccinations at public health facility were also associated with HIV positivity (OR:1.4).

A visit to a traditional healer was also found to be associated with HIV status. (OR:1.83). The odds of being scarified are two times greater in HIV-positive children than in HIV-negative children.

3.1.5 Multiple regression analysis of the relationship among risk factors and HIV

Many of the factors detailed in Table 7 may be related, such as hospital admissions and transfusions. Identification of independent factors related to HIV transmission were determined through multiple logistic regression – the outcome variable being HIV status of the child. All statistically significant exposure factors in Table 7 were entered into the model: number of hospital admissions, blood transfusion, number of injections in the past 12 months, visits to traditional healers, scarification, breastfeeding from a non-biological mother and children getting milk from a milk room at health care facilities. Because age and sex are often related to disease processes, these were also included. The results are shown in Table 8.

Table 7: Exposure to selected risk factors in HIV-positive and negative children, Free State, 2004

Exposure factor	Level	HIV-positive children N (%)	HIV-negative children N (%)	Odds ratio	Level of significance
Prior history of hospitalisation	Ever Never	228 (37.8) 375 (62.2)	711 (20.7) 2725 (79.3)	2.33	P < 0.001
Blood transfusions	Ever Never	10 (1.7) 595 (98.3)	22 (0.6) 3459 (99.4)	2.64	P = 0.02
Injections in the last 12 months	Ever Never	354 (58.5) 251(41.5)	1645 (52.7) (47.3)	1.6	P < 0.001
Injections at dental care services	Ever Never	18 (3.0) 587 (97)	76 (2.2) 3405 (97.8)	1.4	P = .23
Visits to a traditional healer	Ever Never	256 (42.7) 343 (57.3)	995 (28.9) 2438 (71.1)	1.83	P < 0.001
Vaccinations at public health facilities	Ever Never	298 (49.3) 307 (50.7)	1422 (40.9) 2059 (59.1)	1.41	P < 0.001
Scarification	Ever Never	154 (25.7) 445 (74.3)	509 (14.7) 2955 (85.3)	2.01	P < 0.001
Breastfed by a non-biological mother	Ever Never	52 (9.2) 515 (90.8)	20 (0.6) 3343 (99.4)	16.9	P < 0.001
Child receiving milk from milk room	Ever Never	66 (10.9) 539 (89.1)	199 (5.7) 3282 (94.3)	2.0	P < 0.001

Table 8: Multiple logistic regression of risk factors and HIV status of the child, Free State, 2004

Exposure factor	Level	Adjusted Odds ratio	95% CI	Level of significance
Prior history of hospital admissions	Ever	2.0	1.6–2.5	p<0.001
Blood transfusions	Ever	1.5	0.6–3.7	p = 0.3
Injections in the last 12 months	Ever	1.3	0.9–1.8	p =0.07
Visits to a traditional healer	Ever	1.5	1.2–1.9	p<0.001
Vaccinations at public health facilities	Ever	1.1	0.8–1.5	p = 0.7
Scarification	Ever	1.6	1.2–2.1	p <0.001
Breastfed by a non-biological mother	Ever	17.0	9.7–29.9	p <0.001
Received milk from milk room	Ever	1.2	0.7–2.0	p= 0.5
Age	Years	0.97	0.9–1.0	p = 0.3
Sex	Female	1.1	0.9–1.3	p = 0.5

Having had a blood transfusion, being vaccinated at public health facilities, receiving milk from a milk room, age and sex were no longer significantly associated with HIV status of the child in the full model. Having been breastfed by a non-biological mother remained highly associated with a child's HIV status. The odds of a having been breastfed by a non-biological mother are 17 times greater in HIV-positive children. Having a prior hospital admission, having seen a traditional healer and being scarified also remained statistically significant after controlling for age, sex and other exposure factors.

3.2 Risk factors for HIV acquisition in children stratified by mother's HIV status (study B)

3.2.1 Background

In 2002 the first national community-based HIV prevalence study was conducted in South Africa. A surprising finding was the high prevalence of HIV among children. Out of 2 348 children aged 2–14 years, 5.6% were HIV positive and the prevalence did not vary significantly by year of age for children between 2–9 years (Nelson Mandela/HSRC Study of HIV/AIDS 2002). The high HIV prevalence and unexpected distribution of HIV infection led to concerns that a significant proportion of HIV transmission to children may not be from mother to child. A very low (22%) mother-child concordance for HIV infection was found in South Western Nigeria (Omotade, Olaleye, Sliu, Odaibo & Adeyemo 2001). It was suggested that vertical transmission may not be a major route of transmission of HIV infection of the local children. Instead, unsterilised needles and surgical knives used for scarification were suspected to be major routes of HIV transmission. Gisselquist and colleagues have suggested that between 20–40% of HIV infections in African adults are associated with injections (Gisselquist et al. 2002). While UNIAIDS (2004) estimates that only up to 5% of infections in adults may be due to contaminated injections, the role of nosocomial infection needs to be investigated. In addition to nosocomial infections, other potential routes of HIV transmission to children include becoming infected through child abuse, traditional scarification practices and horisontal transmission.

We conducted a cross-sectional study (Study A) of health facilities in the Free State Province of South Africa with two main objectives. Firstly, to estimate the prevalence of HIV infection among children aged 2–9 years using public health services of the Free State. Secondly, to estimate the proportion of HIV positive children aged 2–9 years who have an HIV-negative biological mother. This case-control study (Study B) was nested within the cross-sectional study.

3.2.2 Methods

From the cross-sectional study, a total of 4 113 mother-child pairs were recruited from the in-patient and out-patient departments of 88 health facilities in the Free State of South Africa. Of these 4 113 pairs, 3 510 children were accompanied by their biological mother who had an HIV test result. Of these 3 510, 488 children (13.9%) were HIV-positive, and in only seven cases (1.3% of all HIV-positive children) the child was HIV-positive and the mother HIV-negative.

The HIV status of the child and mother was determined in the field by using a screening and a confirmatory HIV rapid test ('Determine' and 'Unigold' respectively) and confirmed in the laboratory with an ELISA test. Confirmation that the putative mother was the biological mother was done by conducting maternity DNA tests on blood from the mother and child.

3.2.3 Results

Six of the seven cases (86%) were girls compared to 15 (43%) of HIV-positive controls and 16 (46%) of HIV-negative controls. This difference was of borderline significance compared to cases for HIV-positive controls (p=0.07) and HIV-negative controls (p=0.08).

All seven cases came from only two districts in the Free State, with five cases living in and attending health facilities in Thabo Mofutsanyana and two cases living in and attending health facilities in Motheo. Controls were spread across all five Free State districts.

Factors that could be associated with mother-to-child transmission were identified from the literature. Table 9 shows the strength of association between each of these factors and the child's HIV status, first ignoring mother's HIV status (pooling HIV-positive and HIV-negative mothers) and then stratifying by mother's status. In the pooled analysis ignoring mother's status, many factors showed a significant association with the child's HIV status. However, the mother's HIV status is clearly an important factor in the transmission of HIV infection to the child and is potentially associated with many of the other factors evaluated. Hence, the mother's HIV status may confound or modify the association of these factors with the child's HIV status. The analysis was therefore repeated, stratified by the mother's HIV status. It should be noted that there were 1 022 HIV-positive mothers, 481 of whose children were HIV-positive (47%) and 2 488 HIV-negative mothers, only seven of whose children were HIV-positive (0.28%).

With the exception of using a milk room, all the factors significant in the initial pooled analysis were also significantly associated with HIV status of children of HIV-positive mothers. However, it is difficult to interpret these associations, because the time of the child's HIV infection is unknown, therefore a factor could be the cause or result of the infection.

Children of HIV-negative mothers could not have been infected through mother-to-child transmission. Within the stratum of HIV-negative mothers, four factors were significantly associated with the child's HIV status. Children who had visited a dentist were more likely to be HIV-positive than those never visiting a dentist (OR 26.9; 95% CI: 4.4–283.5). A dental injection had been received by 2.4% of children of HIV-negative mothers. However, among the seven HIV-positive children, three (43%) had received a dental injection (OR 31.5; 95% CI: 4.5–189.4). The two other factors that were significantly associated with the child's HIV status were breastfeeding by a non-biological mother and using a milk room. In both cases, children exposed to these factors had a greater chance of being HIV-positive. Overall, 0.6% of the children of HIV-negative mothers had been breastfed at some point by someone other than the biological mother. However, five (67%) of the HIV-positive children had been breastfed by someone other than the biological mother (OR 437; 95% CI: 53–5020). Overall, 3.6% of HIV-negative mothers made use of a milk room. However, four of the mothers of the seven HIV-positive children (57%) made use of a milk room (OR 37.6; 95% CI 6.2–259). Even though the association of child's HIV status with these factors was significant, the width of the confidence intervals is an indication of the rarity of HIV-positive children in this stratum. Again it must be noted that, due to the cross-sectional study design, it is not possible to determine whether exposure to these factors preceded the child's HIV infection. Although not statistically significant, it is also of interest that six of the seven HIV-positive children of HIV-negative mothers were girls (p=0.07).

Many of the factors considered in Table 9 are correlated. For example, having a transfusion and being admitted to a hospital may be related, as may be scarification and visiting a traditional healer. In a multiple logistic analysis carried out on the pooled data (ignoring the mother's HIV status), most of factors identified in Table 9 remained significantly associated with the child's HIV status, with little change in the ORs. This suggests that these factors were independently associated with the child's HIV status.

Table 9: Frequency of risk factors by mother's HIV status

Factors	All mothers combined		Stratified by mother's HIV status			
			HIV-negative, n= 2488		HIV-positive, n= 1022	
	OR	95 % CI	OR	95 % CI	OR	95 % CI
Age						
2–4	–		–		–	
5–9	1.2	(1.0–1.5)	1.0	(0.2–4.5)	1.5	(1.2–1.9)
Sex						
Male	–		–		–	
Female	1.1	(0.9–1.4)	5.9	(0.7–272)	1.3	(1.0–1.6)
Prior history of admission						
Ever	2.1	(1.7–2.6)	2.9	(0.4–17.3)	1.9	(1.4–2.6)
Previous dental visit						
Ever	0.9	(0.6–1.3)	26.9	(4.4–283.5)	0.8	(0.5–1.3)
Blood transfusions						
Ever	2.1	(0.7–5.1)	n/a[1]		1.1	(0.3–3.8)
Injections in the last twelve months						
Ever	1.5	(1.3–1.9)	1.4	(0.2–9.3)	1.9	(1.5–2.5)
Dental injections						
Ever	1.4	(0.7–2.6)	31.5	(4.5–189.4)	2.5	(0.8–9.3)
Visit to a traditional healer						
Ever	2.1	(1.7–2.5)	0.4	(0.01–3.2)	2.4	(1.9–3.2)
Vaccinations at public health facilities						
Ever	1.4	(1.1–1.7)	1.0	(0.1–5.9)	1.6	(1.2–2.1)
Scarification						
Ever	2.1	(1.6–2.6)	0.9	(0.02–7.5)	2.1	(1.6–3.0)
Breastfed by non-biological mother						
Ever	13.5	(7.6–24.6)	437	(53.4–5020.6)	4.8	(2.2–11.5)
Child received milk from milk room						
Ever	1.9	(1.2–2.8)	37.6	(6.2–258.7)	1.1	(0.6–1.9)

Note: 1. n/a = Odds ratio could not be calculated because of a zero cell

However, this analysis ignores the mother's HIV status, which is a major limitation. With only seven discordant pairs (mother negative and child positive) and with many pairs being exposed to several factors, it is not possible to fit a multiple logistic regression model to HIV-negative mothers separately.

A further analysis was undertaken to explore the association of behavioural factors with HIV status of mothers of HIV-negative babies. Interestingly, mothers using a non-biological mother to breastfeed their child were more likely to be HIV-positive than mothers not using a non-biological mother to breastfeed (OR 3.7; 95% CI: 1.4–10.1). Mothers using a milk room showed a similar result (OR: 1.7; 95% CI: 1.1–2.7). It may be that these HIV-positive mothers deliberately chose not to breastfeed for fear of transmitting the infection. This analysis indicates behavioural differences in HIV-positive and HIV-negative mothers, despite their children having identical HIV status.

3.2.4 Discussion

Among HIV-negative mothers, children who visited dental facitlities or had dental injections were more likely to be HIV-positive. Interestingly, another component of this research project highlighted the risk posed by dental procedures prior to the findings from the case control-study being available and will be dealt with separately in this report.

While it is recognised that most oral health procedures require specific strategies and protocols to prevent the transmission of HIV/AIDS between oral health care providers and patients, as well as between patients themselves, there are almost no such protocols in place in South Africa (Ogunbodede & Rudolph 2002). Another study among dentists in Durban (Yengopal, Naidoo & Chikte 2001) concluded that: 'adherence to universally accepted guidelines for infection control remain low amid a climate of an ever-increasing HIV pandemic'.

The finding that there was a strong association between being breastfed by a non-biological mother and receiving milk from milk rooms is also important because interventions to prevent such HIV transmission can be implemented. As with dental procedures, the danger of HIV transmission via unpasteurised human milk obtained from milk rooms was identified as a risk prior to these results becoming available and will be reported on separately in this report.

The finding of five cases coming from one health district and two from one other also deserves attention. It may be that one or both groupings of discordant mother-child case pairs occurred as part of an 'outbreak' due to a breakdown of infection control in either dental services or where a milk room was being operated. Because of this an outbreak investigation needs to be undertaken urgently.

The fact that six of the seven cases were girls is noteworthy. Our concern is that girls may be more vulnerable to sexual abuse than boys – this potential risk factor could not be investigated as part of this study.

Apart from the above findings, this study identified no other risk factors for HIV transmission to children. However, this does not rule out other risk factors as being important because the very limited number of cases made it impossible to identify risk factors that may be more subtle.

3.2.5 Conclusions

This stratified analysis has highlighted dental services, milk rooms and the use of 'wet-nurses' as potential sources of HIV transmission to children. However, care must be taken in interpreting this data, and the threat posed by dental services and milk rooms identified here cannot be generalised beyond this study. Nevertheless, the risk must not be ignored and immediate and urgent attention needs to be focused on dental practices and the operating of milk banks. Also, the risk posed by breastfeeding by a non-biological mother must be taken account of and the public needs to be informed about the dangers posed by this practice

With only seven discordant pairs and the fact that all the children were exposed to several factors, it is not possible to isolate a single factor which would explain the HIV-positive status in children with HIV-negative mothers. It is also important not to lose sight of the fact that 98.6% of HIV-positive children had HIV-positive mothers.

3.3 Facility-based study on IC knowledge, provision and application (study C)

3.3.1 Introduction

IC practices in dental and hospital facilities in the Free State were evaluated in this facility-based sub-study. The methodology was similar in both study groups and is described in one section. However the results from the two sub-studies, i.e. dental and maternity and paediatric services, are reported separately and include the occult blood and milk investigation results.

Dental services in South Africa

The 1998 Demographic and Health Survey found that 36% of South Africans indicated that they have had oral health problems (Department of Health, 1998). Dental problems were reported among Africans in non-urban areas and in the Free State, Eastern Cape and Northern Cape (Naidoo, Chikte, Moola, & Steyn 2001). In the Free State, our survey showed that 8.2% of patients sought dental care in the public sector, of whom 14.8% were HIV-positive. It was reported that between January and March 2004, of the 46 000 attendances at the dental facilities, up to 35% were children under the age of 10 years (Free State Department of Health, 2004)

Oral health care in South Africa is provided by dentists and dental therapists. In 2001, South Africa had a total of 4 648 dentists and 418 dental therapists, of whom only 14% (662) of dentists and 28% (118) of dental therapists were employed in the public health sector. In addition in 2001, South Africa had 10.8 dentists and 0.98 dental therapists per 100 000 population. An increase of 16.4% dentists and 50.2% dental therapists between 1997 and 2001 was noted. Dental therapists have shorter periods of formal training than dentists and deal mainly with dental extractions and non-surgical procedures.

It was reported that only 45% of dentists were prepared to engage in the continued care of known HIV-positive patients (Darling, Arendorf & Samaranayake 1992). Even though dentists acknowledged an increase in the number of HIV-positive patients referred to their rooms, there were notable gaps in their knowledge regarding HIV transmission. Although this was reported 12 years ago, it would appear that little has changed.

Poor compliance with IC practices in dental facilities has been documented, using visible or occult blood as surrogate markers for the presence of contamination (Lewis & Boe 1992). The presence of occult blood has been a well-recognised forensic technique which identifies blood contamination. The Kastle-Mayer test, based on similar principles as those used in forensic investigation (presence of blood) has been applied for identification of blood contamination in dental surgeries and has been validated (Edmunds & Rawlinson 1998). The presence of visible and occult blood has also been reported from other

disciplines such as anaesthetics (Perry & Monaghan 2001), where approximately 30% of the equipment tested was contaminated. Similarly, the incidence of visible and occult blood on laryngoscope blades and handles in an anaesthetic room has been reported (Phillips & Monaghan 1997).

Maternity and paediatric facilities in South Africa

There are few reports on provisions for IC in maternity and child health facilities. Breastfeeding has been given the main focus. Most hospitals in South Africa, including the Free State, have been declared 'baby friendly' and therefore the preparation of formula milk is infrequent. Formula milk is usually offered to babies who cannot breastfeed, need supplements for medical reasons, or whose mothers have died. Mothers are encouraged to breastfeed their babies either directly every three to four hours, or with expressed breast milk (EBM) if the mother works. Breast milk is expressed into a container for the child. The EBM should be labelled by the mother or health care worker with the baby's name and left in the refrigerator. An aliquot is removed for each feed using a recycled and non-dedicated syringe which is cleaned and disinfected in a communal hypochlorite (Milton®) container. The clean preparation of formula milk, accurate labelling of milk bottles, checking that the baby receives his or her own mother's EBM and meticulous cleaning and sterilisation of milk bottles is essential for good IC practice and prevention of nosocomial HIV transmission.

3.3.2 Methods

This facility-based study was conducted independently of the cross-sectional and nested case-control studies, with its own team of researchers and independent time frames operating independently from other field teams. The methodology and results are presented here.

Research team

The team was led by an experienced IC medical practitioner. Five infection control nurses were recruited from the Free State major hospitals and were allocated to districts other than their own. Training on interviewing techniques and observation of clinical practice in health care facilities was conducted for three days and minor adjustments were made to the protocol. The nurses were taught to use the Hexagon OBTI® rapid test kit. This is an occult blood detection system based on a similar principle to the Kastle-Mayer test to document the presence of visible and/or occult blood on items used directly or indirectly for patient care.

This method was used to detect occult blood to document the extent of blood contamination within public sector dental surgeries and maternity/paediatric units. The aim was to identify the presence of visible and/or occult blood as a surrogate marker for poor IC practice.

Time frame

Data collection was conducted over a period of two and a half weeks during 2004 in the Free State province, and focused on health care provision for babies and children up to nine years of age, including those children attending dental clinics. Three service areas were identified:

- Maternity, labour and post-natal wards for the mothers;
- Paediatric and neo-natal units providing health services for infants and children; and
- Dental facilities which provided paediatric care.

Similar investigative methods were used for both dental and maternal and paediatric units and the results are presented as follows:

- Dental facilities: a questionnaire was used to assess knowledge, observation of provision of service and observation of practices, and these are presented in sequence;
- Maternity and paediatric in-patient facilities: a questionnaire similar to that used in dental facilities, but with additional investigation into milk preparation and dispensing in hospitals;
- Detection of blood: this included documentation of visible and occult blood as a surrogate marker for poor IC practices;
- Random milk samples from containers (both formula and breast): this included sampling for viral load estimation.

Dental services study (study C1)

The 24 available public dental facilities in the Free State were visited during the two and a half weeks study period by an IC nurse. In some areas the dental services were provided fortnightly and were not open at the time. Where the unit was not operational on the day of the visit, it was assessed for IC provision. However, the dentists who provided the services in the latter units were interviewed and observed during clinical practice at other clinics which were open when the IC nurses visited.

Maternity and paediatric services study (study C2)

There were 30 in-patient facilities for mothers and children in the Free State; the larger facilities had more than one ward for children while smaller hospitals had a mixed ward for mothers and children. Most hospitals had provision for mothers to 'stay in' with the child if necessary. Each available mother and child facility was visited during the two and a half weeks study period by an IC nurse. Staff were interviewed to assess their IC knowledge. Each unit was observed for available IC provisions for practitioners and finally, clinical practice was observed to assess application of IC knowledge.

Questionnaire

Details of the study were explained to facility staff and they were asked to volunteer to participate in the interviews. A questionnaire was developed in consultation with the WHO and included a review of previous questionnaires used in similar studies.
Sections included:

- General information regarding IC programmes;
- Hand hygiene;
- Personal protection and blood-borne virus (BBV) exposure protection;
- Cleaning of critical care equipment;
- Waste management;
- Sterile services;
- Dental facilities (completed for dental visits only);
- Milk preparation, labelling and storage facilities (completed for maternity/paediatric units).

Each section included an interview to assess knowledge of the health care practitioner. The denominator was established from the number of answers either yes or no to a particular question; replies of 'don't know' or 'no reply' were not included. Therefore, the denominator for each set of questions varied accordingly. Observation of IC provision or supplies in the health care facility was recorded. Finally, an observation of clinical practice was conducted, which assessed the combined use of IC knowledge with the provision of supplies and facilities towards optimal patient care. It was expected that IC policies or trained staff were in place and clinical practice would comply with these IC policies.

Information was recorded as follows:

- Knowledge: the general section of the questionnaire established the presence or knowledge of a written IC policy for the facility. Specific IC knowledge among practitioners working in the dental facilities or maternity and paediatric units was assessed by questions on the appropriate use of protective clothing, cleaning and sterilising equipment and particular practices which might lead to BBV transmission.

- Observation of unit and provision of service: the dental and in-patient facilities (maternity units, neonatal units and paediatric wards) were evaluated for layout, facilities available for cleaning and sterilising equipment as well as an adequate number of gloves, masks and other protective clothing. The number of hand wash-basins, soap and hand drying towels were noted.

- Observation of clinical practice: in dental facilities, the dental procedures observed included extractions or fillings requiring the use of dental injections and dental instruments. The process of handling and cleaning the instruments after each patient use, the cleaning of dental instruments, disinfection and packing for sterilisation was also observed. In maternity and paediatric units, delivery of babies, insertion of IV cannulae or catheters, urinary catheterisation and maintenance, and the preparation of milk were noted.

Blood contamination (study C3)

Occult blood test

The test kit used is a rapid, highly specific and sensitive one-step immunoassay (Hexagon OBTI®, Human Diagnostica, Germany). It is a rapid immunological test for qualitative detection of human haemoglobin in stool samples for faecal occult blood and is based on an immuno-chromatogenic technique with immobilised monoclonal antibodies, capable of detecting haemoglobin (Hb) at concentrations of >0.05 µg/ml. It is specific for human haemoglobin HbA_0, HbA_2, HbF and HbS with no cross reactivity with animal haemoglobins up to concentrations of 1000µg/ml. No cross reactions with bilirubin, triglycerides, acetylsalicylic acid or ascorbic acid have been reported.

The kit comes as a strip of a conjugate consisting of blue dye particles, immobilised anti-human Hb antibodies (mouse) and anti-mouse IgG antibodies (goat), individually sealed. The collection tube contains TRIS buffer pH 7.5 and a firm applicator stick with grooves which is resistant to breaking during sampling. A sample is taken using the applicator and thoroughly mixed in the TRIS buffer. The tip is broken off and two drops are delivered into a well on the strip and read within ten minutes. A blue line appears at the control point within one minute. If Hb is present a second line appears usually within two minutes.

This highly specific test for occult blood proved extremely useful in the field because it is rapid, specific and easy to perform. The test had been validated for forensic identification of human blood by independent researchers (Mochmeister, Budowle, Sparkes, Rudin, Gehrig, Thali, Schmidt, Cordier & Dirnhofer 1999), who reported detection rates in blood dilution of 1:1000 000 or 1µl in 1 litre. There were no cross reactions with animal blood reported.

Items for occult blood sampling were grouped into 'direct' and 'indirect'. The 'direct' samples were from dental instruments after these had been cleaned and/or processed - just before use on the next patient. These included dental instruments, suction catheters and dental injections. The 'indirect' samples included those which were not directly in contact with the patient's mouth or gums, such as surfaces around the dental chair, tray, suction tubing and spittoons. The presence of occult blood was tested after observing for the presence or absence of visible blood. Results reported the type of item sampled, presence or absence of visible blood noted on equipment, 'direct' or 'indirect', associated with the procedure. The minimum required sample size was one hundred samples each from the dental clinics and mother and child units.

Sampling

DENTAL FACILITIES

All surfaces were examined for the presence of visible blood. Surface samples were taken from the vicinity of the dental chair, usually at the beginning or the end of the dental sessions, but occasionally between patients. Random samples were taken from dental instruments and equipment just prior to use on the next patient. It was assumed these instruments had been sterilised or disinfected between patients. Samples for occult blood were also taken from areas in the dental unit which were visibly contaminated with blood as well as items which were not visibly contaminated, but were shared between patients.

MATERNITY AND PAEDIATRIC FACILITIES

During visits to the health facilities, work surfaces were examined for the presence of visible blood. Surface samples were taken from the wards, delivery areas, babies' cots and equipment at the time of visit. Random samples were taken from instruments and equipment just prior to use; it was assumed these instruments had been sterilised or disinfected between patients. Items for occult blood sampling were grouped into 'direct' and 'indirect'. The 'direct' samples included delivery instruments, suturing equipment and other items which came directly in contact with the baby. The 'indirect' samples were taken from surfaces, mattresses and ward surfaces to reflect adequate standards of cleanliness.

Milk preparation and distribution procedures (study C4)

Random milk samples were taken from the bottle after the baby had been fed. These were both of formula and EBM. The samples were collected in a sterile laboratory specimen container, labelled accurately, coded and stored in an ice-box before being delivered to the nearest laboratory for transport to the Universitas Hospital Laboratory Service. The type of milk or sampling site (such as hospital ward) was not revealed to the laboratory. HIV-RNA viral loads were determined using the Ampiclor (Roche) system which detected 50 copies or more of viral particles. The results were returned to the Principal Investigator, the code was broken and the results entered into the database (see separate section on milk viral loads on pages 49–50 of this report).

Statistical analysis

Tables were constructed from the IC data that were collected via the questionnaires. The number of items that tested positive for occult blood was recorded as a percentage of the total number of items tested. The total number of dental procedures undertaken during the past six months was noted from the provincial statistics and was divided into patients above or below the age of 18 years who had attended dental clinics in the past six months. This gave an average workload per clinic.

3.3.3 Results

Dental services (study C1)

There were 26 dental facilities in the Free State, of which 24 were visited. Two dental clinics were closed on the day of the visit, but the dentists providing cover for the patients of those two units were interviewed at another site where they were working.

Sample size

The number of dental units per district is shown in Table 10 (column one, in brackets). There were 24 units observed (column 2), 30 staff agreed to be interviewed (column 3), but two questionnaires were invalid due to inaccurate completion of the forms, therefore assessment of knowledge was based on 28 valid questionnaires. Observation of clinical practice (column 4) was documented on 23 procedures. It should be noted that in Lejweleputswa and Motheo, there was more than one area in each dental clinic observed. Not all of the staff interviewed were observed during clinical practice, and this is reflected in the difference between columns 3 and 4.

Table 10: Total sample size by district

District (units)	Observation	Interview	Practice	Total
Lejweleputswa (4)	8	9	8	25
Motheo (4)	5	7	5	17
Northern Free State (4)	3	5	3	11
Thabo Mofutsanyana (11)	7	9	7	23
Xhariep (1)	1			1
Total (24)	24	30	23	77

Staff at the dental clinics

There were a total of 75 dental staff recorded in the 24 units (Table 11), of which 22 were auxiliary staff including dental nurses and dental assistants (29.3%), nine dental therapists (12%), and 29 dentists (38.6%). The remaining 15 were either support staff or their occupation was not stated on the questionnaire (18%). Several dentists covered more than one clinic in the region.

The districts of Xhariep and Thabo Mofutsanyana are combined in Table 11 because Xhariep had only one clinic and it was closed on the day of the visit.

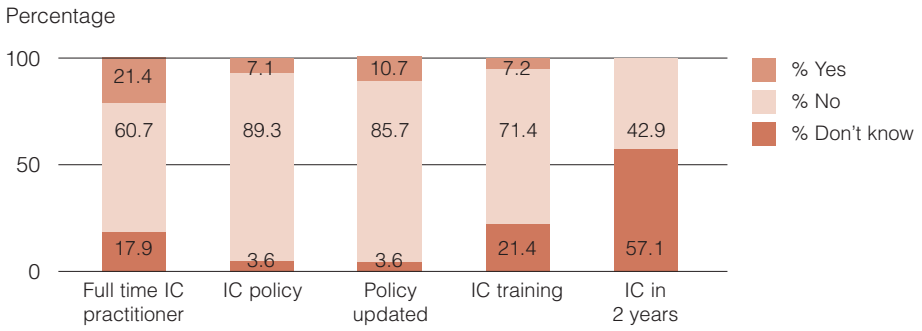
Table 11: The distribution of staff in the dental facilities by district

District	Dentist	Dental therapist	Auxiliary staff	Support staff	Not specified
Lejweleputswa	9	3	13	1	25
Motheo	4	2	5	2	5
Northern Free State	8	0	2	0	0
Thabo Mofutsanyana & Xhariep	8	4	2	1	6/1
Total	29	9	22	3	12

IC policies and practice

With regards to the 28 completed questionnaires, only 17.9% of respondents knew of an IC practitioner in the health facility, and 3.6% knew of an IC policy in existence within the hospital or health care facility. IC training was acknowledged by 21.4% while 57.1% had not had any such training in the past two years. There was no official IC policy found at any of the 24 dental clinics that were visited (Figure 2).

Figure 2: IC support structures reported by those interviewed in the dental facilities visited



Standard precautions

Thirteen out of 28 (46.4%) knew what standard precautions were, while twelve had never heard of such policies.

Protective clothing

Knowledge: The use of gloves (part of standard precautions) among dental staff was reported as follows: 75% were aware of all procedures and 21.4% were aware of precautions related to washing instruments, but only one person was aware of waste handling precautions. Aprons, gowns or laboratory coats were used during dental patient care by 32%. Fifty per cent said they did not have aprons available and only one person said aprons were used during washing instruments. All 30 persons interviewed said that masks should be used for all patients, while only 73.3% reported that the use of eye protection during dental procedures was necessary. Only 9 of the 30 units (30%) reported ever being short of gloves during the year, and this were less than five times per year. Observation of unit: It was observed that the only available gloves were made of latex

and these were used as multi-purpose gloves, irrespective of procedure or risk of exposure. At the 24 units, adequate stocks of gloves, aprons, masks and eye protection were recorded by the research team as 100%, 20.83%, 91.67% and 58.33% respectively, reflecting a good availability of gloves and masks but not gowns/aprons or eye protection.

Clinical practice: During observation of clinical procedures, 52.2% used gloves during a dental procedure and only 8.7% discarded the gloves after each patient use. Masks were worn by 65.3% and 21.7% changed their masks between patients. Four of the 23 persons observed (17.4%) used an apron or gown during a dental procedure, and eye protection was worn by 17.4%. It is noteworthy that neither item of protective clothing was changed or cleaned during the entire session.

Hand hygiene

Knowledge: On interview, 86.7% of respondents acknowledged it was critical to wash hands before and after each patient contact and 30% said it was important to wash hands after removing gloves.

Observation of unit: It was observed that there was at least one hand wash-basin provided per unit or dental work area in 91.7% of cases. Liquid soap was noted in 87.5% of facilities and paper towels for drying hands were noted in 66.7%. However, it was also noted that all the hand wash-basins were multi-use and none were dedicated for hand washing only: in 91.7% of the units the hand wash-basins were used for cleaning dental equipment and in 66.7% body fluids and water from patients were discarded in the hand wash-basins.

Clinical practice: Only 21.7% carried out hand hygiene (washing hands) before each dental procedure; 34.8% had long painted nails, jewellery and/or rings on their fingers.

Sharps injury and BBV protocol

Knowledge: Of the 30 respondents interviewed, 6.7% had a sharps injury/ BBV protocol to hand and 50% were aware of such a policy. Pre- and post counselling was available as reported by 40%, 43.3% of whom said they would receive post exposure prophylaxis within four hours of reporting a sharps injury. Of those interviewed, 63% and 66.7% knew their hepatitis B and HIV status respectively. Eight (26.7%) reported a sharps injury in the past three years: three incidents occurred during the re-capping of a dental syringe and four during injecting a patient for a dental procedure.

Observation of a unit or clinical practice was not expected in this section; the necessary information was included in the questionnaire.

Cleaning of critical equipment

Knowledge: Regarding critical steps in cleaning re-usable equipment, 83.3% of dental practitioners said that the item must be visibly clean, 56.7% said the item should be soaked in a disinfectant, while only one person reported that appropriate protective clothing should be worn. Ninety per cent knew that autoclaving was a sterilising procedure, while 40%, 26.67% and 10% respectively reported gluteraldehyde, hypochlorite (Jik®) and quaternary ammonium compound (Dettol®) as having sterilising properties (which is a general misconception).

Observation of unit: It was observed in the dental units that 87.5% used the hand wash-basin to wash dirty instruments. Only 21.7% used protective clothing during the washing of contaminated instruments, 47.8% disassembled the equipment before soaking in a disinfectant, 65.2% recorded the removal of all visible dirt or organic matter from dental items, and only 60% of critical items were autoclaved before use on another patient.

Clinical practice: It was noted that 60.7% of items were soaked in a disinfectant, and 39.1% of items were disassembled before processing. Wearing protective clothing during the cleaning procedure was noted in 39% cases, highlighting the difference between knowledge and practice.

Waste management

Knowledge: 26.7% of practitioners said they knew of a waste management policy. All of them knew which colour was associated with clinical waste and which with non-clinical waste, but little else.

Observation of unit: Eight of 24 (33.3%) units visited had a waste management policy in place, with an adequate supply of appropriate colour-coded containers and plastic bags in 41.7% of units, and a protected area for storage of waste in 37.5%. However, there was no register for recording sharps injuries in the unit itself, and only one of the 24 units had a sharps injury policy available in the dental unit.

Clinical practice: Observation of handling waste at unit level revealed that, in 82.6% of the units, sharps were discarded carefully and appropriately, but only 39% of clinical and non-clinical waste was appropriately discarded. One person wore appropriate protective clothing to transport waste; in 60.9% of cases the sharps boxes were disposed off correctly.

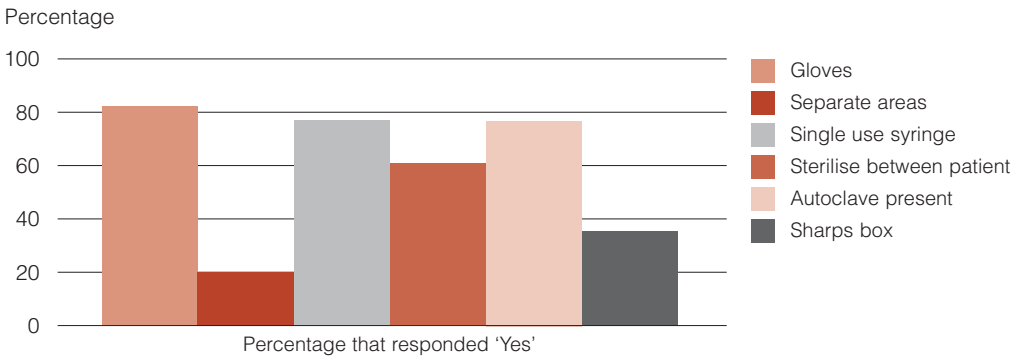
Dental facility IC practice

Knowledge: During interviews, 76.67% reported that all dental items must be sterilised between patients. Approximately half said that protective clothing was important during dental procedures. Twenty-one out of 30 (70%) interviewees said a new needle would be used but only a third said they would use a fresh vial of local anaesthetic (and a sterile or clean dental syringe) for each patient. According to 20% of interviewees, a sterile drill head was used for each patient and a similar number said the water in the flushing system would be changed or disinfected regularly.

Observation of unit: In 83.3% of dental units a box of gloves was present next to the dental chair. A separate area for clean and dirty instruments was noted in 20.8%, single use of dental injection (needle and dental injection holder) in 75%. Sterilisation of dental equipment between patients was noted in only 62.5% even though 75% of the units had a steriliser. None of the dental units had a record or log book of the items processed. Sharps containers were found in 79.17% of units (Figure 3).

Clinical practice: During clinical procedures, it was observed that 87% of dental practitioners wore gloves, while 47.8% wore eye protection and masks, but only during high speed drilling. A new needle (but not a new dental syringe) was used for each patient by 78.3% of dental practitioners, but a separate injection holder for each patient was used in only 65.2%.

Figure 3: Provision for standard precautions in dental units



Sampling of occult blood

A total of 110 samples were collected from the 17 clinics with a mean of 6.5 (range 1–16 samples) from each dental surgery. In five dental units there were no services being provided at the time of visit, and two units were closed. Overall, thirty-one samples (28.2%) were found to be positive for occult blood.

Sixty-nine direct items or instruments that came into contact with the patients' mouth and gums were tested for occult blood, of which 17 (24.6%) were found to be positive. Of those samples taken from the environment around the dental chair and working area (indirect), 34.2% were positive for occult blood. Visible blood was noted in 15 samples, 12 of which were directly used for the next patient. Of concern was that nearly half of forceps used to extract teeth had occult or visible blood.

The list of direct items tested and found to be positive for occult blood is shown in Table 12, where columns 3 and 4 clearly illustrate that occult blood may be present on items which are not visibly contaminated with blood. Visible blood was noted in almost 20% of items, some of which tested positive for occult blood, while occult blood alone was detected in 24.6%. The highest occult blood levels were detected among extractor forceps and the suction tips.

Table 13 illustrates the indirect items that were tested for visible and occult blood. Visible blood was found on 7.3% of items tested while occult blood was documented from 37%. It should be noted that visible blood was found in areas related to instruments such as the hand wash-basin and cleaning brush, and the dentist's visor. Occult blood was also most frequently detected in the immediate vicinity of a dental procedure, such as the dental chair and lamp. Of concern was that the cotton wool swab container was contaminated on the outside and the cotton wool swabs which were used to apply pressure after dental extraction were also found to be positive for occult blood (see Table 13).

Analysis of visible and occult blood results in direct and indirect items shows that, while there was more visible blood noted in direct items (direct v indirect; 19.4% v 7.3%), the percentage of items found with occult blood was higher among the indirect items (37%) as opposed to approximately 25% among direct items.

Table 12: Items used directly in dental procedures

Items	Tested (n)	Positive for occult blood	Visible blood
Amalgam introducer	1	1	0
Dental injection	3	0	1
Cotton swab	1	1	0
Probe	6	2	0
Drill head	3	1	0
Forceps (extractor)	33	5	10
Gloves between patients	2	0	0
X-ray plate	2	1	0
Mirror	3	0	1
Suction tip	9	5	1
Xylol spray	1	1	0
Other	5	0	0
Total	69	17 (24.64%)	13 (19.4%)

Table 13: Items used indirectly in dental procedures

Items	Tested (n)	Positive for occult blood	Visible blood
Autoclave	1	0	0
Hand basin	5	4	1
Bottles & disinfectant	4	0	0
Instrument brush	3	1	1
Dental chair	4	2	0
Dental tray	4	0	0
Cheatles forceps	1	0	0
Heating tray	1	1	0
Lamp/light	10	4	0
Swab containers	3	1	0
X-ray machine	1	0	0
Surfaces/visor	4	2	1
Total	41	15 (37%)	3 (7.3%)

In 25% of observations, the instruments used for dental extraction were taken, used and replaced on the same instrument tray as sterile equipment. Cleaning and sterilisation of dental equipment between patients was recorded in 82.6% of units.

Maternity and paediatric health care facilities (study C2)

One hundred and one mother and child units were visited in the 30 hospitals, of which 98 reports were validated, while three units had incomplete entries and could not be included (Table 14). There were 155 questionnaires administered to assess knowledge among health care workers, of which 137 were valid. Overall there were 6 doctors, 109 nurses of varied grades, one administrative officer, 18 house staff and one nursing assistant who participated, which were representative of the staff employed in the province. Forty seven (47) observations of clinical practice were recorded of which 37 were valid, emphasising that in the presence of visiting teams most clinical work stops.

Table 14: The distribution of types of wards in the facility-based study

Types of wards	Number	Percentage
Labour ward	30	29.7
Maternity	5	5
Paediatrics	25	24.8
Neo-natal unit (NNU)	11	10.9
Sterilisation services division (SSD)	25	24.8
General	2	2
Total	98	97
Missing	3	3
Total	101	100

General knowledge on IC

Regarding the replies on the availability of an IC practitioner, 35% of respondents said there was a full time practitioner present. Some 36% said there were IC policies in place, 29% of which had been updated in the past four years. Some interviewees had received IC training (45%) and 40% said they had at least five hours of IC training.

Hand hygiene

Knowledge: Hand hygiene was assessed by asking when the health care worker thought it was critical to carry out hand disinfection: 83% indicated before and after each patient contact, but only 17% said hand washing was indicated after removing gloves.
The use of alcohol rub was considered safe by only 12% both before going home or handling clinical notes. Alcohol rub after taking a urine catheter sample was considered safe for 3%, while 22% would use it before touching a baby in the NNU. Nine per cent of health care workers said they would use it after changing a nappy. Alcohol hand rub as an alternative to hand washing was not considered a viable option.

Observation of unit: Of the 99 wards visited, 88% had at least one hand wash-basin 88%, 70% had liquid soap next to the hand wash-basin, and 42% had paper towels to dry hands (42%). The basins were used for hand washing alone in 53% of cases, for cleaning clinical equipment and for tipping patient fluids in 43% and 13% respectively. Paper towels were discarded in the right colour-coded container in 54% units, while in 28% of cases alcohol rub next to each high care bed was noted.

Clinical practice: Of the 33 observed instances for possible hand washing prior to carrying out an aseptic procedure, 21% of staff complied. Long painted nails and jewellery was noted in 49%, and alcohol rub was only used by 21% before coming into contact with patients or critical care items.

Personal protection

Knowledge: Of those interviewed, only 27% knew what standard precautions were. Fifty one per cent of those interviewed thought that there were adequate supplies of protective clothing, while shortages were reported less than five times a year by 35% and more than five times by 14% of respondents.

Observation of unit: Wards were adequately stocked with gloves (89%) and masks (63%), and to a lesser extent aprons (35%) and eye protection (29%).

Clinical practice: 60% of staff wore gloves when introducing an intravenous device, while 56% wore gloves during delivery of babies and 20% wore aprons. No masks or eye protection were worn.

Aseptic technique

Intravenous procedures were the most common aseptic procedures carried out in the hospitals. Upon questioning 97% knew that a syringe could not be re-used even if a needle had been changed. Alcohol was most commonly used (98%) to clean the injection site.

Observation of aseptic technique during intravenous cannulation in 16 patients showed that all the necessary equipment was gathered in 56% of cases, staff disinfected hands in 35%, and alcohol was applied to the insertion site in 60%. The cannula was anchored properly in 86% of cases with a free flowing drip (92%). Sharps were discarded directly into sharps containers after use in 67% of cases.

Bolus injection

Knowledge: In a series of questions relating to the most dangerous practice during preparation and administering an injection, 16% identified not washing hands between patients, only 15% said the same syringe could be used on several people providing the needle was changed. The use of a single hypodermic needle inserted in a multi-dose vial and used to re-charge several syringes was not common practice.

Observation of unit: Of the 66 units that were evaluated for presence of supplies, 82% had adequate intravenous items in stock.

Clinical practice: A new needle and syringe was used to draw up medication and to inject the patient in 79% and 73% of cases respectively, while in 86% a new single use syringe was used to inject the medication. Both needle and syringe was discarded 88% of the time.

Table 15: Observation of practice during administering injections

Practice	Number	Percentage
Hand decontamination between patients		
Yes	17	16
No	91	84
Total	108	100
Same syringe but change of needle		
Yes	16	15
No	92	85
Total	108	100
Use of multi-dose vials with same needle but different syringe		
Yes	6	6
No	102	94
Total	108	100
Hypodermic needle in administration set		
Yes	4	4
No	104	96
Total	108	100
Not discarding needles in sharps container		
Yes	63	58
No	45	42
Total	108	100

Sharps policy

A sharps injury policy was available for the IC team to inspect in 37% of units and 91% of those interviewed were aware of such a policy. Ninety per cent had pre- and post-test counselling, 82% knew about post-exposure hepatitis B immunisation if not already immune and 96% about HIV chemo-prophylaxis, while 86% said the drugs should be administered within four hours of reporting a needle stick injury. Forty per cent and 58% of those interviewed knew their hepatitis B and HIV status respectively, and 19% had had a sharps injury in the past three months.

Waste management

Knowledge: 67% knew of an operational waste management policy in the unit.

Observation of unit: It was noted that a colour coding system existed in 77% of the facilities observed. There were adequate supplies of appropriately colour-coded bags in 51% of the facilities. Adequate secured storage area for clinical waste existed in 61% of cases. A register for sharps injuries in existed in 13% of cases, but a policy on BBV exposure which could be viewed by the research IC nurses was only found in 16% of the units visited.

Clinical practice: In 76% of observations of practice, no sharps or needles were found lying around either on the surfaces or near the sharps containers, but only 59% of units disposed of their sharps boxes appropriately.

Sterile services and critical equipment processing

Knowledge: Logging of items was important for 4% and inspection of items for integrity was important for 24% of those who were interviewed. For 77% of the health care workers who were interviewed, it was important that items were visibly clean. Eleven per cent said that items should be cleaned on the wards prior to processing, 17% suggested soaking in hypochlorite and only 16% said that trays should be labelled and packed.

Observation of unit: It was observed that 27% of hand wash-basins were used to clean equipment, while 79% had a separate washing area. Protective clothing was worn by 38% when manually cleaning sharp items. The items were disassembled and soaked in 58% of cases, cleaned thoroughly to remove all visible dirt in 81%, were packed in 67%, and sent for sterilisation in 88% of cases.

Milk preparation

Those working in the milk preparation area were assessed for knowledge, provision and clinical practice. The results of the question on knowledge regarding the most critical steps in preventing BBV transmission are shown in Table 16.

Table 16: Replies to critical steps in milk preparation to prevent HIV transmission in a high-care facility

Replies	yes (n)	% of total N = 215	% Nurses N = 181
Clean and sterile milk bottles	54	25.1	30
Correct labelling of milk bottles	22	10.2	12.1
Pasteurising pooled milk	3	1.4	1.65

There were only 13 hospitals that had dedicated milk preparation areas, the rest were accommodated on the open ward with very few practices to prevent infection. There were 6 (18.75%) mothers who expressed directly into a bottle and labelled it themselves. Forty-seven observations were carried out, with thorough cleaning noted in 4.4% and appropriate labelling and checking the label recorded in 2.2%. A major concern was that bottles were labelled by cot numbers rather than by name of the baby and were rarely checked. So, if the baby's cot was moved for any reason, the wrong milk could be fed to the wrong baby.

Viral load in random samples of milk

The findings reported on viral loads in the breast milk were interesting. The samples were selected randomly and the laboratory was unaware of the type of milk sample taken. No virus was detected in formula milk but almost 30% of EBM was found to contain at least 50 copies/ml of HIV RNA. Viral loads of greater than 5 000 copies were noted in six samples of EBM. It was noted that a large number (21.6%) of milks, both

Table 17: Viral load results from both formula and breast milk

	Number	Positive	Negative	Inhibited
Breast	64	19	36	9
%		29.7	56.25	12
Formula	11	0	4	7
%		0	36.6	63.6
Total	75	19	40	16
%		25.3	53.3	21.3

formula and EBM were inhibited and therefore viral loads could not be detected. It was suggested that this was due to interference from other substances present in the milk, possibly hypochlorites and chemicals in formula milk.

Occult blood from maternity and paediatric units

The results regarding the presence of occult blood from the sites and items used in clinical care for mothers and babies are shown in Table 18. Overall, there were 165 samples taken from the various wards and units, of which 74 (44.8%) were positive for occult blood. Of interest was that of the 165 samples taken, 29 (17.5%) had visible blood, 6 and 23 in the direct and indirect group respectively.

Table 18: Distribution of occult blood from direct and indirect sources in maternity and paediatric wards

Direct		Indirect		Total	
n	Positive	n	Positive	n	Positive
49	11	116	64	165	74
	22.4%		55.1%		44.8%
Visible blood					
6	23.3 %	23	80%	29	17.5%

The items that were tested for occult blood are shown in Tables 19 and 20. Of particular note is the number of artery forceps and suture and staple guns found to be positive for occult blood.

The presence of occult blood in all the three mattresses tested was noteworthy. It is common practice in South Africa for health care workers to remove a stillet from a cannula, or a hypodermic needle from a vein and stick it into the mattress – invariably all these are contaminated with blood. Although only one of the matresses tested was visibly contaminated with blood, blood could also be detected in the other two. All the furniture in the baby care areas was contaminated with blood.

Table 19: Items used in direct care of mother and child

Direct items tested in mother and child units	Tested (n)	Positive for occult blood
Ambu-bag	1	1
Artery forceps	18	2
Cord scissors	6	0
Episiotomy scissors	4	1
Forceps	7	1
Sutures & staple gun	3	3
Suction	4	2
Thermometer	1	1
Miscellaneous	5	
Total	49	11

Table 20: Items used in labour and maternity units not in direct contact with mother or child

Indirect items in maternity and labour wards	Tested (n)	Positive for occult blood
Baby cots and receivers	11	6
Bowls and containers	9	5
Bed frames/mattresses & lockers	11	11
Curtains and chairs	7	5
Emergency & instrument trolleys	3	3
Baby incubators	20	4
Furniture/trolleys	3	3
Walls	5	4
Patient care (IV/suture material)	12	8
Delivery associated	7	5
OT lights	3	2
Patient care items	15	2
HW basins	4	2
Masks and suction equipment	6	4
Total	116	64

IC practices by district

During post-study discussions, it was noted that the seven discordant children found in the case-control study were reported from two districts. This section sumarises IC knowledge, observation of units and clinical practice by district as gleaned from the facility-based study. The occult blood results by district are also presented here and reflect inadequate IC practices. It is proposed that an in-depth investigation be carried out at a later date. It is accepted that, in some instances, the numbers are too few to carry out detailed analysis and therefore percentages are presented as a guide.

Dental services

Knowledge regarding hand washing and IC practice is shown in Table 21.

Table 21: Knowledge of IC practices, among dental practioners

	LE		NF		MO		TM	
Knowledge	Total	N	Total	N	Total	N	Total	N
Hand washing before and after each patient contact	9	8	5	5	7	6	8	7
Percentage		88.9		100.0		85.7		87.5
Hand washing after removing gloves	9	6	5	1	7	0	6	2
Percentage		66.7		25.0				33.3
Pritective clothing out of stock in past year	9	3	5	0	7	3	9	7
Percentage		33.3				42.9		77.8
Sharps policy exists	5	1	4	1	7	0	9	0
Percentage		20.0		25.0				
Know your hep B status	9	5	8	6	6	4	8	6
Percentage		55.6		75.0		66.7		75.0
Know your HIV status	9	6	5	4	6	4	8	6
Percentage		66.7		80.0		66.7		75.0
Any sharps injury in the past 3 months?	9	0	5	2	7	2	9	3
Percentage				20.0		42.9		33.3
Items should be visibly clean	9	7	9	8	7	5	9	8
Percentage		77.8		88.9		71.4		88.9
Dismantle item prior to cleaning	9	4	5	0	7	0	9	0
Percentage		44.4						

Knowledge	LE Total	LE N	NF Total	NF N	MO Total	MO N	TM Total	TM N
Protective clothing during procedures	9	5	5	3	7	4	9	5
Percentage		55.6		60.0		57.1		55.6
New needle for each patient	9	9	5	2	7	3	9	7
Percentage		100.0		40.0		42.9		77.8
New anaesthetic vial	9	6	5	1	7	2	9	1
Percentage		66.7		20.0		28.6		11.1
Sterile drill bit for each patient	9	3	5	1	7	1	9	1
Percentage		33.3		20.0		14.3		11.1

Note: LE=Lejweleputswa, NF = Northern Free State, XH = Xhariep, MO = Motheo, TM = Thabo Mofutsanyana

Motheo and Thabo Mofutsanyana were less knowledgable about handwashing than either Lejweleputswa or Northern Free State.

The Northern Free State reported no shortage of protective clothing in the past year, but shortages were reported from Lejweleputswa 3/9 times and 3/7 and 7/9 times from Motheo and Thabo Mofutsanyana respectively. Sharps injuries had occurred in two respondents each from the Northern Free State, and Motheo, while three were reported from Thabo Mofutsanyana. Knowledge regarding cleaning and dismantling equipment, and wearing protective clothing during dental procedures are also shown in Table 21. The use of a new needle and syringe, sterile drill bit and local anaesthetic vial was available for most but not all patients.

Clinical practice: Hand hygiene was less often observed in Motheo and Thabo Mofutsanyana than the other districts, however gloves and masks were often worn by practitioners in all districts. Gloves were not always discarded between patients (see Table 22).

Motheo and Thabo Mofutsanyana were the two districts where dental injections for single patient use were less frequently available. The appropriate use of sharps containers was better in Lejweleputswa and the Northern Free State than in Motheo and Thabo Mofutsanyana. It was noted that equipment was disassembled before processing in all the districts' dental facilities observed except for Thabo Mofutsanyana, reflecting inappropriate cleaning and therefore inadequate disinfection or serilisation.

Table 22: Dental practice by district

Observation of dental practice	LE Total	LE N	NF Total	NF N	MO Total	MO N	TM Total	TM N
Hand hygiene before each patient	8	3	3	1	5	1	7	0
Percentage		37.5		33.3		20.0		0.0
Long nails & jewellery	8	1	3	1	5	1	7	5
Percentage		12.5		33.3		20.0		71.4
Gloves for dental procedure	6	4	3	3	4	4	5	1
Percentage		66.7		100.0		100.0		20.0
Mask for dental procedure	7	6	3	3	4	4	5	2
Percentage		85.7		100.0		100.0		40.0
Discard gloves after each patient	6	1	3	1	2	0	5	0
Percentage		16.7		33.3		0.0		0.0
Items soaked in disinfectant	5	5	3	2	3	3	5	4
Percentage		100.0		66.7		100.0		80.0
Dental item disassembled	5	5	2	2	2	0	3	2
Percentage		100.0		100.0		0.00		66.7
New needle and anaesthetic vial for each patient	8	8	3	3	5	3	7	4
Percentage		100.0		100.0		60.0		57.1
All sharps inside container	8	8	3	3	3	2	7	6
Percentage		100.0		100.0		66.7		85.7

Note: LE=Lejweleputswa, NF = Northern Free State, XH = Xhariep, MO = Motheo, TM = Thabo Mofutsanyana

There was adequate provision available for hand washing in most of the districts visited (see Table 23), except Motheo where a lack of liquid soap was noted. None of the hand-wash basins in any of the districts was used exclusively for hand washing; instruments were washed in them and patient fluid bowls were emptied down the hand-wash basins. Disassembly and thorough cleaning prior to disinfection or sterilisation was observed to be infrequent in all districts except Lejweleputswa, (shown in Table 23) despite adequate facilities. The recommended method for sterilisation of dental equipment is steam. These facilities were noted in Lejweleputswa and Northern Free Sate but not in all facilities of Motheo and Thabo Mofutsanyana. Overall, IC provisions were better utilised in Lejweleputswa and Northern Free Sate than in Motheo and Thabo Mofutsanyana.

Table 23: Observation of unit and provision of IC supplies

Observation	LE		NF		MO		TM[1]	
	Total	N	Total	N	Total	N	Total	N
Gloves near dentist's chair	8	7	3	3	5	4	7(1)	5(1)
Percentage		87.5		100.0		80.0		71.4
Separate area for processing instruments	8	2	3	1	5	0	7(1)	2(0)
Percentage		25.0		33.3				28.6
Single use syringe and needle for each patient available	8	8	3	3	5	2	7(1)	4(1)
Percentage		100.0		100.0		40.0		57.1
Sterilisation of equipment between patients	8	2	2	2	5	2	7(1)	5(0)
Percentage		25.0		100.0		40.0		71.4
Steam steriliser present	8	8	3	3	5	3	7(1)	3(1)
Percentage		100.0		100.0		60.0		42.9

Note: LE=Lejweleputswa, NF = Northern Free State, XH = Xhariep, MO = Motheo, TM = Thabo Mofutsanyana
** Xhariep data shown in brackets but not in percentages*

It was also noted that, while all dental practitioners wore gloves in Lejweleputswa and the Northern Free State, this was less apparent in Motheo and Thabo Mofutsanyana. In Motheo and Thabo Mofutsanyana the lack of adequate single-use dental injections led to the re-use of the same local anaesthetic vial (with a change of needle) between two to three patients. The mixing of sterile and non-sterile (used) dental equipment on the same sterile instrument tray was noted in all districts.

Table 24: Knowledge of IC practices in maternity and paediatric facilities

Knowledge	LE		NF		XH		MO		TM	
	total	n	total	n	total	n	total	nn	total	n
Hand washing coming on duty	35	13	31	8	9	0	45	7	31	0
Percentage		37.1		25.8				15.6		
Hand washing before and after each patient contact	35	29	31	24	9	9	45	29	31	26
Percentage		82.9		77.4				64.4		83.9
Hand washing after removing gloves	35	13	31	3	9	1	45	5	31	3
Percentage		37.1		9.7				11.1		9.7
Alcohol rub before handling babies	22	3	30	8	4	2	36	7	21	16
Percentage		13.6		26.7				19.4		76.2

Note: LE=Lejweleputswa, NF = Northern Free State, XH = Xhariep, MO = Motheo, TM = Thabo Mofutsanyana

Maternity and paediatric facialities

A similar district-based analysis was carried out for maternity and paediatric facilities in the Free State. The trend of inadequate IC practice is evident from the data shown in Tables 24–28 reporting knowledge, practices and provision in the maternity and paediatric care facilities. Knowledge regarding hand hygiene was better in Lejweleputswa and in the Northern Free State compared with Motheo and Thabo Mofutsanyana (Table 24).

Sterile services in the districts were documented. The procedures were less robust in Motheo and Thabo Mofutsanyana than the other three districts (Table 25).

The frequency of cleaning and disinfecting of milk bottles was an important finding in this study. Labelling of milk bottles and checking the labels before giving the milk to the baby was infrequent (Table 26).

IC practices in the districts were observed. The procedures were less robust in Motheo and Thabo Mofutsanyana than the other three districts (see Tables 27 and 28).

Hand hygiene appeared to be poorly observed in Motheo and Thabo Mofutsanyana. However, the number of occasions on which clinical practice was observed was very low and therefore it was difficult to really assess details of clinical practice.

The provision for IC by district is shown in Table 28. The mother and child in-patient facilities highlight the differences between districts.

Table 25: Replies from interviewees regarding cleaning of clinical equipment and the use and re-use of needles and syringes

Question	LE		NF		XH		MO		TM	
	total	n	total	n	total	n	total	n	total	n
Any sharps injury in the past 3 months	35	6	29	3	9	0	42	10	31	9
Percentage		17.1		10.3				23.8		29.0
Items are visibly clean	33	25	25	20	9	8	40	28	30	18
Percentage		75.8		80.0				70.0		60.0
Dismantle item	33	12	24	2	8	0	40	3	30	1
Percentage		36.4		8.3				7.5		3.3
Vaginal spec safe after disinfectant	11	1	24	2	9	1	36	1	29	3
Percentage		9.1		8.3				2.8		10.3
Decontaminate hand for injections	24	0	26	5	7	1	26	8	25	3
Percentage				19.2				30.8		12.0
Same syringe but change needle	24	4	26	3	7	1	26	3	25	5
Percentage		16.7		11.5				11.5		20.0
Multi-dose vials with needle	24	0	26	3	7	1	26	2	25	0
Percentage				11.5				7.7		

Note: LE=Lejweleputswa, NF = Northern Free State, XH = Xhariep, MO = Motheo, TM = Thabo Mofutsanyana

Table 26: Provision for milk preparation and distribution noted by district, Free State, 2004

	LE		NF		XH		MO		TM	
	total	n	total	n	total	n	total	nn	total	n
Milk bottles clean/sterile	16	12	11	3	3	2	30	24	26	13
Percentage		75.0		27.27				80.0		50.0
Labelling bottles	17	5	10	1	3	2	30	5	26	9
Percentage		29.4		10.0				16.7		34.6
Checking label before feeding	15	1	10	0	3	0	31	1	26	1
Percentage		6.7						3.2		3.9

Note: LE=Lejweleputswa, NF = Northern Free State, XH = Xhariep, MO = Motheo, TM = Thabo Mofutsanyana

Table 27: Observation of hand hygiene, wearing protective clothing, appropriate use of needles and syringes and milk procedures in mother and child facilities

Observation of practice	LE		NF		XH		MO		TM	
	total	n	total	n	total	n	total	n	total	n
Hand hygiene before injection	6	5	5	1	3	1	9	0	10	0
Percentage		83.3		20.0				0		0
Long nails & jewellery	7	1	6	3	3	0	10	5	13	10
Percentage		14.3		50.0				50.0		76.9
Gloves for cannulation	5	3	1	1	2	2	5	3	2	0
Percentage		60.0		100.0				60.0		
Delivery of baby	5	1	3	3	0		4	2	4	3
Percentage		20.0		100.0				50.0		75.0
Discard gloves after each patient	2	0	2	1	0		0		0	
Percentage				50.0						
Hand disinfection before intravenous injection	6	6	3	0	1	0	1	0	6	0
Percentage		100.0								
New needle/syringe used to draw up medication	4	4	5	5			2	1	3	1
Percentage		100.0		100.0				50.0		33.3
New needle for patient	5	5	5	3			2	2	3	1
Percentage		100.0		60.0				100.0		33.3
Milk bottles accurately labelled		2	0					1	1	
Percentage										
Label checked	2	0					1	0		
Percentage										
Sharps outside container	6	6	7	5	1	0	9	4	15	14
Percentage		100.0		71.4				44.4		93.3

Note: LE=Lejweleputswa, NF = Northern Free State, XH = Xhariep, MO = Motheo, TM = Thabo Mofutsanyana

Table 28: Provision for IC in the mother and child units

	LE		NF		XH		MO		TM	
	total	n	total	n	total	n	total	nn	total	n
Hand wash-basin (HWB) in each unit	23	22	18	16	4	4	26	21	21	18
Percentage		95.7		88.9				80.8		85.7
Liquid soap	25	25	21	10	4	2	28	20	20	12
Percentage		100.0		47.6				71.4		60.0
HWB used only for hands	23	16	21	9	4	0	23	10	14	14
Percentage		69.6		42.9				43.5		100.0
Used for cleaning equipment	23	7	17	8	4	4	23	12	14	4
Percentage		30.4		47.1				52.2		28.6
HWB used for tipping fluid	22	1	20	6	1	0	21	3	20	6
Percentage		4.6		30.0				14.3		30.0
Alcohol rub visible	21	9	16	5	4	1	21	6	16	1
Percentage		42.9		31.3				28.6		6.3
HWB to clean equipment	23	4	20	3	4	4	16	6	12	3
Percentage		17.4		15.0				37.5		25.0
Separate washing area	22	14	21	19	4	4	15	10	12	11
Percentage		63.6		90.3				66.7		91.7
Adequate needles & syringes	21	17	16	16	2	2	15	15	12	12
Percentage		80.9		100.0				100.0		100.0
Needle left in multi-dose vial	19	2	13	3	3	0	15	2	12	1
Percentage		10.5		23.1				13.3		8.3
Separate area for preparing milk	10	10	12	4	2	0	10	8	10	6
Percentage		100.0		33.3				80.0		60.0
EBM for babies	7	0	9	3	2	0	12	8	10	4
Percentage				33.3				66.7		40.0
EBM directly into bottles	3	1	5	0	1	0	9	2	6	4
Percentage		33.3						22.2		66.7
Hypochlorite for baby bottles	9	4	10	10	1	1	10	8	7	4
Percentage		44.4		100.0				80.0		57.1

	LE		NF		XH		MO		TM	
	total	n	total	n	total	n	total	nn	total	n
SSD exists	2	2	6	6	3	0	7	5	4	4
Percentage		100.0		100.0				71.4		100.0
SSD well stocked	2	2	6	5	3	0	9	6	7	4
Percentage		100.0		83.3				66.7		57.1
Demarcation of clean & dirty areas	3	2	6	2	3	0	9	6	8	5
Percentage		66.7		33.3				66.7		62.5

Note: LE=Lejweleputswa, NF = Northern Free State, XH = Xhariep, MO = Motheo, TM = Thabo Mofutsanyana

Occult blood

Interesting findings were revealed when the occult blood results were analysed by district. The dental, maternity and paediatric results are shown in Table 29. The percentage of direct and indirect items in Thabo Mofutsanyana and Motheo were considerably higher than those in the other two districts. This finding supports the results by district reported earlier in the study. While all the maternity and paediatric units had occult blood found in the direct and indirect items tested, Thabo Mofutsanyana had the highest number of items which were positive for occult blood (Table 29).

Table 29: Occult blood results from dental as well as maternity and paediatric units

	NF		LE		XH		TM		MO	
	Tested	Pos	Tested	Pos	Tested	Pos	Tested	Pos	Tested	Pos
Dental										
	20	1	19	4	5	0	39	12	27	14
Percentage		5		21		0		30.7		51.8
Maternity & paediatric										
	58	32	31	4	15	6	19	17	42	14
Percentage		55.2		12.9		40		89.5		33.3

Note: LE=Lejweleputswa, NF = Northern Free State, XH = Xhariep, MO = Motheo, TM = Thabo Mofutsanyana

3.3.4 Conclusions

The facility-based study was structured to provide an in-depth analysis of the current situation concerning IC in the public sector health care facilities in the Free State, which probably reflects common practice in most of South Africa. By evaluating the knowledge, supplies and provision for IC, and applying how the combination of these factors is reflected in clinical practice, a very clear picture became apparent. To support findings in the health care facilities, the presence of occult blood as a surrogate marker for poor IC practice and cleaning confirmed the findings of the IC team.

Results show that there is very poor cleaning of the environment in the labour and maternity areas and in dental facilities; the same is true for the baby and neo-natal areas. With the presence of detectable occult and visible blood, a breakdown in the processes of IC has clearly occurred, not just on one occasion but perhaps on several occasions over an extended period of time. It is therefore entirely feasible, and not beyond the realm of possibility, that transmission of bacteria, fungi and most importantly viruses can occur under these circumstances. The presence of blood and a breakdown in IC policies would also suggest that the nosocomial transmission of BBVs is possible. Since the most common users of health care facilities are women and children, these would obviously be most often affected. Should recommendations be made on the basis of this report, clearly the training of robust IC teams who have the authority to ensure good IC practice and quality health management would be a national priority.

The facility-based results by district suggest that the lack of IC practice increases the risk of nosocomial transmission – not just of BBVs but other micro-organisms as well. Since this study is aimed at BBV transmission, it is clear from these findings that the two districts which had the seven cases of discordant children also had the highest transgression in IC practice, including occult blood. The distribution of IC provision was similar for the various districts, but the application of these provisions varied according to district. This was true for both dental and mother and child facilities. Precise investigation is warranted into these cases, but from the current information there is a likelihood that these discordant children were probably born in one of these in-patient facilities and have been to dental clinics and practices in these two districts. The risk of transmission in these situations cannot be ignored.

3.4 Traditional healers and birth attendants (study D)

3.4.1 Introduction

Infection of children by HIV remains a challenge in South Africa and other parts of the world where HIV is prevalent. Worldwide it has been estimated that there are 2.1 million children under the age of 15 years living with HIV/AIDS. South Africa has the second largest number of children living with HIV/AIDS in Africa after Nigeria. Most infection in this age group is said to be through vertical transmission (UNAIDS 2004), however there is a need to investigate the possible role of other risk factors such as certain cultural and traditional health practices that involve exchange of blood and the use of sharp instruments among children 2–9 years.

This component of the study was conducted in support of the epidemiology component and provides supporting data. It assists in understanding practices that happen at home and in traditional healers' clinics that are relevant in understanding HIV infection among 2–9 year olds.

3.4.2 Background

A study conducted by Pretorius (1999), found that 60–80% of the South African population visit traditional healers before attending western/formal health care services. A traditional healer or a traditional health worker or practitioner can be defined as a person who engages in traditional health practices and is able to register as such with the Interim Traditional Council. Despite the high number of people who consult traditional healers, western and traditional health systems have existed separately. In addition, the traditional health systems tend to be viewed negatively by the biomedical fraternity as being unscientific (Hopa, Simbayi & du Toit 1998). The post-apartheid government has sought to improve this situation by attempting to recognise it as an important sector within the South African health care system, notably via the Traditional Health Bill of 2003.

Some traditional healers specialise in childhood ailments and pregnancy. They are referred to as traditional birth attendants (TBA) (Nolte 1998). In South Africa TBA are normally women who provide antenatal care services to other women within the family or the community. They are often older women who have been trained by other women (Mchunu & Bhengu 2004). For the purposes of this study, the interest is in traditional health and cultural practices that may expose children to HIV infection.

3.4.3 Cultural health practices and use of sharp instruments

Possible sources of HIV transmission to infants and children could include cultural practices that involve the use of shared and sharp instruments by traditional healers and TBA. They may use blades, animal horns, thorns, enemas and other symbolic items when

treating children. These instruments are used for circumcision, making incisions, birth procedures and scarification (Hardy 1987). Since these practices result in exposure to blood, they present a potential risk for the transmission of HIV in such settings.

Scarification

There is considerable evidence that scarification involving shared instruments is probably the most common practice among African societies who value specific forms of bodily mutilation as a mark of membership to a particular cultural group (Helman 2000; Marck 1997). Moreover, it is widely recognised that scarification could lead to bleeding, and that group scarification has implications for HIV transmission, especially when a single instrument is used (Orubuyole et al. 1995). However, there has been limited reporting of scarification and its link to HIV in South Africa.

A community-based survey on the prevalence of human immunodeficiency infection in Nigerian women and children in South Western Nigeria, with a sample of 460 mothers and 476 children (including 16 sets of twins), found only one mother-child pair (out of 460 mother-child pairs) that was positive for HIV antibody resulting in mother-child concordance for HIV infection of 0.22%. Antibody to either HIV-1 or HIV-2 was detected in 3.8% (18/476) of the children's sera and in 43% (20/460) of mothers' sera. They also found more positive samples in rural than in urban areas among children (7.1% versus 1.1%) and also among mothers (6.8% versus 2.4%), ($p<0.001$) (Omotade et al. 2001). They concluded that the lack of concordance between mother-child sera suggested that vertical transmission might not be a major route of transmission of HIV infection in children in South Western Nigeria. They identified certain high-risk practices (such as the re-use of unsterilised hypodermic needles for injections and surgical knives in local scarification), which are common practices especially in rural areas, as needing investigation as potential major modes of transmission of the infection.

Circumcision

Circumcision is another cultural practice that involves bleeding and the use of sharp instruments. The purpose of circumcision has been suggested to be mainly for cultural and religious reasons as among some African, Muslim and Jewish populations. Recent studies suggest that circumcision carries with it both health risks and benefits. The risks include haemorrhage and infections such as transmission of HIV and hepatitis B. Those who experience early male circumcision indirectly enjoy health benefits, such as protection against some infections in the penile area (van Dam & Anastasi 2000). Circumcision of children aged 2–9 years within African culture is not common, especially through the traditional health system. Circumcision is largely reserved for the time of initiation of boys to manhood.

A literature search further indicates that no studies had previously investigated the effect of scarification of children aged 2–9 years on HIV transmission in South Africa.

3.4.4 Aims and objectives of the study

This study aimed to address this gap in knowledge by documenting traditional practices that might play a role in HIV infection among children aged 2–9 years. Focus group discussions were conducted with both TBA and traditional healers. The study used open-ended questions to explore how sharp instruments for culturally defined body incisions could expose children to HIV and other blood-borne infections.

The objectives of the study were twofold:

- To document traditional health practices of traditional healers and birth attendants; and
- To document their adherence to standard precautionary measures i.e. hygiene, use of gloves and any other methods to protect themselves, sterilisation of equipment, management of wound and scars, and waste disposal.

3.4.5 Methods

A small qualitative exploratory study was conducted. This study was designed to provide additional data on the traditional health practices that would provide the contextual information for the data collected in the epidemiological component of the study.

Focus groups

Four focus groups were conducted in the Free State to document some of the practices that traditional health practitioners follow in pregnancy care, delivery of babies and treatment of children. Two of the focus groups were conducted with traditional healers and the other two were conducted with TBAs.

Recruitment of participants

A snowball method for recruiting members of the focus groups was used. Key informants were identified in the Free State: one of the informants was a practising midwife with a private maternity clinic in the area and the second key informant was the head of the traditional healers in the area. The key informants assisted with identifying and screening of potential participants.

The criteria for selection were all traditional healers and TBA associations including independent TBA and traditional healers (those practitioners who did not belong to any organised structure of healers or birth attendants). The participants had to be representative of different groupings within the traditional health sector, i.e. age, sex, specialisation area (general healers, those who assist with delivery of babies, surgeons etc.).

Four researchers who were trained in focus group facilitation and recording conducted the interviews. The interviews were conducted in Sesotho. The study was explained to the participants, and participants were given a copy of a consent form translated into Sesotho. The consent form was read to the group, as there were participants who could not read. After reading the consent form, participants were requested to ask questions. Permission was obtained to record the interviews. All participants were assured of confidentiality. All participants were willing to participate and consent forms were signed. Those who could not write used a cross to indicate consent on their forms. The researchers signed as witnesses on the signed consent forms.

Focus group guides were used to elicit information on knowledge of HIV and traditional practices that involve the use of sharp instruments. The focus group guides are provided in Appendix 4.

Description of participants

As this was an exploratory and supporting study, only 49 traditional healers and TBAs participated in focus group interviews conducted over two days in Qwa-Qwa (Free State).

There were 26 traditional healers and 23 TBAs. The majority (40) of the participants were females. The age range of participants was 40–65. The two TBA groups were mainly made up of females with only one male in the group. Each group had between ten and twelve participants. The traditional healers' group was a mixed group of men and women. On the first day the group had seven males and the following day there was one male in the traditional healer's group. The healers had diverse experience and areas of specialisation. Some of the traditional healers specialised in herbs, scarification, faith healing and divination. Several of the TBAs were also traditional healers, providing not only antenatal care and post-natal care but also treatment to mothers and babies.

Analysis

Atlas.Ti, a software programme for analysing qualitative data was used. Audio tapes were transcribed in Sesotho and then translated into English. The transcriptions were loaded into *Atlas.Ti* and codes for analysis were generated. The data is presented according to the themes and sub-themes that were found in the data. Findings from both traditional healers and traditional birth attendants are presented.

3.4.6 Results

Traditional healers' and TBA's knowledge of HIV/AIDS and understanding of HIV transmission

The results showed that the traditional healers and TBAs interviewed were knowledgeable about HIV/AIDS. They knew how HIV was transmitted and how to prevent HIV infections by not re-using blades. However, not all the information they had was accurate. Some believed that HIV could be transmitted from a toilet seat and by wearing the unwashed clothes of someone with HIV. One healer believed that the virus 'died' immediately when it was outside the body.

Another myth documented was related to the incidence of discordant mother-child pairs. This was reported to be something that was not common but known. One of the traditional healers believed that, in this case, the infection was in the sperm and the mother was not infected with HIV. During conception, some women's immune systems were strong, thus they were not infected with HIV even after engaging in unprotected sex. However, the sperm would infect the egg of the mother thus the baby would be born HIV-positive.

Disposal of waste by traditional healers and TBA

Waste from traditional or home births was reported to be normally handled by family members who may not have received any training in IC. The family was given the waste or allowed to clean the patient. The waste from the mother was, in the majority of cases, buried in places that were reported to be inaccessible to children, thus reducing the risk of children coming into contact with waste. The places mentioned included digging inside the mother's hut in villages, outside the house and in forests. Some TBAs reported that they threw the placenta into the river where it would be eaten by crabs. The practice of throwing the placenta into a river contaminates water and also increases the possibility of adults and children coming in contact with the waste while using the river.

Sharp instruments were disposed of differently: burning, digging and flushing down the toilet were the most common methods used for disposing of sharp instruments like blades. There were reports of traditional healers who threw blades into black bags within

the community. The digging and black bag method of disposing blades was identified as being problematic because children might dig where they saw the healer digging or find the discarded blades in black bags and use them on themselves or other children.

Traditional practitioners' knowledge of the PMTCT and their practices during labour

The majority of the healers interviewed knew that it was possible for the child to be infected by the mother but did not know about how to prevent this through the use of antiretroviral therapy. Linked to the prevention of mother-to-child transmission, are practices during labour such as reducing rupturing of membranes and unnecessary internal examinations. It was reported by a TBA that family members assist during labour by doing vaginal examinations of the mother. In the context of HIV, unnecessary invasive procedures may lead to rupturing of membranes and result in the child being infected with HIV. There is also a risk of infection to the mother, child and the person doing the examination if the person performing this examination has cuts, does not use gloves and has HIV, or the mother has HIV.

Infant feeding practices and the risk of HIV infection among traditional practitioners' patients

With regards to infant feeding, healers did not mention that children could be infected through breast milk. They were therefore not able to advise patients whether or not to breastfeed if they had HIV/AIDS. The practice of nursing by a non-biological mother and expressing milk for feeding a baby that belongs to someone else was something that was reported to be taboo within the Sesotho culture. The practice of expressing milk to give to another mother's baby was reported to be something done in hospitals. While the practice of a baby breastfeeding from a woman who is not the biological mother was seen as taboo by both TBAs and healers, it was indicated that in certain instances (e.g. where a mother of the baby had died or where the biological mother did not have milk and there was a family member with a baby) this was allowed.

Practices in labour that may expose babies and mothers to HIV

In this study we did not document any practices related to traditional birth clinics that suggested a possibility of cross-infections among mothers during labour. TBAs reported to work mostly from home and normally did not attend to more than one woman at a time. This reduced the risk of infection between two mothers giving birth at the same time and in the same room. TBAs reported that they do not re-use any of their sharp instruments used during labour. Each mother was required to buy all the items to be used for delivery. Some TBAs provided these to the mother and included this in the fee for baby delivery. In future studies there is a need for further investigation by interviewing mothers who have used these services about the practices that they have observed when consulting traditional health practitioners.

Sterilisation of instruments

Methods of sterilisation of instruments were not standard – different healers used different substances and methods. Some indicated that they soaked their instruments in disinfectants like Jik, Jeyes Fluid, or Dettol. Time frames varied: some would soak instruments for 20 minutes, others for several hours, and others overnight. Some always had their used instruments in a disinfectant solution. The syringe used for enemas was also soaked after use, although some healers indicated that they preferred that each

patient bring their own. While most traditional healers were aware of the importance of sterilising equipment, there was no standard guide on the method of sterilisation being used. The most common method of sterilising equipment was to boil it for one hour. Some use methylated spirits for sterilisation. Some healers used the boiling method but did not keep track of the duration of boiling. Other healers reported to use two methods, boiling and methylated sprits.

Not all the instruments used by traditional healers were sterilised. One healer who used porcupine quills in scarification said he did not sterilise his quills, because they were medicine by themselves and as such had supernatural powers to cleanse themselves of any diseases. Some healers believed in sterilising new blades before using them while others had not heard of such a practice.

Traditional health practices among children aged 2–9

There were differing practices in relation to the treatment of children by traditional healers. The age at which children were scarified was also different: some healers only scarified children immediately after birth while other healers only scarified children from age one. There were those who treated children at birth and others who only saw children at 15 days old. Scarification was sometimes done to children at this stage. Most children visited traditional healers for '*sireletsa*' (strengthening purposes) while others attended traditional healers because they were sick. Strengthening involved protection of children from evil spirits and sickness through the use of traditional medicines. It is important to note that not all the healers interviewed scarified children. Some reported that they used herbs, prayer and special wristbands and small waist ropes that are made from wool or animal skin and tied on the child's abdomen or wrists for protection from evil spirits.

The majority of healers indicated that it was not common practice for children under 9 years to be circumcised. However this was still done and was reported by some healers. Circumcision was seen as a rite of passage into manhood, thus it was not culturally accepted to circumcise a child under 16 years of age. We found that there were a few healers who knew about this practice among children and some had indeed circumcised children in the past. Most circumcision at this age was said to be done at the hospitals.

SECTION 4. DISCUSSION

Findings arising from the four sub-studies are discussed in this section with a view to triangulating them.

4.1 Discussing the findings

First, the HIV prevalence among children aged 2–9 in primary health care facilities was 14.8%, lower than the 21.5% found among an adult hospitalised population (Brookes, Shisana & Richter 2004). Evidence suggests that HIV infection levels are generally higher among hospital in- and out-patients than in the general population. Van Gend, Haadsma, Sauer & Schoeman (2003) found an HIV prevalence of 31.1% among patients in health care facilities in Bloemfontein. Shisana, Hall & Maluleke (2003) found an HIV prevalence of 25.7% in primary health care facilities and 46.2% in hospital patients, while in the general population of the Free State the prevalence was estimated to be only 14.9% (Nelson Mandela/HSRC Study of HIV/AIDS 2002).

Second, the finding that HIV prevalence levels are fairly evenly distributed across the age groups is surprising, given that there is an estimated 50% mortality by two years among infants infected by their mothers (Newell et al. 2004). A similar finding was observed in a community-based survey that showed that the HIV prevalence among children was also evenly distributed across the children aged 2–5 years (5.6%) and 6–9 years (6.8%). This is a puzzling finding. Not much research has been done on survival rates of children older than five years who were infected through mother-to-child transmission. There are, however, indications that survival of children is longer among HIV-positive children who have acquired infection in the postnatal period through breastfeeding (Newell et al. 2004). This is an important area for further research.

Thirdly, the epidemiological study has shown that the overwhelming majority of HIV infections in children under 9 years of age are associated with a mother who is HIV-positive. The risk of an HIV-positive mother having an HIV-positive child is 165 times higher than the risk for an HIV-negative mother having an HIV-positive child. This suggests that an overwhelmingly large proportion of children are infected through mother-to-child transmission of HIV (MTCT). This can occur *in utero*, during delivery and post-delivery through breastfeeding. Estimates of the contribution of breastfeeding to MTCT vary, but a recent individual patient meta-analysis (Bulterys, Fowler, van Rompay & Kourtis 2004) found that at least 24% and possibly as much as 42% of overall MTCT occurs after delivery and is due to breastfeeding. In Africa, estimates of MTCT of HIV range from 15–45%, with 15-20% resulting from breastfeeding (Newell et al. 2004). Our study observed high rates of prolonged breastfeeding among HIV-positive mothers, considering that more than 60% of children were breastfed beyond the first year of their lives. The risk of transmission of HIV through breastfeeding remains fairly constant throughout breastfeeding (Bulterys et al. 2004). Given the 'baby friendly' policy that encourages breastfeeding for all mothers, it implies that even if the mother was HIV-negative at delivery and subsequently acquired infection while breastfeeding for a year or longer, the child is likely to acquire HIV. This has major public heath policy implications.

The only method of eliminating the risk of HIV transmission via breastfeeding is to formula feed exclusively or to heat treat expressed breast milk. Although one study in Durban (Coutsoudis, Pillay, Spooner, Kuhn & Coovadia 1999) found that exclusive breastfeeding (i.e. no other fluids or solids apart from prescription medications) may lower the risk of infection, this finding has not been confirmed.

Fourthly, the new finding that children are being breastfed by a non-biological mother, thus increasing their risk of HIV acquisition, requires further comment. There is little published data on the risks associated with a baby breastfeeding from a 'wet-nurse'. This practice was observed among the Eshira ethnic group of Gabon. Ramharter, Chai, Adegnika, Klopfer, Langin, Agnandji, Oyakhirome, Schwarz, Grobusch, Issifou & Kemsner (2004), suggested that this practice may have contributed to an increase in HIV infection risk in children in that country. A supporting sub-study of traditional health practitioners found that this practice was acceptable among family members in cases where the mother is sick or does not have sufficient quantities of breast milk. As suggested by Ramharter et al. (2004), the fact that epidemiological studies do not show a high level of unexplained HIV infection in infants whose mothers are HIV-negative, does not prove that shared breastfeeding is not important. In the context of the HIV epidemic in South Africa, with nearly 28% of pregnant women being HIV-positive (Department of Health, 2003), this practice should be strenuously discouraged.

Fifth, another risk factor associated with HIV is infant feeding from milk rooms. It does appear that a small per cent (3%) of children received milk from milk rooms. Random samples of breast and formula milk were taken for estimation of viral load. Evidence of HIV viral RNA in breast milk was also found in nearly a third of the sample. IC practices were inadequate. None of the milk bottles had been autoclaved, but were cleaned. Only one had been accurately labelled and checked before giving it to the baby. These findings suggest the possibility of breast milk from an HIV-infected mother being given to the wrong baby because of mislabelling. The potential for HIV transmission through the milk room is not trivial, particularly if one considers that, of the 109 women who gave milk to the milk room, 27 (24.7%) were found to be HIV-positive at the time of the survey. However, because the question asked about ever giving milk to the milk room, the mother's HIV status was unknown at the time of giving milk. Therefore, it cannot be concluded that the mother was HIV-positive when she gave milk to the milk room.

Sixth, out of 484 children, seven or 1.4% were HIV-positive and yet their mothers were HIV-negative. This particular finding would have justified a further in-depth analysis of possible sexual abuse, but was not possible for ethical and legal reasons. The phenomenon of HIV serodiscordant mother-child pairs in South Africa was first identified by Stellenbosch researchers. They identified two siblings who were HIV-positive and yet their parents were HIV-negative. The 2002 Nelson Mandela/HSRC study of HIV/AIDS also identified sero-discordant pairs, where 15 children were HIV-positive although their parents were HIV-negative. Unlike in this study, where DNA tests were used to establish biological maternity, the researchers were unable to confirm that the parents of these 15 children were their biological parents. Because these results were inconclusive, the researchers recommended that further research be conducted and hence the present study. Hiemstra, Rabie, Schaaf, Eley, Cameron, Mehtar, van Rensburg & Cotton (2004) established a registry of sero-discordant mother-child pairs, which had 14 children, Thirteen of these children had a history of hospitalisation and 12 were reported to have had intravascular cannulation and intravenous drug administration occurring before HIV diagnosis. They concluded that their findings did not prove nosocomial HIV transmission and called for further studies and identification of medical procedures that are conducive to HIV spread. The present study takes this matter further by identifying a range of practices that may contribute to HIV transmission in health care settings.

Seventh, the observation that five serodiscordant cases came from one health district and two from another suggest that the infection might have occurred as part of an 'outbreak'

due to a breakdown of infection control. During the HIV epidemic there have been many reports of such outbreaks, which led to investigations. The first large such report came from investigations in Russia in 1988–89, where injections and other hospital procedures spread HIV from an index patient to over 250 other children in several hospitals. (Dehne et al., 2000; Bobkov et al. 1994; Sauhat et al. 1992). Less than a year later, doctors in Romania uncovered a much larger outbreak in which medical procedures in orphanages and hospitals had infected over 1 000 Romanian children (Hersh et al. 1993; Patrascu & Dumitrescu 1993; Apetrei et al. 1997; De Coul et al. 2000). In Libya in 1998, medical procedures at one hospital spread HIV from one child to more than 390 others (Quadri, 2000). Many smaller outbreaks have been reported but not thoroughly investigated in Africa (Mann et al. 1986; Prazuck et al. 1993; Hitimana et al. 1993). Many factors are known or suspected to affect the infection risk in specific cases, including the route of transmission, the inoculum of infectious virus and the host's immune response to the exposure. For these reasons, a cross-sectional study, such as this, that unintentionally omits the one health facility where an outbreak might have occurred, may mistakenly report no nosocomial infections. For this reason, universal precautions have to be rigidly applied at all times and all sites and the findings from this study cannot be used to argue for any relaxation in standards.

Eighth, in the pooled analysis ignoring the mother's status, many factors showed a significant association with the child's HIV status. However, the mother's HIV status was clearly the overriding factor in the transmission of the HIV infection to the child and was potentially associated with many of the other factors evaluated. Hence, the mother's HIV status may confound or modify the association of these factors with the child's HIV status. The analysis was therefore repeated, stratified by the mother's HIV status. It should be noted that there were 1 022 HIV-positive mothers, 481 of whose children were HIV-positive (47%) and 2 488 HIV-negative mothers, only seven of whose children were HIV-positive (0.28%).

Among children of HIV-negative mothers, four factors were significantly associated with the child's HIV status. Children who had visited a dentist were more likely to be HIV-positive than those never visiting a dentist (OR 26.9). Approximately 2.4% of children of HIV-negative mothers had received a dental injection, however, among the seven HIV-positive children, three (43%) had received a dental injection (OR 31.5). The two other factors that were significantly associated with the child's HIV status were ever breastfeeding by a non-biological mother and using a milk room. In both cases, children exposed to these factors had a greater chance of being HIV-positive. Overall, 0.6% of the children of HIV-negative mothers had been breastfed at some point by someone other than the biological mother, however five (67%) of the HIV-positive children had been breastfed by someone other than the biological mother (OR 437). Overall, 3.6% of HIV-negative mothers made use of a milk room, however, four of the mothers of the seven HIV-positive children (57%) made use of a milkroom (OR 37.6). Even though the association of the child's HIV status with these factors was significant, the width of the confidence intervals is an indication of the rarity of HIV-positive children in this stratum. Again it must be noted that, due to the cross-sectional study design, it is not possible to determine whether exposure to these factors preceded the child's HIV infection.

Although this study has shown that the great majority of HIV infections among children were associated with maternal HIV status, it has not demonstrated the route of infection. It cannot determine the proportion infected at or around birth, nor what proportion was

due to breastfeeding. What is certain is that breaks in infection control in the public health services seem to be occurring.

Finally, when the epidemiological study results are taken within the context of the findings of the facility-based infection control sub-study a different picture emerges. The results showed that there was very poor cleaning in the environment in the labour and maternity areas as well as the dental facilities; and the same was true for the baby and neo-natal areas. With the presence of detectable occult and visible blood, a breakdown in the processes of IC has clearly occurred, not on just one occasion but perhaps on several occasions over an extended period of time. It is therefore entirely feasible, and not beyond the realm of possibility, that transmission of bacteria, fungi and most importantly viruses could readily occur under these circumstances. The presence of blood and a breakdown in IC practices would also suggest that the nosocomial transmission is entirely possible. Since the most common users of health care facilities are women and children, this group would obviously be most often affected. The training of robust IC teams who have the authority to ensure good IC practice and quality health management should therefore be a national priority.

SECTION 5.
RECOMMENDATIONS

5.1 Key recommendations

First, with the high HIV prevalence among patients served in public health facilities in the Free State, the province is likely to have more children who are HIV-positive surviving to adolescence. Many of them would require support when they become sexually active. The Free State government will need to be ready to provide counselling, care and support and treatment for these children.

Second, with respect to the finding that breastfeeding by a non-biological mother may be a potential risk of HIV infection, it is recommended that the Free State Department of Health and the national Department of Health urgently conduct a national public campaign to:

- Inform the public that breastfeeding of children by a non-biological mother is a potential risk factor for HIV infection in children;
- Discourage women from breastfeeding children who are not their own unless both mother and the non-biological mother have tested negative for HIV.

This is an HIV risk that can be reduced through education. We recommend that HIV prevention messages carried out through TV, radio, posters and other methods should also carry these messages related to shared breastfeeding.

Third, based on the finding that seven HIV-positive children had HIV-negative mothers, we recommend that the Free State Department of Health provide treatment for opportunistic infections and also antiretroviral therapy when so indicated. In addition, the Free State Government, the HSRC and the University of Stellenbosch should urgently conduct an outbreak investigation to determine, if possible, the source of the infection, the procedures and sites involved, and the number of similar infections. These investigations require tracing where children might have been exposed, testing other children in those venues, testing mothers, and sequencing viruses to determine linkages.

Fourth, South Africa currently promotes a policy of breastfeeding for all children. It was encouraging to find that more than 90% of the mothers were breastfeeding. The mother-baby friendly policy is encouraging mothers to breastfeed, which is beneficial for children. However, in the case where the mother is HIV-positive and the child is HIV-negative, there is a need to review the policy, taking into account the socio-economic conditions of the mother and the infant mortality rate in the district where the mother lives. This becomes important when considering that 92% of HIV positive women breastfeed their children and six in ten breastfeed longer than one year.

Our fifth recommendation relates to milk rooms. We found that:

- Nearly 25% of women who expressed milk destined for the milk room were HIV-positive;
- The expressed milk tested was infected with HIV; and
- Due to mislabelling it is likely that the milk will be served to the wrong child.

The health care system could improve in labelling milk in the milk rooms to prevent HIV-negative children being inadvertently infected with EBM from another HIV-positive

mother. It is suggested that the Free State government ensure that mothers be responsible for labelling expressed milk destined for their own child. In addition, if breastmilk is going to be pooled, it must be pasteurised before use.

Sixth, the high HIV prevalence of mothers and children attending public health facilities in the Free State suggests the need for a range of supportive strategies. In a recent policy statement on HIV testing, UNAIDS/WHO (2004) have proposed routine HIV testing in health care settings for:

- All HIV/AIDS symptomatic patients;
- All patients being assessed for STIs;
- All patients presenting in the context of pregnancy; and
- All patients presenting in contexts where antiretroviral treatment is available (even if they are asymptomatic).

Whilst this latter policy would extend to all patients, the high prevalence of mothers and children with HIV suggests that this focus would be an important and urgent starting point to ensure that relevant medical and psychosocial support be provided. Specific child-centred counselling and support would also need to be provided.

Finally, it is essential to conduct a campaign to educate the public to insist that health workers must practice universal precautions whenever they provide services. These precautions include washing hands, wearing gloves and changing them between patients, etc.

SECTION 6.
STRENGTHS AND LIMITATIONS OF THE STUDY

6.1 Strengths and weaknesses

The study had a very high participation rate of 99.4% among children, while 98.3% of the mothers approached agreed to be interviewed and tested for HIV status through the voluntary counselling and testing approach. They were also given the HIV test results for themselves and their children. Those found to be HIV-positive were referred to the health care system for further support.

The co-operation among the Free State Government, the funding agencies and the researchers enabled this study to be undertaken. The government of the Free State now has data for planning health services.

This is the first study to investigate the risk of HIV among children using a variety of research methods. These included interviews, HIV testing, observation of units, assessing knowledge of health workers, and testing for HIV in EBM in the milk room. The combination of these methods will assist in understanding the risk exposure to HIV infection.

The HIV testing protocol allowed for confirmation of results. All HIV-positive specimens were confirmed. Since the participants went through voluntary counselling and testing, it was possible for the research team to follow the mothers and obtain additional information, if necessary.

The limitations of the study relate firstly to the cross-sectional nature of the investigation. It was difficult to determine the direction of causation between the purported risk and HIV status of the child.

Secondly, this study assessed HIV amongst children and mothers attending health care facilities. HIV prevalence in this group is likely to differ from HIV prevalence in the general population. Even within the study population, certain mother-child pairs may be under-represented – for example, where the mother has died of AIDS.

Thirdly, the study was conducted only in the Free State, and findings are relative to a range of conditions in this province that may differ in other provinces – for example, relative levels of HIV prevalence, relativities in health service access, and socio-cultural and contextual factors.

Another limitation of the study is that it was not possible to verify that all concordant HIV-positive mother-child pairs had linked infections. This implies that we could not determine whether all the children who were HIV-positive acquired the infection from their biological mother. Thus, for ethical reasons, exploration of child sexual abuse as a factor in HIV status could not proceed. While other factors have been identified as important risk factors, the possibility of risk as a result of child sexual abuse cannot be ignored.

SECTION 7.
APPENDICES

Appendix 1: Standard operating procedures (SOP) for Abbott 'Determine' rapid HIV test

1. Procedure

a. Put on latex gloves.
b. Remove the protective foil cover from each test.
c. For serum or plasma samples:
   i. Apply sample (using capillary tube) to the sample pad.
   ii. Wait a minimum of 15 minutes (up to 60 minutes) and read result.
d. For whole blood (venipuncture) samples:
   i. Apply sample (using capillary tube) to the sample pad.
   ii. Wait one minute, then apply one drop of Chase Buffer to the sample pad.
   iii. Wait a minimum of 15 minutes (up to 60 minutes) and read result.

2. Quality control

a. To ensure assay validity, a procedural control is incorporated in the device and is labelled 'control'.
b. If the control bar does not turn red by assay completion, the test result is invalid and the sample should be retested.

3. Interpretation of results

a. Positive: red bars appear in both the control window (labelled 'control') and the patient window (labelled 'patient') of the strip. Any visible red colour in the patient window should be interpreted as positive.
b. Negative: one red bar appears in the control window of the strip (labelled 'control'), and no red bar appears in the patient window (labelled 'patient').
c. Invalid (no bar): if there is no red bar in the control window of the strip, and even if a red bar appears in the patient window of the strip, the result is invalid and should be repeated. If the problem persists, contact the Abbott Customer Service and Support Centre.

Appendix 2: Standard operating procedures for blood collection for DNA testing

1. Materials

a. Tourniquet – soft rubber tube or elastic band.
b. Specimen tubes.
c. Vacutainer and needles.
d. Gloves.
e. Specimen forms and labels.
f. Elastoplast
g. Ziplock plastic pockets

2. Procedure

a. Explain the procedure to the participant.
b. Nurse washes and dries hands and puts on gloves.
c. Participant's arm can be placed on a pillow or flat surface.
d. A tourniquet is applied above the elbow in order to make the veins stand out as prominently as possible.
e. Participant can be asked to clench and open fist.
f. The nurse assembles the vacutainer and needle, the needle is inserted through the skin and the vein is punctured (recommended site is forearm).
g. The vacuum tube is placed in the plastic holder.
h. When the stopper has been pierced by the short end of the needle, the blood is automatically sucked into the tube.
i. When the tube is full, it is taken out (invert it 2 or 3 times, depending on the instructions). Release the tourniquet, then withdraw the vacutainer and needle.
j. Apply pressure on the site with a cotton wool swab and apply a light dressing.
k. The participant's study ID number is filled in on the specimen bottle and laboratory form or stickers as indicated.
l. Enter all details on the specimen log form.
m. Avoid inserting the needle more than once.

Appendix 3: DNA blood testing tracking sheet (MRC/HSRC) – completed by specimen collector

Name of collector/fieldworker _____

Signature of fieldworker _____

Signature of lab technician _____

Name of hospital _____

Barcode	Gender (M or F)	Age	Date collected (dd/mm/yyyy)	Time of collection	Lab received
Child					
Mother					
Child					
Mother					

Appendix 4: Focus group guides

A 5.1 Traditional healers

An investigation into the risk factors associated with HIV acquisition among children between 2 and 9 years of age in the Free State Province (Nosocomial HIV Study)

Questions specific to traditional healers

a. What are the traditional health practices you specialise in? (probe using categories below)
Ke eng eo u ipabalang ka yona ha usebedisa methokgo? (Ikamahanye le tse latelang)
   i. Surgical practices – *Tshebediso ya lehare (ho patsa)*
   ii. Give injections – *Neha Sepeiti*
   ii. Sucking of wounds – *Holomeha/Ho momona madi*
   iv. Blood letting – *Ho phallisa madi*
   v. Conduct birth/delivery – *Ho belehisa*
   vi. Circumcision – *Lebollo*
   vii. Biting out foreign objects – *Ho lomeha*

b. Have you ever heard about HIV/AIDS? – *Le Kile wa itlwa ka kokwana-hloko ya bosolla thlapi?*
Probe for:
   i. General knowledge – *Tsebo Ka kakaretso*
   ii. Traditional beliefs about HIV transmission – *Tsebo ya setso ka tshwaetsano/ ho neheletsana ka kokwana hloko ena*

c. How do you prevent HIV transmission in your clinics? *Nna le thibeletswa jwang tshwaetsano dibakeng tseo le sebetsang ho tsona?*
Probe for:
   i. What precautionary measures or guidelines are used, i.e. gloves, washing of hands or traditional medicines? *Tlhokomediso kapa tataiso ke e jwang jwaloka ditlelafo tsa matsohong kapa methokgo?*
   ii. How often is this done i.e., for every consultation or for certain procedures? *Ho etswa neng ke hore ha o bona mokudi kapa ka donako tse itseng feela?*
   iii. Do they sterilize sharp instruments? *Na disebediswa di bediswa pele di sebediswa?*

d. How are instruments used for scarification procedures cleaned or sterilized? *Na disebediswa di bediswa pele di sebediswa?*
Probe for:
   i. What methods are used, duration and what process is used? *Mekgwa ke efe, nako e kae le hona ho etsuwa kapa ho bediswa?*

e. What type of children's health problems do you attend to? *Ke mafu a fe a bana ao le a alafang haholo?*

f. When is scarification indicated in children? *Ho hlokahala neeng hore ngwana a phatswe?*
Probe for:
i. At what age is this done? *Ke ha a le mokae ha ho etswa ho?*

g. What types of instruments are used for scarification? *Ho ebediswa mahare a mofuta ofe ho phatsa?*

h. Are there any risks involved in scarification of children? *Na ho ka ba le dikotsi dife baneng ha ho phatswa?*

i. After the scarification process how are the instruments disposed of? *Ho ho qetwa ho phatswa mahare kapa disebediswa di lahlwa ka tsela e jwang?*

j. How do you circumcise children of different age groups? *Bana ba dilemo tse fapaneng ba bolotswa jwang?*
Probe for:
i. Young children – *Bana ba banyane*
ii. Older children – *Bana ba baholwanyana*
ii. Youth – *Bana ba baholo*

k. Have you heard of cases where the disposed instruments ended up in the hands of the children?
Na o kile wa utlwa hore mahare a seng a sebeditswe a kile a wela matsong a bana ka bohlaswa?

A 5.2 Traditional birth attendants

An investigation into the risk factors associated with HIV acquisition among children between 2 and 9 years of age in the Free State Province (Nosocomial HIV Study)

Questions specific to traditional birth attendants (TBAs)

a. Have you ever heard about HIV/AIDS? – *Le Kile wa itlwa ka kokwana-hloko ya bosolla thlapi?*
Probe for:
i. General knowledge – *Tsebo Ka kakaretso*
ii. Traditional belief about HIV transmission – *Tsebo ya setso ka tshwaetsano/ ho neheletsana ka kokwana hloko ya bosolla thlapi*

b. Do all TBA's undergo formal training to deal with HIV in pregnancy? *Na Ba belehis ba setso ba fumana thupello ho ka sebetsana le kokwana-hloko ya bosolla tlhapi?*

c. How do you prevent HIV transmission in your clinics?
Le thibella jwang hore kokwana-hloko ena e se ke ya neheletsana tshebotsong ya lona?
Probe for:
i. What precautionary measures or guidelines are used i.e. gloves, washing of hands or use of western or traditional medicines? *Ke tlhokomediso kapa yona tataiso e sebediswang ke tshebediso ya ditlelafo kapa ho hlatswa matsoho, ka disebediso tsa sejwalejwalr kapa tsa setso?*

ii. How often is this done i.e., for every consultation or for certain procedures only? *Ho etswa makgetlo a make, hore ho mokudi e mong le e mong kapa maemong a itseng feela?*
iii. Do they sterilize sharp instruments? *Na disebediswa di a bediswa ho hlatsuwa ho nepahetseng bakeng sa ho sebetsa morero o?*
iv. As far as you know do all practitioners adhere to precautionary measures? *Ho ya ka tsebo ya lona, na dingaka tsa setso kaofela ba nka mehato e ya tshireletso ho phemisa dikotsi?*

d. During delivery do mothers have to bring their own instruments or does the TBA bring her own? *Ha ba tlilo beleha, na bo mme (baimana) ba tla le disebediswa tsa bona kapa ba belehisi ba setso ba tla ka tsa bona?*

Probe for:
i. Are these instruments re-used after delivery? *Na disebediswa tse, di a sebediswa hape ha mokudi a qeta ho beleha?*
ii. If these are re-used how are they sterilized? *Haeba di sebadiswa hape, di sebediswa jwang ho hlwekiswa?*
ii. For how long? *Nako e kae?*
iv With what? *Ka eng?*

e. Where do you usually deliver the baby? *Bakudi ba lona, le ba belehetsa kae?*
5.1 If at home, who else attends the birth and helps? *Haeba ke hae, ke bo mang hape ba thusang?*

f. How is the umbilical cord cut? *Mokgubu le o kgaola jwang ka eng?*

g. Does the baby need support to start crying or breathing when it was born and if so, what do you do? *Na ngwana o hloka thuso hoore a lle kapa a qale ho hema, ha eba ho le jwalo, o etsa jwang?*

h. How do you dispose of the waste after the delivery of the baby? *Ha o se o qetile ho belehisa, tseo o qetileng ka tsona, le di lahla jwang kae?*

Probe for:
i. Have you heard of cases where the disposed instruments or waste ended up in the hands of the children in your area? *O kile wa utlwa kapa wa bona hore di sebediswa di ile tsa wela matsohong a bana?*

i. Do you ever have cases of mothers who cannot breast-feed and whose babies have to be breast-fed by other mothers? Why is that happening? *Le kile la kopana le motswetse ya sa nyantsheng ngwana wa hae a antshitsweng ke mme e mong? Hobaneng sena se etsahala?*

Probe for:
i. What about cases of milk being expressed by one mother to be given to another baby? *Kapa ho motswetse a tlamehang ho hamela bana ba batswetse ba bang?*

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