

FACTORS INFLUENCING THE IMPLEMENTATION OF AN EFFECTIVE INFECTION CONTROL PROCESS IN A NEONATAL INTENSIVE CARE UNIT

by

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Met liefde en dankbaarheid aan my Ma en Pa
Lizelle

DECLARATION

I, THE UNDERSIGNED, HEREBY DECLARE THAT THE WORK CONTAINED IN THIS THESIS IS MY OWN WORK AND HAS NOT PREVIOUSLY BY ITS ENTIRETY OR PART BEEN SUBMITTED AT ANY UNIVERSITY FOR A DEGREE.

SUMMARY

Nurses are being held responsible and accountable for the quality of nursing care, which includes quality infection control nursing, they provide. This change in accountability has been brought about by the need to reduce the ever escalating costs of health care. During the 1980's, health care services created a demand for high-quality, efficient, cost-effective and competitively priced health services. In order to provide these services, health care organisations are forced to consider new strategies. This is a process that produces outcomes. Quality improvement methods, which include infection control, help organisations to produce these outcomes.

Donabedian (1980) defined high-quality care as "that kind of care which is expected to maximise an inclusive measure of patient welfare, after one has taken account of the balance of expected gains and losses that attend the process of care in all its parts" (Grossman, 1998: 43). Quality improvement in infection control relates to the activities employed to improve the performance of a process, and includes the process of planning and control.

Management is responsible and accountable for providing resources in order to implement quality infection control nursing care.

The purpose of the study was to identify factors influencing the implementation of an effective infection control process in a NICU. An exploratory and descriptive design with a qualitative orientation was implemented. It consisted of a narrative and a literature study by means of which factors have been identified to influence the implementation of an infection control process in a NICU. The case study design, an in-depth analysis of a single unit of study, was utilised in this study as part of the data-gathering process.

Recommendations were made on the macro, meso and micro levels, which included quality circles, hand hygiene and antibiotic usage, in-service education, recognition of personnel, mission statement and the infection

control manual. The shortage of human and physical resources in nursing is a global problem. In S.A. there has been no previous study to emphasise the importance of an effective infection control process, and therefore no solutions to the problem have been suggested. The Japanese view with regard to quality circles is recommended.

OPSOMMING

Verpleegkundiges is verantwoordelik en aanspreeklik vir die gehalte van verpleging wat gelewer word, insluitende gehalte infeksiebeheer verpleging. Hierdie verandering in aanspreeklikheid het voortgespruit uit die behoefte om die voortdurende styging in gesondheidskoste te verminder. Gedurende die 1980s, het 'n aanvraag vir hoë gehalte, kosteffektiewe en kompeterende gesondheidsorgdienste ontstaan. Gesondheidsorg dienste moes nuwe strategieë oorweeg om in hierdie dienste te kan voorsien. Uitkomste word op hierdie proses gebaseer. Om hierdie uitkomste te bereik, behoort organisasies gehalteverbetering metodes, wat infeksie beheer insluit, te implementeer.

Donabedian (1980) definieer hoë gehalte as "that kind of care which is expected to maximise an inclusive measure of patient welfare, after one has taken account of the balance of expected gains and losses that attend the process of care in all its parts" (Grossman, 1998: 43). Gehalteverbetering in infeksiebeheer, verwys na die aktiwitiete wat geïmplementeer word om die uitvoer van 'n proses te verbeter, insluitende beplanning en beheer.

Bestuur is verantwoordelik en aanspreeklik vir die voorsiening van hulpbronne, om gehalte infeksiebeheer verpleegsorg te implementeer.

Die doel van die studie was om faktore wat die implementering van 'n effektiewe infeksie beheer proses in 'n NICU beïnvloed, te identifiseer. 'n Verkennende en beskrywende ontwerp, met 'n kwalitatiewe oriëntering, is geïmplementeer. Dit het bestaan uit 'n narratief en 'n literatuur studie, waardeur faktore wat die implementering van 'n effektiewe infeksie beheer proses in 'n NICU beïnvloed, geïdentifiseer word. Die gevalliestudie ontwerp, wat 'n in-diepte ondersoek van 'n enkele eenheid van studie is, is in hierdie studie gebruik as deel van die data-insamelings proses.

Aanbevelings is gemaak of makro, meso en mikro vlak, en sluit in gehalte sirkels, handhygiëne en antibiotika gebruik, indiensopleiding, erkenning van personeel, 'n missieverklaring en ten opsigte van die infeksiebeheerhand-

leiding in. Die tekort aan menslike en fisiese hulpbronne in verpleging is 'n globale probleem.

Aangesien daar nog nie voorheen 'n studie in S.A. gedoen is om die belang van 'n effektiewe infeksiebeheerproses te beklemtoon nie, is daar nog nooit oplossings vir die probleem voorgestel nie. Die Japanese siening van gehalte sirkels word aanbeveel.

▼

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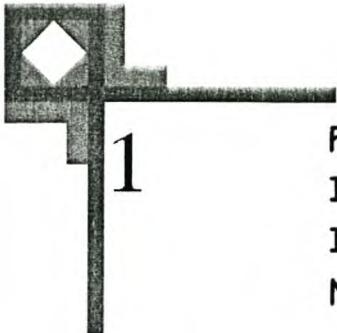
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FACTORS INFLUENCING THE IMPLEMENTATION OF AN EFFECTIVE INFECTION CONTROL PROCESS IN A NEONATAL INTENSIVE CARE UNIT

1.1 OVERVIEW OF THE STUDY

The goal of the study is to identify factors influencing the implementation of an effective infection control process in South African (S.A.) Neonatal Intensive Care Units (NICU).

S.A. is currently experiencing an economic recession which has resulted in a negative influence on health care. It is a well-known fact that S.A. used to be one of the leaders in health care. The first registered nurses in the world were registered in S.A. in 1891 (Searle, 1965). The first heart transplant was performed in 1967 in S.A. The economic recession has resulted in a regrettably negative paradigm shift. The government hospitals that used to be the "pride and joy" of the health care system, are now in dire financial straits.

There is a difference between NICU's in government and private hospitals in S.A. In government NICU's there are smaller budgets, resulting in less equipment, a smaller variety of medication with the emphasis on generic medication and patients with higher acuity levels. Due to the above, the private sector has better equipped hospitals, more nursing staff, better salaries, more available medication and patients with lower acuity levels. The outbreak of nosocomial infections appears to be much higher in government hospitals, due to the risk factors described above (Cotton et al, 1989: 676). Because of the scarcity of data available on the incidence of nosocomial infections and specific factors influencing the implementation of an effective infection control process in NICU's in S.A., a need has been identified for research to be done in this field (Cotton et al., 1989: 676-682).

According to Stetson & Swyer (1975) the definition of care in the sick newborn is: "The care which provides careful watching and treatment to a certain category of very ill newborns." The aim in a NICU should be to save the life of the infant who is in a desperate condition, and simultaneously to preserve the integrity of the central nervous system. The professional nurse is responsible and accountable for an effective nursing regimen. Any deviation from biochemical and physiological homeostasis, even in the absence of clinical manifestations, should also be detected, reported and documented as soon as possible and the necessary remedial actions implemented (Nursing Act, no 50 of 1978). This implies one nurse for each infant, constantly available medical staff, constant monitoring of vital signs, twenty-four hour availability of biochemistry analysis and radiological services (Stetson & Swyer, 1975: 5). In the United Kingdom (Halliday, 1989: 72) it is estimated there are five nurses for each NICU cot and one and a half for each special care cot. The ideal in S.A. is one registered nurse per intensive care neonate (Muller, 1996).

The risk of infection in nurseries can be described according to the host, the nursery and invasive procedures (Wenzel, 1997: 1025). The (newborn) host has an immature immune system which makes the newborn more susceptible to atypical/asymptomatic viral infections, which have a limited repertoire of clinical signs which make diagnosis difficult. Risks in the nursery include overcrowding and understaffing with inadequate placement of handwashing facilities and invasive procedures. An invasive procedure can be identified as any procedure that interrupts the normal barrier to infection, e.g. nasogastric tubes, continuous administration of nutrition, bacterial colonisation and infection of intravascular catheters and ventilator associated pneumonia (Wenzel, 1997: 1026). It is believed that the number of qualified nurses working in nurseries has an influence on the quality of nursing being rendered and quality nursing includes quality infection control skills.

The goal of infection control for the newborn is not the treatment, but the prevention thereof. This goal is effected through the early detection of complications and the implementation of remedial action before and during pregnancy. Cautious care of the neonate with his immature host defences, requires committed handwashing, adequate nursing staff, adequate space

and isolation facilities with a continuous attempt at minimal invasive support and monitoring equipment (Wenzel, 1997: 1027).

At present inflation and the recession have placed increasing pressure on nursing and hospital management to reduce the costs of hospital operation. In most hospitals and clinics personnel salaries represent the principal budgetary expenditure, sometimes up to 60% of the total budget. When personnel costs in a hospital have to be reduced, management tends to trim the nursing budget before that of any other department, for two reasons. Firstly, the nursing budget is the largest and a reduction of only a small percentage of its total would result in considerable savings. Secondly, the nursing group is both less vocal and less powerful than other employee groups with comparable personnel budgets, such as doctors or clerical staff (Gillies, 1989: 94).

It is a well-known fact that if nursing staff is reduced, the quality of nursing is affected negatively. To overcome this problem, careful assessment of the type of nursing modality, in this case neonatal intensive care, should be considered. When reducing nursing staff, it is important to remember that to increase nursing staff effectiveness, there should still be a balance between personnel and workload (Van der Merwe, 1993: 24-30).

Although some South African hospitals are accredited and an infection control programme is one of the requirements of the structure standards, it is found that in these so-called accredited hospitals, the infection control nurse is not trained for the position and cannot implement effective educational and training programmes, because there is no basic knowledge of infection control nursing, epidemiology and microbiology. It has been stated by students doing a distance learning course for infection control nursing at a tertiary institution, that the so-called "problem" nurse was very often charged with the hospital infection control (Van der Merwe, 1999).

1.2 PROBLEM STATEMENT

Infection control is not recognised as part of quality nursing care, because of the management's limited knowledge of infection control and the effect that staff shortage/reduction has on the situation (Van der Merwe, 1993:

24-30). The S.A. public is being informed of their rights and are becoming aware of the legal implications of nosocomial infections.

This gives rise to the question of what factors influence the implementation of an effective infection control process in a NICU.

1.3 PURPOSE STATEMENT

The purpose of this study is to identify factors influencing the implementation of an effective infection control process in a NICU.

The objectives are thus:

- to explore the literature and the environment on
 - * effective infection control programmes
 - * nosocomial infections in NICU's
- to identify factors influencing the implementation of an effective infection control process in a NICU.

1.4 RESEARCH MODEL

Botes' (1993) Nursing Research Model will be utilised as it presents a comprehensive approach to research. It is based on the following:

- the first order - the nursing practice with nursing as the activity,
- the second order - the theory of nursing with research and theory formulation as the activity; and
- the third order - the paradigmatic perspective of the research.

1.5 PARADIGMATIC PERSPECTIVE OF THE STUDY

The research design for this study is based on the Botes's model (1993) dealing with research in nursing. The paradigmatic perspective of the study is based on Roper, Logan & Tierney's Activities of Living Model for Nursing (ALM) (Pearson, Vaughan & Fitzgerald, 1996: 72).

The Activities of Living Model for Nursing are arranged according to the person, lifespan, the dependence/independence continuum, the activities of living, factors influencing activities of living, individuality in living, health and the environment (Pearson et al, 1996: 72). The following assumptions are made:

- The person is an individual engaged in living throughout his or her lifespan, and moving from dependence, according to age, circumstances and environment.
- Lifespan is defined as beginning life at conception and continuing until death.
- Dependence/independence continuum is dynamic and can be influenced by a whole range of factors, eg. a newborn baby will be at the dependent end and an adult will be at the independent end of the continuum.
- Activities of living include 12 basic activities, eg. preventing, comforting, seeking, maintaining a safe environment, communicating, breathing, eating and drinking, eliminating, personal cleansing and dressing, controlling body temperature, mobilising, working and playing, expressing sexuality, sleeping and dying.
- Factors influencing activities of living have five components - physical, physiological, sociocultural, environmental and politico-economical.
- Individuality in living is summarised, as preventing activities, comforting and seeking activities.
- Health changes involve a dynamic process with many facets.
- Environment is anything external to the person.

1.5.1 Meta-theoretical assumptions

Mouton & Marais (1992: 198) describe the origins of meta-theoretical assumptions as a philosophy that provides a framework for congruency. The researcher believes in Christianity and sees each human being as a creation of God, and as such believes that all individuals are involved in certain activities which enable them to live and grow. The unique function of the nurse is assist the individual, sick or well, in the performance of these activities. In this way the nurse contributes to the independence of the individual.

1.5.2 Theoretical assumptions based on the Activities of Living Model

Theoretical assumptions will be based on the person, lifespan, the dependence/independence continuum, the activities of living, factors influencing the activities of living, individuality in living, health and the environment.

1.5.3 Methodological assumptions

The researcher accepts the functional strategy of reasoning in nursing research. This implies that the ultimate goal of research in nursing is to facilitate quality improvement in infection control nursing.

1.5.4 Central theoretical assumption

The identification of factors influencing an effective infection control process in a NICU will facilitate:

- an awareness for quality infection control nursing and the
- prevention of nosocomial infections in the neonate.

1.6 TERMINOLOGY

• Government Hospital

A government hospital is a health care institution financed by the government and functioning on a non-profitable basis.

• Process

A process is a cause of action or a series of stages in manufacture or some other operation (Oxford: Thompson)

• Programme

A programme is a printed list of a series of events or a definite plan(Oxford: Thompson).

- **Professional nurse**

A professional nurse is a nurse registered with the South African Nursing Council, as a general nurse with or without additional qualifications.

- **Nursing Manager**

A nursing manager is a professional nurse who implements the planning, organising, directing and control functions in the daily performance of his/her managerial function in a private or government hospital.

1.7 RESEARCH DESIGN

The research design includes the strategy, target population, data-gathering and analysis, trustworthiness and strategies of reasoning.

1.7.1 Research Strategy

The research strategy, implies the methods for obtaining data , analysis and trustworthiness (Botes, 1993). In this study an exploratory and descriptive design with a qualitative orientation will be implemented, with the case study as the method of obtaining data, and coding will be utilised to obtain and analyse the data. (Uys & Basson, 1995: 47-49).

- **Exploratory**

The literature will be within the context of infection control in neonatology and factors influencing the implementation of an effective infection control process in a NICU. According to Uys & Basson (1995: 38) exploration is aimed at gaining insight and understanding a phenomenon.

- **Descriptive**

A descriptive study is described as the methodological collection of accurate data on the main phenomenon to be studied (Uys & Basson, 1995: 38). This study will identify, analyse and describe the process of:

- * identification of factors influencing the implementation of an effective infection control process in a NICU

- **Contextual**

The research will be done within the context of quality infection control in nursing and quality neonatal intensive care nursing.

- **Phenomenological research**

Phenomenological research is one of the five approaches used in the execution of qualitative research. It investigates the specific experience of an individual in a certain situation (Uys & Basson, 1995: 52).

This study is phenomenologically subjective, because factors influencing the implementation of an effective infection control process in a NICU, are identified. The various strategies that can be used, are:

- respondents may be asked to describe their experience in words, e.g. what they think the factors are that influence the implementation of an effective infection control process in a NICU;
- these experiences may also be described in writing; and
- the researcher can observe the respondents and describe the observations (Uys & Basson, 1995: 52).

- **Case study**

The case study design is a thorough analysis of the subject of study, which in this case deals with the factors influencing the implementation of an effective infection control process. The case study is done in the subject's natural environment, under natural conditions (Wilson, 1985: 136).

1.7.2 Target population

The target population will consist of:

- A purposeful literature population sample.
- A convenience sample will be taken from a state hospital where the researcher accompanies students doing the intensive care nursing course.
- NICU's in government hospitals.

1.7.3 Data-gathering and data-analysis

The three levels advocated by Burger (1996: 32-35) that is macro, meso and micro levels, will be utilised in the study. The framework for the case study, data sources and data gathering methods will be described in chapter two. Observation, semi-structured interview and coding will be utilised as methods of data-gathering.

1.7.4 Trustworthiness

Trustworthiness will be implemented according to Guba's (1981) model and literature on the subject dealing with infection control nursing and neonatal intensive care nursing. The internal and external validity are within the context of infection control and neonatal intensive care nursing.

Guba's (1981) model is based on the identification of four aspects of trustworthiness, namely:

- * *truth value* which is based on the discovery of human experiences as it is experienced and observed by the informants;
- * *applicability* which describes the extent to which findings could be implemented in different contexts and set-ups with other groups;
- * *consistency* of data, which explains that with recurrence the same subjects, the findings would stay the same, and
- * *neutrality* in trustworthiness, which is the elimination of prejudice in the research procedure and research results.

1.7.5 Strategies of reasoning

Strategies of reasoning that will be used in this study are analysis, deduction and synthesis.

- Analysis

According to Walker & Avant (1988: 24) analysis is especially useful to clarify, refine or sharpen concepts and statements.

- Concept analysis: it is a strategy for examining the attributes or characteristics of a concept.

- Statement analysis: it is a process of examining the relational statement to determine in what form they are presented and what relationship the concepts within those statements have to one another.

- Deduction

Deductive reasoning is described by Abdellah & Levine (1979) as the process of developing specific predictions from general principles of deriving logical answers or conclusions from reliable premises.

- Derivation

In derivation analogy or metaphor is employed in transposing and redefining concept or statement (Walker & Avant, 1988: 25).

- Concept derivation consists of moving a concept from one field of interest to another field.
- Statement derivation occurs when a set of statements from one field of interest is used to derive the content/structure of a second set of statements for a second field.

- Synthesis

In synthesis, isolated pieces of information are combined and used to construct a new concept, or a new statement. Two types are identified:

- Concept synthesis which is a strategy for developing concepts based on observation or other forms of empirical evidence.
- Statement synthesis which is a strategy that is aimed at specifying relationships between two or more concepts based on evidence (Abdellah & Levine, 1979).

1.8. DIVISION OF THE RESEARCH

Division will take place according to the allocated chapters:

Chapter 1: Overview of the study

Chapter 2: Research Methodology

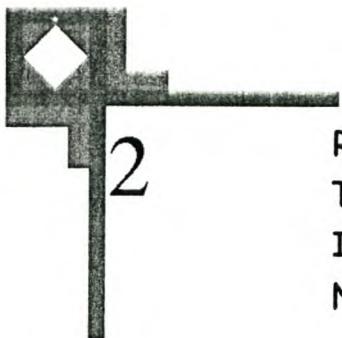
Chapter 3: The Narrative

Chapter 4: Literature review

Chapter 5: Summary and Recommendations

1.9 SUMMARY

The goal of the study is to identify factors that will influence the implementation of an effective infection control process in S.A. neonatal intensive care units. Infection control is not recognised as part of quality nursing care, because of management's limited knowledge regarding infection control. Every neonate has the right to quality nursing care and the professional nurse, whether he/she is in management or practising in the NICU, is responsible for and accountable for ensuring that the neonate receives such care. In Chapter two the research methodology employed in the study will be described.



RESEARCH DESIGN: FACTORS INFLUENCING THE IMPLEMENTATION OF AN EFFECTIVE INFECTION CONTROL PROCESS IN A NEONATAL INTENSIVE CARE UNIT

2.1 INTRODUCTION

The research design and method of identifying factors influencing the effective implementation of an infection control process in a NICU, will be described in this chapter. The research methodology involves the planning, structuring and execution of research, and describing the actual research approach (Uys & Basson, 1995: 8). The researcher's philosophy of science will ultimately determine the research design with the greatest potential for advancing nursing knowledge. Schantz & Lindeman (1982) isolated six generic elements of research designs, namely:

- *setting* - environment where research will take place,
- *subjects* - those being observed or the recipients of experimental research,
- *sample* - reasonable number of subjects,
- *treatment* - the research intervention
- *measurement* - observation or data collection methods
- *plan* for communicating results, including analysis and interpretation of data.

Choosing a correct research design tends to isolate variables of interest or concern, eliminate bias and decrease the margin of error and enables the researcher to have confidence in his/her conclusions (Wilson, 1989: 130-131)

2.2 PURPOSE OF THE STUDY

The purpose of this study is to identify the factors that influence the effective implementation of an infection control process in a NICU. The objectives are thus:

- to explore the literature, environment and expert opinions on
 - * effective infection control programmes
 - * nosocomial infections in NICU's, and
- to identify factors that influence the effective implementation of an infection control process in a NICU.

2.3 RESEARCH DESIGN

The term research design implies "the total strategy for the study - from identification of the problem to the final plans for collecting data; or the structural framework within which the study is to be implemented" (Uys & Basson, 1995: 37-38). In this study an exploratory and descriptive design with a qualitative orientation, will be implemented. The case study design will specify the method of obtaining and analysing data (Uys & Basson, 1995: 38).

The research design will be discussed under the following headings:

- * research model
- * assumptions of the research
- * characteristics regarding the research field; and
- * research context
- * the case study
- * phenomenological research

2.3.1 Research Model: The Botes'(1989) Nursing Research Model

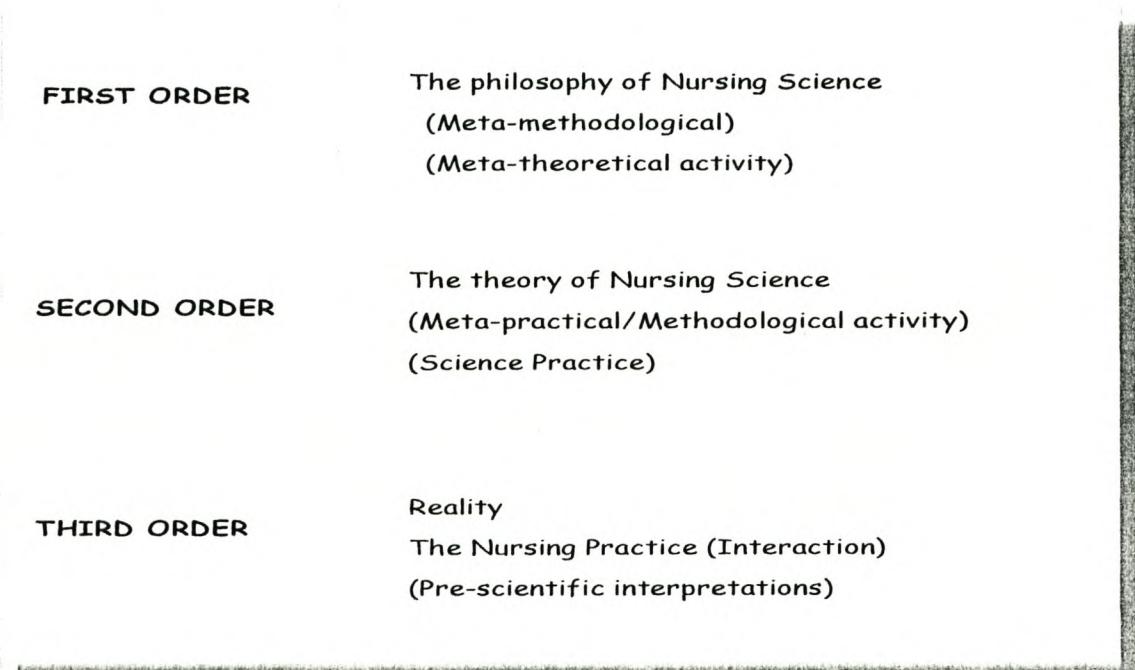
The Botes model (1989) for research in nursing will be utilised in the study. It provides a holistic perspective of the research rather than a detailed description of the methods and techniques of research (Botes, 1993: 6). A model is described (Mouton & Marais, 1992) as a precursor of a theory. According to Brink (1996: 24) research is guided by theory and is dependent on theory to increase its meaningfulness and generality.

2.3.1.1 *The nature of the Botes Nursing Research Model*

The Botes Nursing Research Model consists of three interacting orders, namely:

- the first order which defines the nursing practice and the activity of nursing , as the field of research;
- the second order deals with the theory of nursing, theory formulation and research as activity;
- the third order is the paradigmatic perspective of the research.

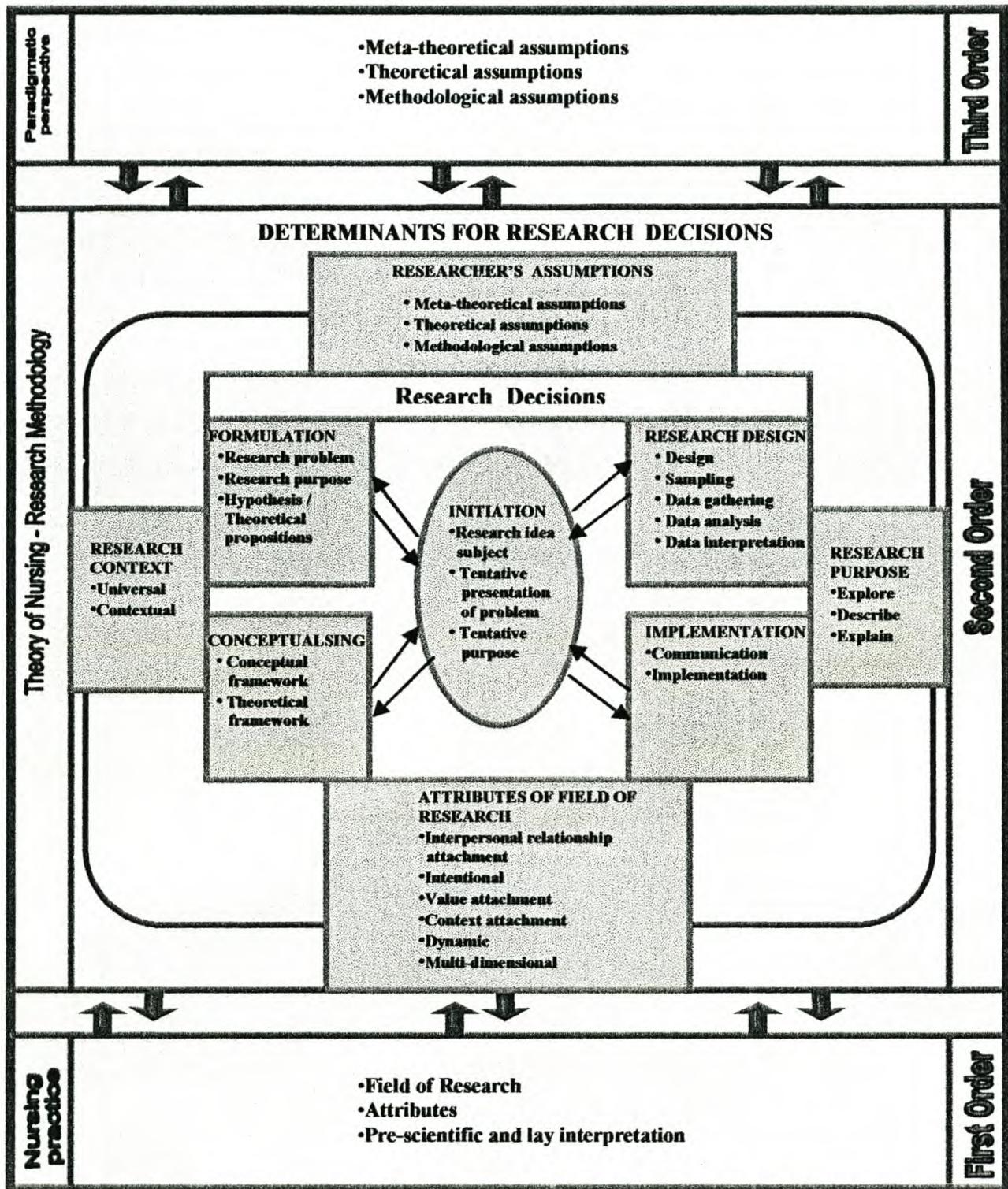
fig. 2.1 The three orders of the Botes model.
(Botes, 1989: 5)



2.3.1.2 The rationale for utilising the Botes Nursing Research Model

The Botes model (1989) is comprehensive and is aimed at nursing practice. The three orders are in interaction with one another and always return to the practical situation.

Figure 2.2: A Model for Research in Nursing (Botes, 1989)



(Botes, 1989)

Emphasis is placed on:

- the researcher who has to be active in the field of study - in this study the researcher , as a professional nurse working in ICU, will research the literature in order to assist in the identification of factors influencing the implementation of an effective infection control process in NICU;
- the research must be focused on the practice - the researcher will identify factors influencing the implementation of an effective infection control process in a NICU.

2.3.1.3 Utilisation of the Botes Nursing Research Model

Utilisation of the Botes Nursing Model will be done according to the three orders as discussed in 2.3.1.1.

a) First order: Nursing practice

The first order represents nursing as part of the nursing regimen, which is directed at the implementation of infection control in a NICU. The specific action that is explored, focuses on factors that influence the effective implementation of an infection control process in a NICU.

b) Second order: Theory of Nursing - Research Methodology

According to Botes (1989: 9) research methodology is the foundation of nursing science. The researcher will utilise a descriptive method that is based on the Botes Nursing Research Model and the Activities of Living Model for Nursing as proposed by Roper et al.

Botes (1989) describes the following concepts:

* Exploratory

According to Uys & Basson (1995) exploring is aimed at gaining insight and understanding a phenomenon. The literature on factors in a NICU, to implement an effective infection control process, will be explored in the

research. This will enable the researcher to gain insight and understanding of the field of study.

* Descriptive

A descriptive study is described as the methodological collection of accurate data on the main phenomenon to be studied (Uys & Basson, 1995: 281). It is also described by Polit & Hungler (1997: 456) as a research study which has the accurate portrayal of the characteristics of persons, situations, or groups, and/or the occurrence or frequency of certain phenomena, as main objective. This study will identify, analyse and describe the process of the identification of factors influencing the implementation of an effective infection control process in a NICU.

* Contextual

The research will be done within the context of quality infection control nursing and quality neonatal intensive care nursing in a NICU in a government hospital.

* Phenomenological research

Phenomenological research is one of the five approaches to the execution of qualitative research. It investigates the specific experience of an individual in a certain situation (Uys & Basson, 1995: 52).

This study is phenomenologically subjective, because factors influencing the implementation of an effective infection control process in a NICU, are identified. Various strategies can be used:

- Respondents may be asked to describe their experience in words, e.g. their opinions about factors that influence the implementation of an effective infection control process in a NICU;
- these experiences can also be described in writing; and
- the researcher can observe the respondents and describe the observations (Uys & Basson, 1995: 52).

* Case study

The case study design can be defined as an in-depth analysis of a single unit of study, for example a person, family, community, a hospital ward, a health care facility or a small number of subjects under intensive examination (Wilson, 1989: 136; Burns & Grove, 1997: 256-266). It is done under natural conditions and examines only a single subject or a small number of subjects with respect to a number of variables, for example history, characteristics, and interactions.

In this study the aim of the case study is to gain insight into a problem area, namely the factors influencing the effective implementation of an infection control process in a NICU.

c) Third order: Paradigm

The researcher's meta-theoretical, theoretical and methodological assumptions are influenced by a specific paradigm in the third order.

The assumptions of the researcher will be discussed according to the following aspects:

- meta-theoretical assumptions
- theoretical assumptions - i.e the Activities of Living Model
- methodological assumptions

2.3.2.1 *Meta-theoretical Assumptions*

Mouton & Marais (1992: 198) describe the origins of meta-theoretical assumptions as a philosophy that provides a framework for congruency. The researcher believes in Christianity and sees each human being as a creation of God, and thus believes that all individuals are involved in certain activities which enable them to live and grow. This implies that the unique function of the nurse is to assist the individual, sick or well, in the performance of those activities. In this way the nurse contributes to the independence of the individual. Meta-theoretical assumptions form part of the third order of the Botes' Nursing research Model.

2.3.2.2. Theoretical Assumptions according to the Activities of Living Model

The researcher supports the theoretical assumptions of the Activities of Living Model for Nursing, of Roper, Logan & Thierney (Pearson et al, 1996: 72) Theoretical assumptions will be based on factors related to the person, lifespan, the dependence/independence continuum, the activities of living, health and environment.

a) The nature of the Activities of Living model of Roper et al.

The fundamental belief is that all individuals are involved in certain activities which give them the opportunity to live and grow (Pearson et al, 1996: 72). Virginia Henderson defined nursing as follows:

"The unique function of the nurse is to assist the individual, sick or well, in the performance of those activities contributing to health or its recovery (or to a peaceful death) that he/she would perform unaided if he/she had the necessary strength, will or knowledge, and to do this in such a way as to help him/her to gain independence as rapidly as possible."

Henderson described the function of nursing by placing emphasis on 14 activities of daily living:

- * Normal breathing
- * Eating and drinking adequately
- * Eliminating body wastes
- * Moving and maintaining desirable postures
- * Sleep and rest
- * Selecting suitable clothes - dress and undress
- * Maintaining body temperature within normal limits by adjusting clothing and modifying the environment
- * Keeping body clean and well-groomed and protecting the skin
- * Avoiding dangerous environment and injury to others
- * Expressing emotions, needs, fears and opinions through communication
- * Worshipping according to one's faith
- * Working to create a sense of accomplishment
- * Promoting participation in various forms of recreation

- * Using available health facilities and learning and discovering factors leading to normal development and health.

Roper, Logan & Tierney developed their model by condensing Henderson's ideas into a model which focuses on the daily activities people engage in, in order to live. According to this model, one of the best ways of understanding people, is in terms of the activities they perform. Roper identified sixteen Activities of daily living, which after revision specify only twelve Activities of Living (Aggleton & Chalmers, 1986: 28). The sixteen activities of daily living are shown in table 2.1.

Table 2.1 Activities of Daily Living (Aggleton & Chalmers, 1986: 28)

ESSENTIAL	Breathing
	Eating
	Eliminating
	Controlling body temperature
	Mobilising
	Sleeping
	Fulfilling safety and security needs
INCREASE QUALITY OF LIVING	Personal cleansing
	Dressing
	Communicating
	Learning
	Working
	Playing
	Sexualising
MORTALITY	Procreating
	Dying

The revised 12 activities relate to particular human needs. The activities are shown in table 2.2.

The activities of daily living can be visualised on the continuum as being dependent or independent, depending on the health status of the neonate. The neonate is totally dependent on the nurse for safety of the environment. Communication takes place by means of crying or restlessness. When the breathing of the neonate is impaired, the neonate moves over to

the dependent continuum. The neonate is dependent on the nurse for the following activities: eating and drinking, personal cleansing and dressing, mobility and playing. The neonate has the following independent activities: eliminating, controlling body temperature (if the neonate is pyrexial, this becomes a dependent function) and expressing sexuality. Sleep and dying can both be dependent and independent activities of living.

Table 2.2 Activities of living (Aggleton & Chalmers, 1986: 29)

- ➡ **maintaining a safe environment**
- ➡ **communicating**
- ➡ **breathing**
- ➡ **eating and drinking**
- ➡ **eliminating**
- ➡ **personal cleansing and dressing**
- ➡ **controlling body temperature**
- ➡ **mobilising**
- ➡ **working and playing**
- ➡ **expressing sexuality**
- ➡ **sleeping**
- ➡ **dying**

- **The person**

The patient is seen as an individual, moving from dependence to independence throughout his lifespan, according to his age, circumstances and environment. In this study the person is the neonate in the intensive care unit.

- Lifespan

Life begins at conception and ends at death. A person's position on the lifespan influences his/her capacity to act independently. The lifespan of the neonate has just begun and therefore the neonate has no capacity to act independently.

- The dependence/independence continuum

This continuum is affected by factors which can be predictable or surprising. On the dependent end of the continuum an example can be neonates, because they are not mature enough to be self-sufficient in any activity of living. On the independent end, mature adults are self-sufficient in all activities of living, unless they are affected by illness or an unfamiliar environment.

Factors influencing activities of living can be divided into five components:

- physical
- physiological
- environmental
- politico-economic
- socio-cultural

These factors play an important role in the disease process of the neonate in the intensive care unit, eg. the neonate, born in a negatively affected politico-economic environment, will not have the finance to be treated in a private hospital.

- Individuality in living

According to this model, three types of activities namely preventing, comforting and seeking which are interrelated to each other, as well as the 12 activities of living, can be identified .

- Preventing activities:

These refer to activities that will prevent situations which will impair living, for example, illness and accidents. Examples of preventing activities are hygiene to prevent infection.

- Comforting activities

These are activities that will provide physical, psychological and social comfort, eg. feeding the neonate when it cries at feeding times.

- Seeking activities

These are activities engaged in , in order to gain knowledge, new experience and to relate to new problems. An example is when the neonate experiences a symptom or symptoms, the mother seeks health care, or the nurse in the NICU contacts the doctor.

Childhood, pregnancy and old age may call for nursing interventions related to particular activities of these stages of life which can only be accomplished with help from others. Five main sets of factors that can give rise to such needs, have been identified namely, disability and disturbed physiology, pathological and degenerative tissue change, accident, infection, and effects arising from a person's physical, psychological or social environment (Aggleton & Chalmers, 1986: 30).

According to Roper et al, nursing can be described as follows:

People carry out certain activities during a lifespan from conception to death. Attaining self-fulfilment and maximum independence in each activity of daily living, within the limitations of their circumstances can be described as their main objective. Many activities of a preventing, comforting and seeking nature are performed. By means of the above-mentioned activities the individual strives to be healthy and independent in the process of living (Pearson et al, 1996: 74).

- Health

Roper describes health as a dynamic process with many facets.

- Environment

The environment is described as anything external to a person. It is an essential component as well as an influencing factor which impinges upon all the activities of daily living.

b) Goals of nursing (Pearson et al, 1996: 72)

When the individual is unable to function independently in any of the activities, or family is unable to ensure that these activities are performed, nursing is needed.

The aim of nursing comprises

- * Acquiring, maintaining or restoration of maximum independence in the activities of living, or helping patients to cope with dependence on others.
- * Enabling the individual to carry out preventing activities to avoid illness.
- * Providing comforting strategies to promote recovery and independence.
- * Providing medically prescribed treatments to overcome illness, leading to recovery and independence.

The nurse must be informed with regard to the physiological, sociocultural, environmental, politico-economic and psychological aspects of the 12 activities of living, and it is imperative that he/she understands the following areas:

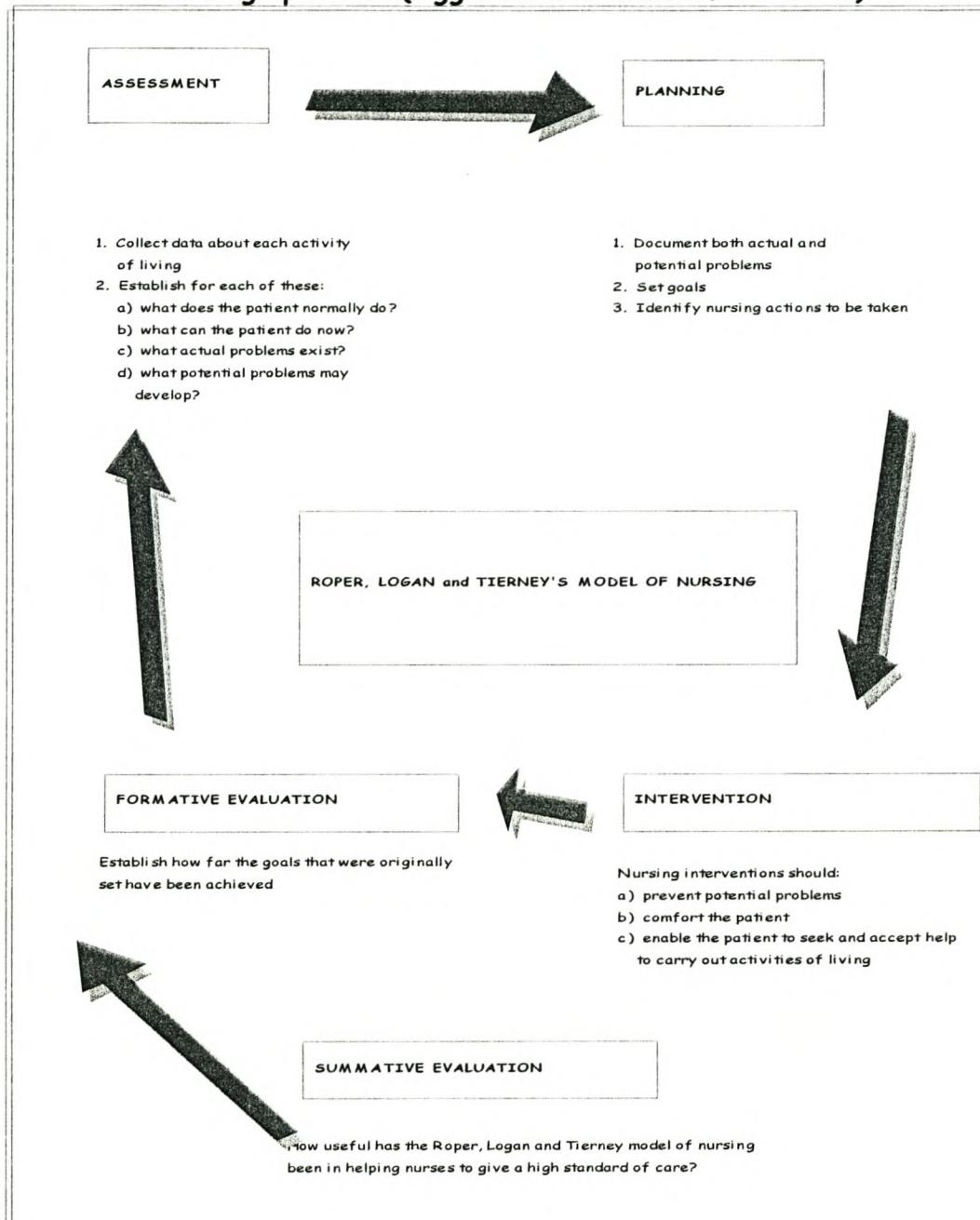
- human developmental progression along the lifespan
- appropriate skill and attitude to provide comfort

- education and the skill to carry out medical prescriptions to meet 'seeking' and preventing needs;
- carrying out the activities of living for those unable to do so.

c) Using the Activities of Living model in the nursing process

The Activities of Living model and the nursing process is demonstrated in fig. 2.3.

fig. 2.3 Roper, Logan and Tierney's Model of Nursing with the nursing process (Aggleton & Chalmers; 1986:23)



2.3.2.3 Central theoretical assumption

The identification of factors influencing an effective infection control process in a NICU will facilitate:

- an awareness about the implementation of quality infection control nursing and·
- the prevention of nosocomial infections in the neonate

2.3.2.4 Methodological assumptions

The researcher accepts the functional strategy of reasoning in nursing research. This implies that the ultimate goal of research in nursing is to facilitate quality improvement in neonatal nursing and in infection control nursing.

The case study design will be utilised within the methodological assumptions of this study.

2.3.3 Characteristics of the research field

Characteristics of the research field include:

- a neonatal intensive care unit in a state hospital
- registered nurses and other nursing staff
- acuity levels of neonates
- number of cots accommodated in the unit
- handwashing facilities available and the condition thereof
- infection control measures implemented and policy manuals available

2.3.4 Research context

The research will be done within the context of quality infection control in a NICU. To enable the researcher to identify factors for the implementation of an effective infection control process in a NICU, a study of universal literature on neonatal intensive care nursing and quality infection control has to be performed.

2.4 RESEARCH METHODOLOGY

The research strategy includes the methods for obtaining data, analysis and trustworthiness, as well as the target population (Botes, 1993). In this study, an exploratory and descriptive design with a qualitative method will

be implemented, with the case study design as the strategy for obtaining data and Coding will be utilised to analyse the data.

The research method will be described according to:

- the nature of the case study, that is definition, types, aim and rationale for utilising the case study design;
- the research strategy as exploratory, qualitative and phenomenological.

2.4.1 The nature of the case study

The nature of the case study design will be described with regard to the definition, types of case studies, the aim, steps in the case study design, advantages and disadvantages.

* Definition of the case study design

The case study design can be defined as an in-depth analysis of a single unit of study, for example a person, family, community, a hospital ward, a health care facility or a small number of subjects under intensive examination (Wilson, 1989: 136; Burns & Grove, 1997: 256-266). It is done under natural conditions and examines only a single subject or a small number of subjects with respect to a number of variables, for example history, characteristics, and interactions.

According to Burns & Grove (1997: 257), a well-designed case study can be a valuable source of descriptive information and can be used as evidence to support or oppose theories. By definition, case studies are both more flexible and vulnerable to bias, than many other designs (Wilson, 1989: 136). As the researcher is not acquainted with the nursing staff in the NICU which will be studied, bias is thus controlled. The case study method relates to the reader's experience and provides a basis for making generalisations. It is a very detailed descriptive analysis, and describes its subject in depth in its natural setting (Treece & Treece, 1982: 206). According to Naude & Muller (1996: 25) the interest and focus is more on the process than the outcome, and in the discovery of knowledge, rather than the confirmation thereof.

* Types of case studies

Case studies are classified according to single cases and multiple case of which both can be wholistic or embedded. Characteristics vary from a single unit of analysis with a global nature of the topic under study, or different subunits of analysis to multiple units of analysis with a global nature of the topic under study or different subunits of analysis to be identified and explored (Yin, 1989: 45). The types of case studies that have been identified are shown in Table 2.3:

Table 2.3 Different types of case studies (Yin, 1989: 45)

TYPES	CHARACTERISTICS
<ul style="list-style-type: none"> * single-case (wholistic) 	<ul style="list-style-type: none"> * single unit of analysis * global nature of topic under study
<ul style="list-style-type: none"> * single-case (embedded) 	<ul style="list-style-type: none"> * single unit of analysis * different subunit of analysis are identified and explored
<ul style="list-style-type: none"> * multiple-case (wholistic) 	<ul style="list-style-type: none"> * multiple units of analysis * global nature of topic under study
<ul style="list-style-type: none"> * multiple-case (embedded) 	<ul style="list-style-type: none"> * multiple units of analysis * different subunits of analysis are identified and explored

* **Aim of utilising the case study method**

Wilson (1989: 136) summarises the aim of the case study design as follows:

- "gaining insight into little-known problems,
- providing background data for planning of broader studies,
- developing explanations of social-psychological and social-structural processes, and
- offering rich, descriptive anecdotes or examples to illustrate generalised statistical findings."

The above are all applicable to the study.

According to Yin (1989: 25) there are four applications for case studies, namely:

- to explain the causal links in real-life interventions that are too complex for surveys;
- to describe the real-life context in which an intervention has occurred;
- to explore situations in which the intervention has no clear, single set of outcomes; and
- to evaluate a specific intervention.

In this study the aim of the case study is to gain insight into a problem area, namely the factors influencing the effective implementation of an infection control process in a NICU.

* **Steps in a case study design**

The different steps in the case study design are shown in table 2.4, and consist of the following six steps: determination of the aim to conduct a case study, identification of the unit of analysis, the determination of how data sources will be selected, the collection, analysis and interpretation of data. A description on the findings will be given in chapter four. Suggestions for further research will be done in chapter five, in the format of recommendations.

**Table 2.4 Steps in a case study design
(Wilson, 1989 : 136)**

STEPS	APPLICATION
Determine the aim of conducting a case study.	To identify factors influencing the effective implementation of an infection control process in a NICU.
Identify the unit of analysis.	A NICU in a government hospital
Determine how data sources will be selected.	Through literature, interviews and observation, utilising the structured interview in 1.7.3.
Collect, analyse and interpret data.	Chapters 3 & 4
Write a report of findings.	Chapter 4 - a full description on the findings will be given.
Make suggestions for further research based on these findings.	Chapter 5 - will include the recommendations.

* Advantages and disadvantages of the case study design

According to Treece & Treece (1982: 207), Wilson (1989: 136) and Burns & Grove (1997: 257), the case study has the following advantages and disadvantages as shown in table 2.5.

Table 2.5 Advantages and disadvantages of the case study design(Wilson, 1989: 136; Burns & Grove, 1997: 257; Treece & Treece, 1982: 207)

ADVANTAGES	DISADVANTAGES
* Researchers may begin and stop the case study at any time.	* The researcher must sometimes decide if it is only one or several factors to be studied in great depth.
* This method is very appropriate to nursing, due to the emphasis placed on patient care and relationship between the nurse and the patient.	* The researcher can become so close to the subject he studies, that he can misinterpret the depth and insight he has in his subjects behaviour.
* It allows the researcher to see individuals in their total network of relationships.	* It can be costly in both time and money in relation to the knowledge gained.
* As a result of the in-depth analysis of a given situation, the researcher is provided with a rich source of hypotheses and ideas.	* The researcher must be objective, indicating the particular bias of the observer.
	* There might be a conflict in the data obtained from different sources.

ADVANTAGES

- * The researcher has more freedom with regard to the amount of data to be collected, as well as the sources.
- * Stake stated the usefulness of testing hypotheses, especially those believed to be false.
- * It often provides information that is rich and difficult to obtain.
- * Appropriate for studying a process over time.
- * The case study design is synonymous with descriptive research.
- * A case study can test or build theory.

DISADVANTAGES

- * Because undesirable traits are frequently the reason for doing a case study, they receive the most emphasis.
- * The methods for compiling a case study are not as strictly prescribed as for other study designs.
- * Researchers have no guidelines to help them decide when the data is enough.
- * There is a possibility of researcher bias influencing the findings and conclusions.
- * The case study design is inadequate for testing causal hypotheses and definitely unsuited for trying to establish scientific cause and effect.

2.4.2 Sampling

The target population will be purposefully, as well as conveniently, selected.

- Target population

The target population will consist of a purposeful literature population sample, NICU's of which a convenience sample in a government hospital will be taken. The target population for the literature of this study includes quality infection control and neonatal intensive care.

- Purposeful sampling method

Purposeful sampling is described (Brink 1996: 141; Polit & Hungler, 1997: 237) as a sampling method based on the researcher's judgement regarding subjects/objects that are typical/representative of the phenomenon/topic under study or where the research is especially knowledgeable about the question at issue. An advantage of purposeful sampling is that it allows the researcher to hand-pick the sample, based on knowledge of the phenomena of study. A disadvantage of this sampling method is potential sampling bias. Similar to bias in the case study, bias will be excluded by the fact that the researcher will make use of convenience sampling and is not familiar with the staff working in the NICU.

- Convenience sampling

The researcher accompanies intensive care students at this specific government hospital. It is convenient to choose a NICU here, as it also accommodates more neonates with higher acuity levels at this hospital.

2.4.3.2. Data Gathering

According to Winter (1989) in Zuber-Skerrit (1996: 15), data gathering is a process of gathering information that will tell us more than we as practitioners, usually know. The strategy of gathering data for this study includes:

- Guidelines for the case study which will include the contents of the case study that will be based on the Activities of living model;
 - The three levels of Burger (1996: 32-35), that is macro, meso and micro levels, will be utilised in the study.
 - The structured interview will serve as a basis for gathering the data in the NICU.
- The interview

Fox (1976) defined an interview as:

"a technique in which the researcher poses a series of verbal questions for the respondents in a face-to-face situation." (Uys & Basson, 1995: 58)

An interview is an interaction of a complex nature, with certain basic principles that the interviewer must adhere to, namely:

- sensitivity to understanding,
- preparation for identification and handling of misleading answers, and
- improvement of the interview technique, by remaining responsible for the purpose of the interview (Uys & Basson, 1995: 59).

Uys & Basson (1995) described the purpose of the interview as obtaining information about the human being, which includes his opinions, attitudes, values and perceptions towards his environment. Only with enough information regarding these aspects, can we derive information to change human behaviour. There are two types of interviews, namely structured and unstructured interviews. The majority of interviews is a combination of a structured and unstructured interview (Brink, 1996: 150).

- Unstructured interview

The unstructured interview is mainly used in descriptive and qualitative studies (Burns & Grove, 1997: 353). This type of interview allows the interviewee a great deal of freedom. The researcher suggests the topic that information is required about, but no list of structured interview questions. The topic can be discussed without any pressure from the interviewer (Uys & Basson, 1995: 59). The interviewer can initiate the discussion through a broad question, and then only encourage the subject to continue talking, using techniques such as nodding the head (Burns & Grove, 1997: 354).

Wilson (1989: 386) states that listening in the unstructured interview is more crucial than the art of interviewing. Effective listening requires:

- coding what is said into something sensible for the interviewer
- interpreting the meaning of the subject's perspective

- responding to the subject to make it clear that they have been heard or understood.

Brammer (in Wilson, 1989: 386) developed specific strategies for effective listening:

- establishing eye contact
- clarifying and checking perceptions, by giving a summary
- use of clarifying questions.
- Designing interview questions

The development, wording and sequencing of the questions are similar to those of the questionnaire (Brink, 1996: 158). They vary from broad and general to narrow and specific (Burns & Grove, 1997: 354). There are several methods for question development, namely:

- * The researcher can develop them personally.
- * The researcher can talk to experts in the field.
- * The researcher can obtain an already prepared interview.
- * The researcher can make adaptions to the instrument used by other researchers.

Open-ended questions can be utilised during an interview. These questions are flexible, but it is difficult to categorize the answer (Treece & Treece, 1982: 250). The closed- question allows the subjects to select from the same responses, but the choices are limited and not always appropriate (Treece & Treece, 1982: 250). The types of questions are grouped according to the topic, starting with the 'safer' topics and progressing to those that are more sensitive. The educational level of the subjects will determine the wording of the questions (Burns & Grove, 1997: 354).

- Preparing for an interview

An appointment needs to be made if the interview is to be lengthy. The researcher must be neatly dressed. The environment must be quiet and pleasant and allow privacy for interaction (Burns & Grove, 1997: 355). The

interview should be planned for a time that is convenient for both the researcher and the subjects (Brink, 1996: 159).

By creating a friendly and pleasant atmosphere, rapport is established. Confidentiality must be assured, and the subject should be informed that there are no right and wrong answers (Treece & Treece, 1982: 250).

- Probing

The researcher will make use of probing if he/she needs to obtain more information. An example is to repeat the question. The probes should be neutral, to prevent bias (Burns & Grove, 1997: 355).

- Recording interview data

Recording can be done in the form of hand written notes or tape recordings, during or immediately after the interview. Recording needs to be done without distracting the subject. Tape recordings can only be made with the consent of the subject (Burns & Grove, 1997: 355).

- Advantages of the interview

- Data from each interview is usable. This may not be true about each questionnaire which is returned,

- An interview gets a better response, because the subjects get a chance to tell their stories to an empathetic person, rather than mailing them a impersonal questionnaire,

An interview allows room for clarification if you do not understand completely,

Interviews allow you to discover the unexpected, especially the unstructured interview,

Because interviewing is a flexible technique, the researcher can explore a greater depth of meaning,

The use of interpersonal skills will make co-operation easier and contribute to more information,

- Interviews allow collection of information from those unable to complete a questionnaire, eg. very ill people, or the blind,
- Because an interview is a form of self report, one can assume the data is fairly accurate,
- The context of the response can be controlled by the presence of the interviewer, and
- No items are overlooked during an interview.
- Disadvantages of the interview
 - Conducting interviews is very time-consuming,
 - Differences in question order may result in bias,
 - The cost is determined by the number and length of the interviews,
 - The subjects interviewed have little or no choice with regard to the time and place of the interview,
 - Due to costs and time, the sample size is limited,
 - The interview makes it difficult to make quantitative comparisons, unless the same interview schedules with the same questions and terminology are used,
 - If a large number of interviews are conducted, the interviewers must be trained, and
 - Tape recording of replies or making notes can lead to the subject feeling selfconscious.

- Observation

Brink (1996) defined observation as a technique for collecting descriptive data on behaviour, events and situations. The data is obtained by observing (looking, listening, smelling, touching and tasting), without any communication with the subject observed (Uys & Basson, 1995: 56). Several types of observation have been identified, namely direct, participatory, indirect, undisguised, disguised, scheduled, unscheduled, structured and unstructured observation. These different types of observation are summarized in table 2.6

Table 2.6 Types of observation (Uys & Basson, 1995: 56; Burns & Grove, 1997: 352; Brink, 1996: 151)

TYPES	DESCRIPTION
Direct	- researcher is in the same room as the subject being observed
Participant	- researcher is in the same room, participating in the activity being observed
Indirect	- researcher is in another room, observing through a one-way mirror
Undisguised	- subjects are aware that they are being observed
Disguised	- subjects are unaware of being observed
Scheduled	- observation takes place at predetermined time
Unscheduled	- the time for observation is not predetermined
Structured	- observation is carried out according to a predetermined scheme, eg. checklist
Unstructured	- observation is done without a predetermined scheme

- Guidelines for observation
 - Orientate yourself to what Schatzman & Strauss (1982) call "the various social, spacial and temporal maps of the setting." In a NICU you might take notes on the physical layout, routines and emergencies, pacing of work, division of labor, status relationships, treatment ideologies, ideals and values, and problems and concerns.
 - Take an extensive, but not intensive look at the situation. This step is useful in identifying informants, meeting and cultivating people, establishing your legitimacy, and planning your next step.
 - Sample people, places, events and the categories that are suggested by the initial mapping, and begin your analysis.
 - Decide on which locations are to be used for your observation. Schatzman & Strauss (1982) suggest that single, multiple and mobile positioning is used. Single positioning is staying in one place over a period of time, multiple positioning refers to moving around, and mobile positioning refers to following someone around (Wilson, 1989: 380).
- Advantages of observation
 - It is an important technique for studying human behaviour.
 - It is relatively inexpensive to use.
 - The research is not dependent on subjects who consent to answer.
 - Subjects are available.
 - This technique is open to the use of recording devices.
 - The instrument is simple to develop.
 - It allows the researcher to view the complete situation.
 - It can be begun or stopped at any time.
 - No other method of data-gathering can equal the depth and the variety of information collected through observation.

- Disadvantages of observation

- Inability to predict the time and duration of an event.
- Interviewing may provide more information from an economical point of view.
- The presence of the observer creates an artificial situation.
- There are ethical problems if consent is not obtained.
- Emotions, prejudices and values can influence the process of observation.
- If more than one observer is used, extensive training is necessary.
- Observers may lose their objectivity due to personal involvement.
- Some situations, eg counselling, are not open to observation (Treece & Treece, 1982: 272; Brink, 1996: 152).

- Coding

Wilson (1989: 418) described coding as "the process of conceptualizing the underlying patterns in a set of empirical indicators." It is a means of categorising by using a symbol or abbreviation to classify words or phrases (Burns & Grove, 1997: 533). There are three major types of coding, namely:

- open coding,
- selective coding, and
- theoretical coding (Strauss & Corbin, 1990: 58).

Open, or substantive codes are words that describe "what is going on." These terms are often used by the subjects themselves, and are used to describe:

- dimensions
- properties
- conditions
- strategies
- consequences (Wilson, 1989: 418).

During open coding, the data are broken down into parts, examined and compare for similarities and differences, and questions are asked about the information reflected in the data (Strauss & Corbin, 1990: 62).

Selective coding is the process of selecting the core category and systematically determining its relationship to other categories, and validating those relationships. There are several steps involved in accomplishing selective coding:

- step 1: involves the story line,
- step 2: consists of relative subcategories around the core category by means of the paradigm,
- step 3: relating categories at dimensional level,
- step 4: validating those relationships against data, and
- step 5: filling in categories that need some development (Strauss & Corbin, 1990: 118).

Theoretical coding is used to determine the relationship between the substantive codes. Glaser (1978) identified the following groups of theoretical codes namely, the six C's, process, degrees, dimensions, types, strategies, interactions, identity, cutting points, culture, consensus, mainline, ordering, and units. Examples of these groups are named in table 2.7 (Wilson, 1989: 420). Substantive coding will be utilised in the study. The following groups of theoretical codes, according to Wilson (1989: 420), will be used namely, the six C's, degrees, interactions, cutting points, culture, consensus and units.

Table 2.7 Groups of theoretical codes (Wilson, 1989:420)

TYPES	EXAMPLES
6 C's	causes, contexts, contingencies, consequenses, conditions covariances
process	stages, phases, passages, transitions, careers, orderings, sequenses, cycles
degrees	limits, ranges, intensity, amount, boundaries, rank, averages, grades, criteria
dimensions	elements, facets, properties, segments, aspects, sections
types	kinds, styles, classes, genres
strategies	tactics, mechanisms, techniques, plays, procedures
interactions	reciprocity, covariance, interdependency
identity/self	self-image, self-concept, self-worth, self-evaluation, self-realization
cutting points	boundaries, tolerance levels, breaking points
culture	norms, values, beliefs, rules
consensus	agreements, contracts, opinions, conformity
mainline	social control, recruitment, socialization, social mobility
ordering	temporal, conceptual
units	group, nation, organization, social world, society, family role status

Table 2.8 The framework for the case study, data sources and data-gathering

CONTENT	SOURCES	METHOD
MACROLEVEL		
1. External environment	ICU	Direct observation Semi-structured interview
<ul style="list-style-type: none"> - ICU: ~ type ~ size ~ lay-out 		
<ul style="list-style-type: none"> - physical structure: ~ condition ~ aesthetic ~ handwashing facilities 		
<ul style="list-style-type: none"> - equipment and stocks: ~ applicable ~ sufficient ~ pedal bins ~ rigid walled containers ~ waste containers ~ gloves ~ masks ~ eye protection ~ liquid soap ~ paper towels ~ handspray 		
<ul style="list-style-type: none"> - personnel: ~ qualifications ~ experience ~ knowledge : infection control ~ motivation ~ job satisfaction ~ number of staff 		
MESOLEVEL		
1. Philosophy	Documents	Document research
2. Values	Nursing staff	Literature research
	Literature	Semi structured interview
3. Legislation		
4. Infection control manual		

CONTENT	SOURCES	METHOD
MICROLEVEL		
1. The person: Neonate 2. Lifespan: age 3. Dependence/Independence continuum	Documents Nursing staff Literature	Document research Literature research Semi structured interview
neonate		
		
4. Activities of living		
		
<ul style="list-style-type: none"> - maintaining a safe environment - communication - breathing - eating and drinking - eliminating - personal cleansing and dressing - controlling body temperature - mobilising - playing - expressing sexuality - sleeping - dying 		

CONTENT	SOURCES	METHOD
<p>5. Factors influencing the Activities of living model</p> <ul style="list-style-type: none"> - physical - physiological - sociocultural - environmental - politico-economic 	Documents Direct ob-servation Nursing staff	Document re-search Direct obser-vation Semi- struc-tured inter-view
<p>6. Individuality of living</p> <ul style="list-style-type: none"> - preventing activities - comforting activities: physical psychological social - seeking activities: nursing help medical help 	Documents Direct ob-servation Nursing staff	Document re-search Direct obser-vation Semi- struc-tured inter-view

The above table (2.8) is the framework for the study. It identifies the content, sources and method to be implemented on the macro-, meso- and micro-levels.

2.4.4 Data analysis

Data analysis will take place simultaneously with data gathering. Data sources in a case study should be as extensive as possible within certain limits. Except for the subject, other persons can provide data through interviews, verbatim reports and various records. The amount of data required depends on the purpose of the study. Data from a single case are reported descriptively (Treece & Treece, 1982: 209).

In a qualitative study the researcher needs to use methods of data collection and analysis that may be unique to qualitative research. The researcher simultaneously gathers the data and interprets the meaning of the data (Burns & Grove, 1997: 527).

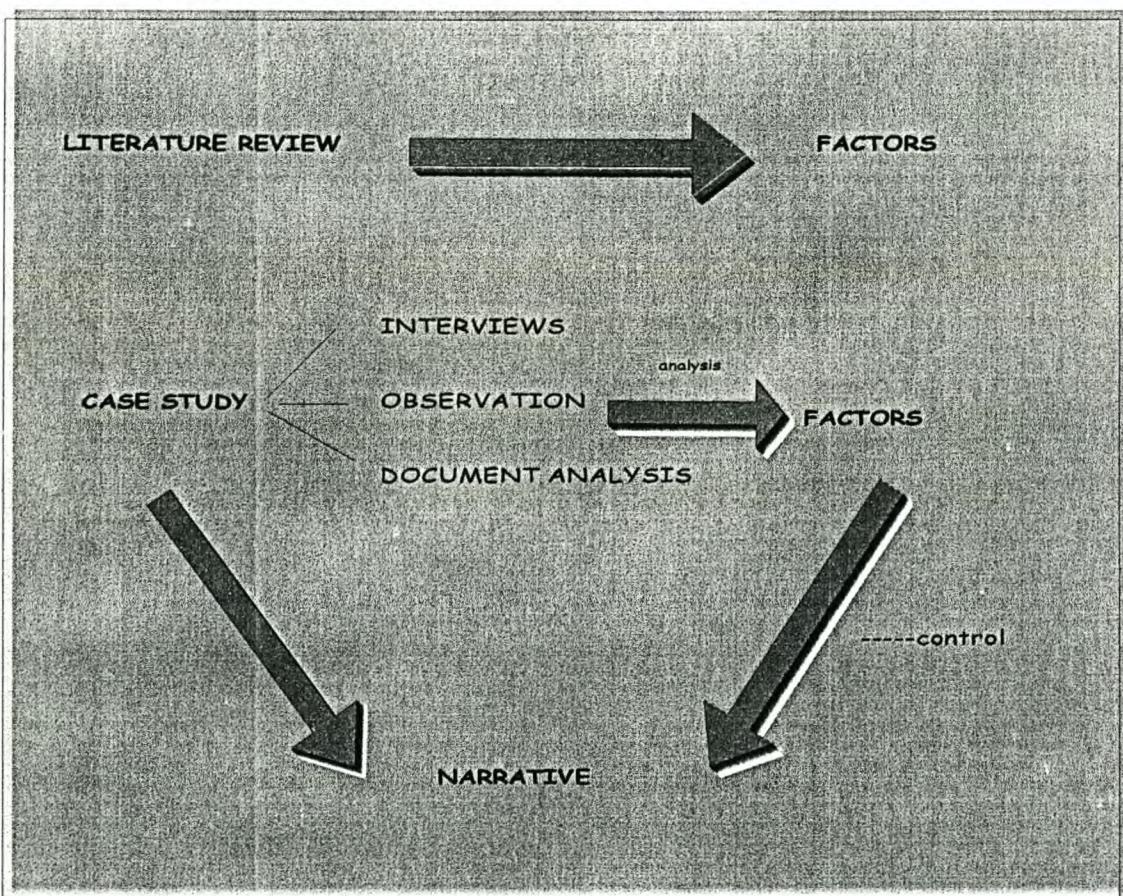
Wilson (1989: 396) defined analysis as "the separation of data into parts for the purpose of answering a research question and communicating that answer to others."

By using analytical thinking, researchers create order in a large body of data to answer a study's questions and avoiding overwhelming detail (Wilson, 1989: 397).

The goal of data-analysis in this study is to identify factors influencing the effective implementation of an infection control process in a neonatal intensive care unit. Factors will be identified from the data obtained from the case study, as well as the literature research. The data will be presented in chapter three as a narrative. Figure 2.4 gives a graphic presentation of the process of data analysis.

Fig. 2.4 Graphic presentation of the process of data-analysis

(Burger, 1996: 54)



The identified factors will be organised and categorised. The process is separate, but similar for the literature research and the case study. The end result is a list of factors influencing the effective implementation of an infection control process in a NICU.

The narrative will be written to present the data of the case study in a orderly, sensible manner. The narrative is checked with the raw data to ensure accuracy.

2.4.5 Trustworthiness

Trustworthiness will be implemented according to Guba's (1981) model and literature on the subject according to infection control and staffing needs. The internal validity is within the context of infection control and neonatal intensive care nursing. The external validity will be done by experts in neonatal nursing and infection control nursing.

Guba's (1981) model for trustworthiness is based on the identification of four aspects of trustworthiness, namely:

- * *truth value* (credibility) is based on the discovery of human experiences as it is experienced and observed by the informants;
- * *applicability* (transferability) describes the extent to which contexts and set-ups with other groups are related;
- * *consistency* (dependability) of data explains that with recurrence of the same subjects, the findings would stay the same, and
- * *neutrality* (conformability) in trustworthiness is the clearance of prejudice in the research procedure and research results.

Table 2.9 gives a summary of the strategies to be implemented to ensure trustworthiness in this study.

Table 2.9 Summary of strategies to ensure Trustworthiness and techniques in Qualitative Research

STRATEGY	CRITERIA	IMPLEMENTATION
CREDIBILITY	<ul style="list-style-type: none"> - practical experience - triangulation - interview technique coding - sufficient referrals 	<ul style="list-style-type: none"> - experience of researcher - literature study - semi-structured - literature study
TRANSFERABILITY	Complete description	<ul style="list-style-type: none"> - Thorough description of the conduct of the case study strategy.
DEPENDABILITY	<ul style="list-style-type: none"> - Complete description - Triangulation 	<ul style="list-style-type: none"> -Thorough description of the conduct of the case study strategy. - Literature study
CONFORMABILITY	<ul style="list-style-type: none"> - Evaluation - Triangulation 	<ul style="list-style-type: none"> narrative - literature study

2.4.6 Strategies of reasoning

Strategies of reasoning to be used in the study are analysis, deduction, derivation and synthesis.

- **Analysis**

Walker & Avant (1988: 35) described analysis as especially useful to clarify, refine or sharpen concepts and statements. Two types of analyses are identified. Concept analysis is a strategy for examining the attributes or characteristics of a concept, whereas statement analysis is a process of examining the relational statements to determine in what form they are presented and what relationship the concepts within those statements have to one another. The narrative will be utilised to identify factors which will have an influence on the infection control process.

- **Deduction**

Deductive reasoning is described by Abdellah & Levine (1979) as the process of developing specific predictions from general principles of deriving logical answers or conclusion from reliable premises. Deductions will be made from the literature study and the narrative to identify factors influencing the implementation of an effective infection control process.

- **Synthesis**

In synthesis, isolated pieces of information are combined and used to construct a new concept, or a new statement. Concept synthesis is a strategy for developing concepts based on observation of other forms of empirical evidence. Statement synthesis is a strategy that is aimed at specifying relationships between two/more concepts based on evidence (Abdellah & Levine, 1979). According to the narrative, relationships between the incidence of infections and the identified factors will be described.

Table 2.10 summarises the above strategies of reasoning.

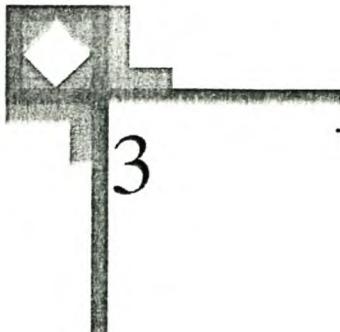
Table 2.10 Summary of strategies of reasoning

STRATEGIES OF REASONING	CHARACTERISTICS
* Analysis: <ul style="list-style-type: none"> - concept analysis - statement analysis 	<ul style="list-style-type: none"> * Examining the attributes/ characteristics of a concept * Examining the relational statements: determine in what form they are presented
* Deduction	* A priori acceptance of truth
* Synthesis <ul style="list-style-type: none"> - concept synthesis - statement synthesis 	<ul style="list-style-type: none"> * Develop concepts based on empirical evidence * Specify relationships between two/more concepts- based on evidence

2.5 SUMMARY

The research design and the utilisation of the case study method have been described in Chapter Two. The researcher supports the theoretical assumptions of the Activities of Living models for Nursing of Roper et al. (Pearson et al, 1996: 72), and the assumptions are according to the person, lifespan, the dependence/independence continuum, the activities of living, health and environment, and will include this as part of Botes' (1989) research model. The aim of the case study is to gain a fuller understanding

of a situation and to improve the quality of a social situation. In Chapter Three the researcher will provide the narrative. The literature study within the context of infection control nursing and neonatal intensive care nursing will be dealt with in Chapter Four.



THE NARRATIVE

3.1 INTRODUCTION

In this chapter, the case study will be discussed as part of the data-gathering process to identify factors influencing the effective implementation of an infection control process in a NICU. The information gathered will be described in the form of a narrative.

Three levels of assessment have been identified, namely, macro-, meso and micro levels. These three levels have been investigated by means of direct observation and a semi-structured interview.

3.2 THE NARRATIVE

The narrative will be described according to the macro-, meso-and micro levels. The case study was done in a NICU in a government hospital in Cape Town. The NICU is situated on one of the top floors of the hospital. It is seven floors higher than the labour ward, which is situated on the second floor.

On arrival, the researcher had to ring a bell at the door, one of three security doors allowing entry to the unit. After the second ring, the researcher heard a voice over the intercom, asking for the reason for her presence. After an explanation, the door was opened. There was no way past this solid door without the security code, which only the nursing personnel and the doctors of the unit knew. These security doors were installed a few months ago, as the area had become a thoroughfare for a continuous stream of visitors, patients, and personnel which increased the risk of exposure to infection. These three doors are viewed from another room in the unit. Some of the nurses found it very inconvenient to answer

they have to put everything down to open the door. In the unit there is a camera, which allows one to see exactly who is at the door, before opening it.

The researcher walked down a long passage to go and report at the nursing supervisor's office. She was sent to report to a registered nurse in one of the NICU rooms. The whole floor consisted of a unit caring for the 'healthier' children with tracheostomies, two rooms that serve as the NICU, and a large room that serves as the paediatric ICU.

As the researcher entered the first room, only one auxiliary nurse and three young doctors were present with five neonates, in open incubators on ventilators. This friendly nurse started to orientate the researcher with regard to the physical layout of the unit, as the registered nurse and the other auxiliary nurse were on a teabreak.

3.2.1 Macro level

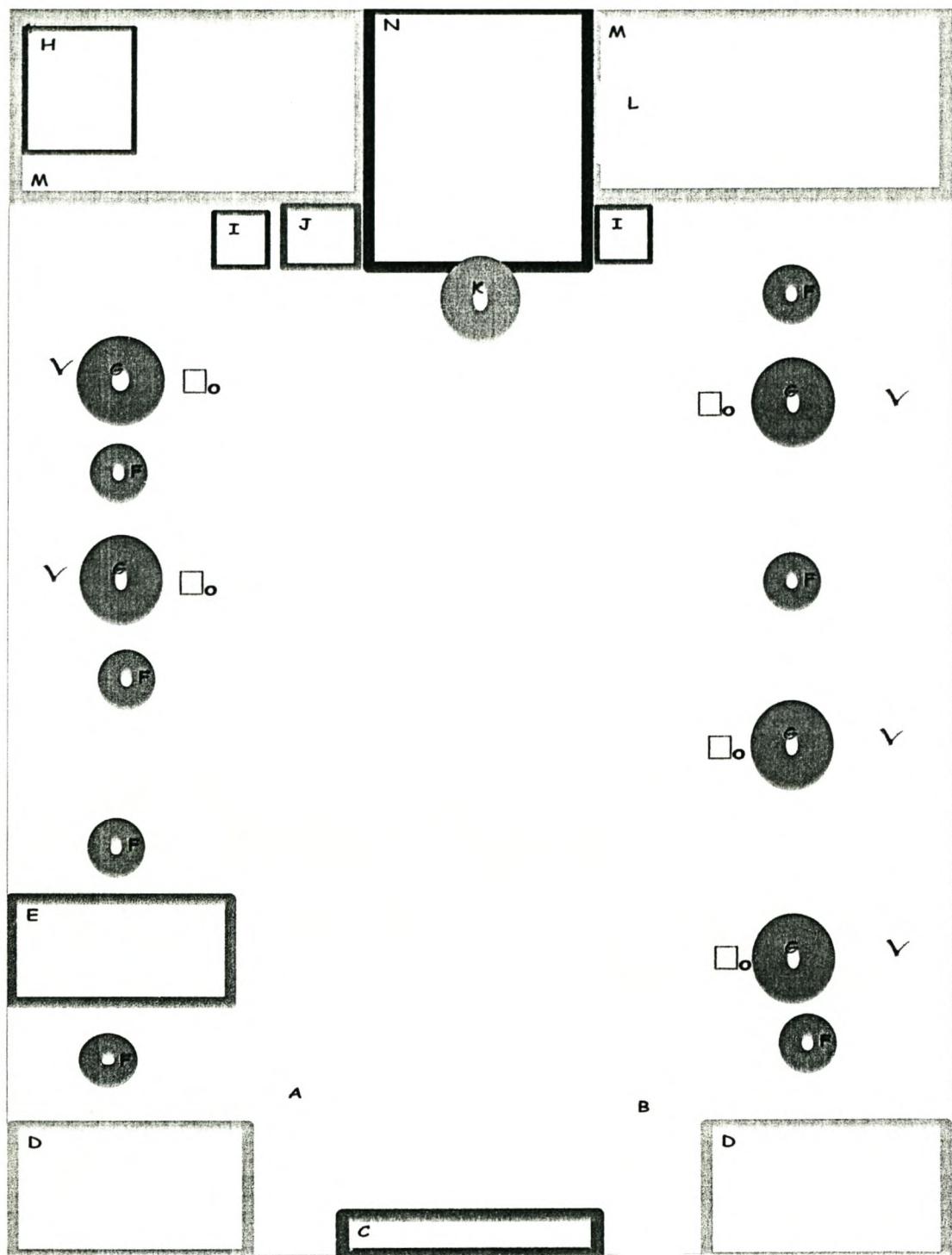
The macro level describes the external environment, which includes the physical layout of the NICU, the equipment and stocks, and the qualifications and knowledge of the nursing personnel.

- **Physical layout**

The NICU consists of two rooms which are identical. Both rooms are equipped for five neonates each, but can accommodate six neonates if the need should arise. The only problem then will be that the rooms are too crowded, allowing no space for the desk and two chairs. As one enters the room, there is a desk with two chairs on the left. Next to the desk, on the left, are two open incubators housing neonates on ventilators. On both sides of the door are cupboards for the storage of linen and nappies. On the left of the door, next to the cupboard, there is a space for the dressing trolley. Behind the door, next to the cupboard, is the emergency trolley. Next to the cupboard on the right are three neonates in open incubators, on ventilators. Next to the windows are two working surfaces, where the stock and refrigerator are kept. Between these two working surfaces is a sink next to which is a waste tech box and a grey pedal bin to the left, and a second grey pedal bin to the right of the sink. Between each incubator is a

second grey pedal bin to the right of the sink. Between each incubator is a chair for the mother to sit on while visiting, and at the foot of the incubator is a locker where the flowcharts and files are kept. On the walls are friendly nursery pictures of cartoon characters, creating a warm, baby-friendly atmosphere. Fig 3.1 demonstrates the physical layout of the NICU.

Fig 3.1 Physical layout of the NICU



KEY TO PHYSICAL LAYOUT

A = DRESSING TROLLEY

B = EMERGENCY TROLLEY

C = DOOR

D = CUBOARDS

E = TABLE

F = CHAIR

G = OPEN INCUBATORS

H = REFRIGERATOR

I = PEDAL BIN

J = WASTE-TECH BOX

K = WASHBASIN

L = KIMDRI CONTAINER

M = WORK SURFACE

N = WALL

O = LOCKER

V = VENTILATOR

- **Physical structure**

One's first impression of the unit was that it was well organised and clean. However, a closer look revealed some long-standing dirt. An example was the suction bottles that were grey and discoloured, due to age, but more likely because of dirt. The walls also revealed streaks of something that had splashed against it. In the mornings, a general assistant spent some time mopping the floor. According to the nurses, they are responsible for daily dusting in the unit.

The handwashing facilities consist of one sink per room. It is possible to operate the tap with one's elbow, and the nozzle is not directly above the outlet. The tap could not close properly, with the result that there was a constant dripping, or sometimes a flow of water. There was a bottle of Hibiscrub soap that rested on the tap, because there was no mount against the wall for its placement. On the right side of the wall was a container with a sufficient amount of kimdri papertowels. Next to the sink, to the right, was a waste-tech container with its lid closed, and next to it a grey, pedal-operated bin for non-infected wastes. Unfortunately, the pedal to open the lid did not work . On the left was another pedal-operated bin, which was in working condition. Next to the sink were several highlighted notices referring to

- the handwashing facilities
- prevention of the spread of dangerous infections among neonates, by washing and spraying of hands between handling of neonates, and through the use of non-sterile latex gloves at each nappy change.

There was also a notice in four different languages with regard to the use of unsterile gloves when changing nappies. Most of the time no gloves were worn for the changing of nappies. The doctors did not even use gloves when drawing blood.

On the left of the room, on the working surface, was the refrigerator containing medication as well as blood specimens. The surface on the inside was not too clean, and seemed slightly disorganised, as the medication and blood were mixed and not separated. There were premixed antibiotics,

insulin and pavulon present. The medication was issued according to the prescriptions by the pharmacist on the same floor. On the door of the refrigerator, a notice indicated the stability of premixed antibiotics.

- **Equipment and stocks**

All stocks in the unit were applicable to the nursing of neonates in ICU. The amount present in the unit appeared to be sufficient, although this was not always so, according to some of the nurses. On the working surface, to the right of the sink, were containers with the following stocks:

- inhalation fluids
- cottonwool balls
- gauze
- webcols
- intravenous catheters
- plaster
- needles
- syringes
- unisolves
- three-way stopcocks
- heplocks
- t-connections
- bloodpressure cuffs
- haemoglucose machine
- blood specimen tubes
- intravenous fluids
- restraints
- splints

There were two pedal bins in each unit. One pedal bin in the one unit was broken and could not be operated by the pedal. There was one waste-tech container per unit. It was situated next to the handwashing facility, with the top closed. There was a bottle of hibiscrub soap in each unit, but no rigid wall container for the soap. In each unit, there were two boxes of unsterile latex gloves available. Plenty of masks were present on the dressing trolley, but these were without visors. Each unit had a container with kimdri papertowels for drying of hands, close to the sink. On each

locker, at the incubators, was a spray bottle containing hibitaine and 70% alcohol, for the spraying of hands before and after handling of the neonates. All these bottles did not work properly, and had to be opened to pour the hibitaine and alcohol mixture instead of spraying it.

- **Personnel**

Every month, the nursing supervisor gets issued with a change list with all the names of personnel allocated to the unit for the next month. These include the old personnel as well as those that circulate. New personnel must circulate through the whole module before permanent placing. Using these personnel, the matron must cover the paediatric ICU, the two rooms of the NICU, and the tracheostomy unit with sufficient personnel to render a safe and holistic service. The personnel allocated for this particular month were as follows:

- Registered nurses	:	25
trained (neonatal and paediatric nursing)	:	15
untrained	:	10
- Enrolled nurses	:	14
- Enrolled nursing auxiliaries	:	41

The trained, registered nurses had completed the course offered at a children's hospital. With this personnel, the matron had to cover day duty, night duty, annual leave and maternity leave. The result is that each room of the NICU is covered by one registered nurse and two enrolled auxiliary nurses, and occasionally an enrolled nurse.

The staff's knowledge with regard to infection control appears to be very limited. According to the nursing supervisor, there is no in-service programme in her unit with regard to infection control. Their only exposure to infection control is when they attend the meetings conducted by a doctor, a paediatrician training in infectious diseases, or when the infection control sisters do rounds in the unit and do on-the-spot training. There are

only two registered nurses that do the infection control in a level three hospital, and do not get to these units every month. In the unit they have a video programme on handwashing that they watch occasionally as their contribution to infection control.

It appeared that the motivation of the staff was not very high. The researcher experienced her reception in the unit as unfriendly. The registered nurse made no effort to make her feel at home and orientated her towards what they do for their patients. There was no eagerness to discuss their work, rather annoyance at the intrusion. The shortage of staff could be contributing to this lack of motivation, because these nurses have to render care with minimal staff.

It further appeared that there were some elements of job satisfaction, because all members of staff showed their love for these neonates. None of the personnel would have stayed in the unit, if they did not experience some form of satisfaction. These nurses do a lot for the mothers of the neonates, who are mostly very needy persons. They collect second-hand baby clothing for the babies. For the young mothers, most of whom come from the rural areas, they even put together a hamper containing the basic requirements for these babies after discharge, for example, a babygrow and powder. The parents are also allowed to visit anytime during the day or night. They allow them to feed their babies, even if they are on nasogastric feeds. The death of one of these neonates can be so traumatic and demotivating to the staff, that they need debriefing, which is rendered by a clinical psychologist from time to time.

3.2.2 Mesolevel

The meso level describes the philosophy, values, legislation and infection control manual of this NICU.

- **Philosophy**

None of the nurses or sisters knew about the philosophy of the unit. Some did not even know what a philosophy is. The nursing supervisor was able to direct the researcher to a board in the passage where she suspected that

researcher could find the philosophy. On this board there was only a form listing some goals. These are summarised as follows:

- * render quality care to critically ill children,
- * create an atmosphere for learning situations,
- * give support to the service,
- * promote healthy interpersonal relationships,
- * give good orientation in order to allow all personnel to know their responsibility.

The personnel of the unit probably did not participate in the formulation of these goals, as they had no idea where to find the philosophy, and only the nursing supervisor could direct me in some way.

The legislation file was locked away with all the rest of the files. It appeared that it was fairly difficult to get hold of these files. None of these files were kept in the unit for reference purposes, so they were not readily available to be used as references. Some of the personnel were not too sure what was being referred to when asked for the legislation file.

The infection control manual was also locked away with the rest of the files. The content of the infection control file consisted of:

- Guidelines for:
 - * blood precautions
 - * respiratory precautions
 - * wound and skin precautions
 - * gastro-enterology precautions
 - * protective and reversed isolation
- Aids protocol
- Antiseptic/disinfection policy
- Reporting of sharp instrument injuries
- Prophylaxis for meningococcal meningitis

- Treatment for head/pubic lice
- Protocol for contaminated and lice contaminated private clothes.

Very few, if any of these protocols were specific to this unit. There were no articles or information with regard to the specific infections in this unit. No information was identified with regard to the prevention of these infections.

- **3.2.3 Microlevel**

The micro level includes all the information with regard to the neonates. The NICU consists of two rooms, number one and number two. There were five neonates in number one and five neonates in room two.

In room one:

- * NEONATE NO 1 transferred from labour ward
 - Age: 41 weeks gestation
 - Weight: 3578 gram
 - Diagnosis: Meconium aspiration
Pneumonitis
 - Micro-organisms: None were cultured
 - Medical treatment: Penicillin &
Gentamycin intravenously
Full mechanical ventilation
 - Nursing treatment: Baby is nursed in open incubator.
Nasogastric feeds from expressed breast milk.
- * NEONATE NO 2 transferred from labour ward
 - Age: 30 weeks premature

- Weight: Not available
- Diagnosis: Post patent ductus arteriosus ligation
Post extubation stridor
Candida sepsis
Necrotic foot due to extravasation after intravenous infusion insertion
- Micro-organisms: *Gram positive coccii*
Candida albicans both cultured from blood
- Medical treatment: Vancomycin
Imipenem
Amphotericin B
Flucanasol
Full mechanical ventilation
Total parenteral nutrition (TPN)
- Antibiotic resistance pattern Not to be found in file
- Nursing treatment: Nurse neonate in an open incubator.

* NEONATE NO 3 Transferred from labour ward

- Age: 30 weeks premature
- Weight: None available
- Diagnosis: Hyaline membrane disease grade III
Broncho-pulmonary dysplasia
Hydrocephalus
Necrotic left hand from arterial line
- Micro-organisms: None cultured
- Medical treatment: No antibiotics
Mechanical ventilation

- Nursing treatment: Nursed in open incubator
Nasogastric feeds
 - * NEONATE NO 4 transferred from labour ward.
 - Age: 25 weeks premature
 - Weight: 874gram
 - Diagnosis: Apnea due to prematurity
 - Micro-organisms: None cultured yet
 - Medical treatment: Tienam
Vancomycin
Mechanical ventilation
 - Nursing: Nursed in an open incubator
Nasogastric feeds
 - * NEONATE NO 5 transferred from labour ward.
 - Age: 30 weeks premature
 - Weight: 1165 gram
 - Diagnosis: Enlarged heart
Respiratory distress
Possible congenital sepsis
 - Micro-organisms: None yet cultured
 - Medical treatment: Amikacin
Amphotericin B
Vancomycin
Mechanical ventilation

- Nursing treatment: Nursed in open incubator
Total parenteral nutrition

In room two:

- * NEONATE NO 1 transferred from labour ward
 - Age: 31 weeks premature
 - Weight: Not available
 - Diagnosis: Patent ductus arteriosus ligation
(procedure done in unit)
Hyaline membrane disease grade II
Subglottic oedema with stridor
 - Micro-organisms: None cultured
 - Medical treatment: No antibiotics
Mechanical ventilation
 - Nursing treatment: Nursed in an open incubator
Nasogastric feeds
-
- * NEONATE NO 2 Transferred from a private hospital
 - Age: 32 weeks premature
 - Weight: 1002 gram
 - Diagnosis: Pneumonia
Respiratory failure with broncho pulmonary dysplasia
 - Micro-organisms: From tracheal aspirate: *enterobacter aeruginosa*
 - Medical treatment: Amoxicillin and Bactrim,then

Klacid and Claforan
Mechanical ventilation

- Nursing treatment:
 - Nursed in an open incubator
 - Nasogastric feeds

* NEONATE NO 3 Transferred from labour ward

- Age: 29 weeks premature
- Weight: Not available
- Diagnosis:
 - Hyaline membrane disease grade III
 - Asphyxia
 - Convulsions
- Micro-organisms:
 - None cultured from the tracheal aspirate and blood cultures.
 - CRP negative
- Medical treatment:
 - Penicillin
 - Amikacin
 - Imipenem
 - Vancomycin
 - Mechanical ventilation
 - Total parenteral nutrition
- Nursing: Nursed in an open incubator

* NEONATE NO 4 Transferred from labour ward

- Age: 28 weeks premature
- Weight: 824 gram
- Diagnosis: Hyaline membrane disease
- Micro-organisms: None cultured

- Medical treatment: Penicillin
Mechanical ventilation
Phototherapy
- Nursing: Nursed in an open incubator
Nasogastric feeds
- * NEONATE NO 5 Transferred from labour ward.
- Age: 34 weeks premature
- Weight: 1590 gram
- Diagnosis: Fulminant Necrotic bowel syndrome with perforation, and colostomy
Septicaemia with DIC
- Micro-organisms: *E coli* cultured from blood
- Medical treatment: Zinacef
Gentamycin
Claforan
- Nursing treatment: Nursed in an open incubator
Total parenteral nutrition

All the above neonates who are being ventilated are susceptible to ventilator associated pneumonia and the other neonates are susceptible to other nosocomial infections for example neonate number one (room two) with subglottic oedema with stridor. Neonate number two in room one has also presented with post extubation stridor. Other factors contributing to nosocomial infections were, surgery, length of stay in the unit (the neonates were all in the unit for longer than 48 hours) nasogastric feeds, total parenteral nutrition, fulminant necrotic bowel syndrome with perforation and a colostomy. It was difficult to identify nosocomial infections in this unit as the researcher spent only one day in the unit and some of the laboratory

reports were not available in the neonates files. Table 3.1 gives a summary of the neonates in the NICU.

Table 3.1 Summary of patients in the NICU

	MECHANICAL VENTILATION	NASOGASTRIC FEEDS	TPN	MICROORGANISMS CULTURED	ANTIBIOTICS
NEONATE NO 1	✓	✓			✓
NEONATE NO 2	✓		✓	✓	✓
NEONATE NO 3	✓	✓			
NEONATE NO 4	✓	✓			✓
NEONATE NO 5	✓		✓		✓
NEONATE NO 6	✓	✓		✓	✓
NEONATE NO 7	✓		✓		✓
NEONATE NO 8	✓	✓			✓
NEONATE NO 9	✓		✓		✓
NEONATE NO 10	✓	✓		✓	✓

- **Statistics**

The statistics of infections in the NICU from the beginning of January 1999 until 31 October 1999 are summarised in table 3.2. *Klebsiella* and *staphylococcus* seemed to be the biggest problem nosocomial infections in this unit.

Table 3.2 Statistics of infections in the NICU

<i>Staphylococcus aureus</i>	4%
<i>Coagulase negative Staphylococcus</i>	13%
<i>Serratia marcescens</i>	10%
<i>Candida albicans</i>	10%
<i>Acinetobacter baumanii</i>	6%
<i>Escherichia coli</i>	6%
<i>Klebsiella</i>	17%
<i>Pseudomonas aeruginosa</i>	3%
<i>Streptococci</i>	1 %
<i>ESKP</i>	11 %
<i>MRSA</i>	5%
<i>Enterobacter cloaceae</i>	5%
<i>Enterococcus faecalis</i>	3%
<i>Staphylococcus epidermidis</i>	1 %

- The following became apparent through direct observation:
 - The door of room one and two were open most of the time, and any of the personnel from the other units on the floor could enter freely. Nurses from the other units came to enquire about the neonates' progress.

- Any of the nurses could enter at any time, touching the babies without washing their hands. This included the supervisors.
- The auxiliary nurse demonstrated endotracheal suctioning without washing her hands or wearing an apron or mask.
- A doctor was busy putting up a new intravenous infusion for a baby. The old infusion set and intravenous cannula were still connected, lying on the linen of the incubator. He intended to use the same infusion set, even though it was not kept sterile.
- All three-way taps were cleaned and covered daily with gauze soaked in betadine solution and covered with plaster in order to keep these connections clean.
- The sluice room was situated in the passage, and one had to leave the unit, in order to discard any wastes.
- All total parenteral nutrition sets were changed on a daily basis. A trolley with sterile towels was set, but no masks or gloves were used.
- The registered nurse changing the TPN, blew her nose. She continued her work, touching the babies, without washing her hands.
- The intravenous infusions were not placed on sterile towels.
- Disposable bloodpressure cuffs were used more than once, and were cleaned with hibidol soap.
- The babies on nasogastric feeds usually get expressed breast milk. Before feeding, all the bottles were warmed in one container .
- According to the nurses, it is their responsibility to dust the units, although it did not appear to be done on a daily basis.
- The supervisor could not give me any information or statistics with regard to the most common infections in the NICU.

3.3 RISK FACTORS

The following positive and negative factors have been identified as being able to influence the implementation of an effective infection control process in a NICU. These factors can be categorised according to the macro-, meso- and micro level and are summarised in table 3.3.

Table 3.3 Factors identified to be able to influence the implementation of an effective infection control process in a NICU

MACRO LEVEL	
POSITIVE	NEGATIVE
<ul style="list-style-type: none"> - presence of pedal bins - presence of waste-tech container - care of three-way stopcocks - daily changing of TPN sets 	<ul style="list-style-type: none"> - cleanliness of the unit - the open door - no wall mount for the hibiscrub soap - only one refrigerator used for blood and medication - warming of bottles with expressed breast milk in one container - no masks with visors for suctioning - not all equipment, necessary for infection control is in working order - insufficient numbers of nursing personnel - inadequate knowledge of infection control - non-compliance with regard to handwashing and the wearing of gloves - lack of motivation
MESO LEVEL	
Positive	Negative
	<ul style="list-style-type: none"> - no philosophy or mission statement in the unit - the infection control file has no relevant information with regard to neonatal infections - the infection control file is not easily accessible

MICRO LEVEL	
Positive	Negative
<ul style="list-style-type: none"> - the babies' basic needs are seen to - the nurses love the babies dearly - the nurses do a lot for the needy mothers - they promote parental bonding 	<ul style="list-style-type: none"> - prematurity - low birth weight - antibiotic use

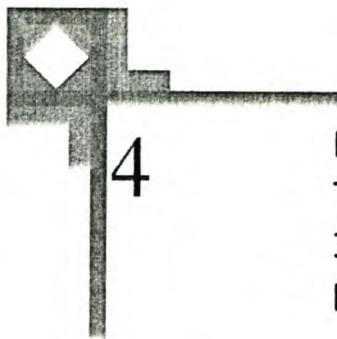
3.4 LIMITATIONS OF THE STUDY

The following are limitations to the study:

- The research was done only in one NICU, in one hospital.
- The researcher spent only one day in the NICU for data-gathering.

3.5 SUMMARY

The narrative of the case study has been described in this chapter. Direct observation and a semi-structured interview were used to gather information. The factors identified as influencing the implementation of an effective infection control process in a NICU, are classified according to the macro-, meso- and micro levels. In chapter four, the researcher will describe the literature study within the context of infection control nursing and neonatal intensive care nursing.



4

LITERATURE STUDY: FACTORS INFLUENCING THE IMPLEMENTATION OF AN EFFECTIVE INFECTION CONTROL PROCESS IN A NEONATAL INTENSIVE CARE UNIT

4.1 Introduction

Neonatal intensive care is a technological development of the ABC: airway, breathing and circulation. Its success will be measured against mastering this trinity and designing the best milieu interieur, which encourages healing and growth, without causing mental retardation and spasticity (Collier & Longmore & Harvey, 1992: 232). Intensive care medicine is that part of health care responsible for the management of patients that have sustained, or are at risk of sustaining an life-threatening disorder (Worthley, 1994: 923).

Part of the successful health management of neonates is the implementation of effective infection control measures in the NICU. In order to identify factors that influence the implementation of an effective infection control process in a NICU, a literature study, as part of the data-gathering process, will be done in this chapter. A variety of literature consisting of subject literature, journals, and dictionaries will be used. Data-gathering will be done on the three levels: macro, meso and micro as described in the framework for data-gathering in chapter two.

4.2 Historical Perspective

An intensive care unit (ICU) is a hospital ward that is specially staffed and equipped to manage patients with life-threatening diseases, injuries or complications. According to literature, the ICU developed from the post-operative recovery room or the poliomyelitis endemic in the early 1950s. The use of long-term artificial ventilation contributed to a reduction in mortality (Oh, 1990: 1). In South Africa, critical care had its origin in the late 1950s with the management of neonatal tetanus. Mortality was reduced significantly by the introduction of tetanus units at the Red Cross Children's

Hospital, the use of curare and intermittent positive pressure ventilation. The development of adult ICU's in major teaching hospitals followed (Hall, Schmidt & Wood, 1992: 2290).

Modern Intensive Care medicine, is a speciality that is not limited to postoperative care or mechanical ventilation, but which evolved from the experience of respiratory and cardiac care, physiological organ support and coronary care units which were established in the early 1960s (Oh, 1990: 1). The first heart transplant was done in S.A. in 1967, by Christian Barnard. The ICU's started with the development of specialised units which set the pattern for subsequent development in critical care (Hall, 1992: 2290).

In the 1970s research was done into pathophysiological processes, treatment regimens, outcome of critical illnesses and the founding of journals and training programmes (Oh, 1990: 1). Apartheid had been enforced in South Africa since 1948. Due to major changes, the "apartheid" system has been rapidly dismantled over the past few years. The first integration started in medicine, especially in the ICU's, and as early as 1972, medical staff were fully integrated (Oh, 1990: 1). Today, most ICU's are open to patients of all races, with Intensive Care as a separate speciality, which is no longer part of anaesthesia, chest medicine, general surgery, or any acute discipline (Oh, 1990: 1; Hall, 1992: 2290).

4.3 MACROLEVEL

4.3.1 External environment

An intensive care unit can be either a general unit with a medical or surgical bias, or a specialised unit which includes neonatal, burns, coronary care and cardiothoracic units. Depending on the staffing and support facilities of the hospital, these units can be classified into three levels, namely: level I in a small district hospital, level II in larger general hospitals and level III in a major tertiary referral hospital. Table 4.1 summarises the three-level classification of intensive care units, with specific characteristics. The NICU where the research was done, can be classified as a level three.

**Table 4.1 The three-level classification of intensive care units
(Worthy, 1994: 923; Oh, 1990: 1).**

LEVEL	CHARACTERISTICS
level I	<ul style="list-style-type: none"> * high dependency unit, rather than ICU * role in small district hospitals * unit allows for close nursing observation and ECG monitoring * only immediate resuscitation and short term ventilation * nurse to patient ratio is 1:3 * medical staff not at all times in unit
level II	<ul style="list-style-type: none"> * located in larger general hospitals * undertakes more prolonged ventilation * junior medical staff at all times in unit * access to physiotherapy, pathology and radiological facilities * more complex forms of life support, eg dialysis, invasive monitoring and investigations (CT scans) * has educational programmes, and may be involved in research
level III	<ul style="list-style-type: none"> * located in major tertiary referral hospital * a comprehensive intensive care unit with cardiothoracic and neurosurgical facilities * medical staff in the unit at all times * nurse to patient ratio is 1:1 * have a teaching and research obligation * support of complex investigations and imaging * specialists of all disciplines are available at all times

- Design of an ICU

The committee involved in designing an ICU should include the intensive care director, the charge nurse, and administrator, the chief architect, and engineer, as well as members of other disciplines, eg. emergency and radiological departments(Worthley, 1994: 924). The NICU should be located in a low-traffic area, with restricted access and no through traffic (Apic, 1996: 94-3 & Worthley, 1994: 924). Frequently used areas such as nursing stations and storage areas should be separated from patient care areas (Apic, 1996: 94-3). The ICU should be close to relevant acute areas, eg labour ward, operating theatres and casualty. It is very risky to move critically ill patients, therefore there should be sufficient numbers of spacious lifts available to accommodate easy passage of beds and equipment (Oh, 1990: 2). In a level III ICU, there should be two/three beds per 100 hospital beds, closely situated to a high-dependency area of a similar number of beds (Worthley, 1994: 924).

There must be a single entry and exit point and the through traffic of people or goods must never be allowed (Oh, 1990: 2).

- * Physical layout

According to Apic (1996: 94-4), the NICU should have 80-100 square feet for each patient station, accommodating the patient, staff and equipment without overcrowding (Oh, 1990: 2). The bed area must contain at least three oxygen outlets, two compressed air outlets and three to four suction outlets for gastric, tracheal and underwater drain suction. For a Level III ICU, 16 power outlets and a bedside light are optimal. These may be supplied by a floor or ceiling column, depending on individual preference (Worthley, 1994: 924 & Oh, 1990: 2). There should be adequate space for additional portable equipment, charts, syringes, sampling tubes, suction catheters, etc (Worthley, 1994: 924 & Oh, 1990:2). There should also be adequate distance between bedspaces to ensure privacy and minimise nosocomial infections (Miller, 1994: 2442).

Patient and staff areas must have large, clear, windows that allow natural light in thus decreasing stress levels (Oh 1990: 3). ICU staff practically live in the environment, therefore there should be space for reading,

meeting and showering if necessary (Miller, 1994: 2442). The nurse station is less important, because critical care nursing should be at the bedside (Oh, 1990: 3; Miller, 1994: 2442). It houses a central monitor, drugs cupboard, drugs/specimen fridges, telephones, computers, policy files and relevant manuals and patient records (Oh, 1990:3). Apic (1996: 94-4) suggests sufficient numbers of strategically placed handwashing sinks in a NICU. One sink per three to four patients should be sufficient, as long as the personnel do not have to move more than eight steps from any patient station to reach a sink. Each sink should be deep enough to prevent splashing and be equipped with an elbow-, foot- or knee- operated tap (Worthley, 1994: 924). It has been recommended that ventilation in the NICU provide positive-pressure airflow with at least 12 exchanges per hour. There should be at least one or more isolation rooms with negative air pressure vented to the outside in each NICU to accommodate newborns with airborne infections (APIC, 1996: 94-4).

- **Equipment**

The role and type of ICU will determine the quantity and level of equipment in the unit. A level III unit will obviously require more equipment than a level I or II unit (Oh, 1990: 3). Stetson & Swyer (1975) listed the following equipment required for a NICU:

- portable and fixed x-ray apparatus,
- monitoring for heart rate, ECG and blood pressure, respiration and temperature,
- ventilators: positive and negative pressure,
- equipment for constant positive and negative breathing,
- equipment to measure intravascular pressure,
- equipment to measure intracardiac pressure,
- autoclave,
- infusion pumps, catheters, and
- laboratory equipment for emergency service in biochemistry, bacteriology and microcoagulation technics.

Equipment, according to Oh (1990), required in a major ICU is listed in table 4.2.

Table 4.2 Equipment in a major ICU (Oh, 1990: 3)**EQUIPMENT IN A MAJOR ICU****MONITORING**

bedside and central monitors
12 lead ECG recorder
intravascular and intracranial pressure monitoring devices
cardiac output computer
pulse oximeters
pulmonary function monitoring devices
expired CO₂ analyzers
patient weighers
temperature monitors
blood glucose meters

RADIOLOGY

x-ray viewers
portable x-ray machine
image intensifier

RESPIRATORY THERAPY

ventilators
humidifiers
oxygen therapy devices and airway circuits
intubation trolley
manual self-inflating resuscitators
fibroscopic bronchoscope

CARDIOVASCULAR THERAPY

cardiopulmonary resuscitation trolleys
defibrillators
temporary transvenous pacemakers
infusion pumps and syringes

LABORATORY

blood gas analyser
electrolyte analyser
osmometer
haematocrit centrifuge
microscope

HARDWARE

dressing trolleys
drip stands
bed restraints
heating/cooling blankets
pressure distribution mattresses
sterilising equipment

Due to many advances over the past 30 years, the information obtained from medical devices is more accurate, consistent, and reliable. One should, however, not forget that these services are only tools and should be regarded accordingly. Blind acceptance of information, can be harmful or even fatal for your patient (Tordres & Fugate, 1996: 89). The goal of monitors is to act as a warning of approaching danger. Human senses cannot detect hypoxia or adequacy of ventilation with sensitivity or reliability to judge accurately the presence of cardiovascular or respiratory failure, therefore pulse oximetry, bloodgas analysis, plasma electrolyte measurements and expired carbon dioxide measurement are used as aids to the human senses. Monitor alarms should be audible to alert rather than irritate staff (Worthley, 1994: 925).

The nurses' responsibility is not only to care for the psychological and physiological needs of the patient, but also to regulate and monitor the equipment within the patient's environment, record the effects of the devices on the patient, recognise and report equipment malfunction, and often to do initial trouble shooting. There is little formal education for the nurses on the use of biochemical equipment. This lack of education can be due to:

- inadequate on-the-job instruction,
- inadequate in-service time for newly-introduced equipment,
- lack of input in the evaluation process for equipment purchases,
- proliferation of medical device companies with a short or poor track record for quality control,
- variable biomedical engineering support, and
- no systemic recall mechanism for defective devices (Kenner, Brueggemeyer & Gunderson, 1993: 987).

Equipment purchases are usually preceded by a systematic evaluation, but much equipment is introduced to a NICU with little or no evaluation. Supplies warranting a critical evaluation include:

- intravenous catheters
- stopcocks
- t-connections
- adhesives

- endotracheal tubes
- suction catheters
- feeding tubes
- chest tubes

Due to the large number of medical supply companies, quality control, technological back-up and clinical trials, may be inadequate and lack depth (Kenner et al, 1993:989).

The following measurements should be monitored continuously or intermittently to ensure a constant environment for the ill infant:

- heart rate and variability (continuously)
- respiration rate and pattern (continuously)
- temperature: skin temperature (continuously)
- blood gasses: arterial (intermittently, about 4 hourly)
- glucose strip test/blood glucose (intermittently, about 4 hourly)
- electrolytes and urea (intermittently, at least once daily)
- calcium and magnesium (intermittently, at least once daily)
- bilirubin (intermittently, at least 12 hourly for the first 5 days)
- packed cell volume (intermittently, at least daily)
- blood pressure (6 hourly)
- for babies having total parenteral nutrition:
 - * daily:
 - glucose strip test: 6 hourly
 - urine glucose: 6 hourly
 - haematocrit and examine supernatant for lipaemia
 - electrolytes and urea
 - * weekly or more frequently:
 - calcium, phosphate, magnesium
 - alkaline phosphatase
 - protein electrophoresis
 - transaminases
 - blood culture (Halliday et al, 1990: 67, 167).

4.3.2 Personnel requirements

According to Knaus et al (Tordres & Fugate, 1996: 698), the interaction and co-ordination of the nursing and medical personnel has a greater effect on outcome, than technological equipment or advanced treatments. The type and size of the hospital will determine the level of staff required (Oh, 1990: 4).

In order to deliver high-quality critical care to a patient, we need to bring together a variety of highly trained personnel, providing them with the necessary physical facilities, equipment and organisational structure, allowing them to operate effectively. There are many different ways of organisation and staffing, but it all depends on what works best for the hospital, depending on the individual needs of the hospital and its patients. The quality of the ICU is not determined by the age of the physical building, the level of technology used or the education of the staff, but rather the effectiveness of teamwork.

Ineffective management can lead to poor organisation, lack of essential supplies and facilities, poor planning of new programmes, and lack of staff motivation and satisfaction, therefore it is the responsibility of those who participate in the administration of ICU's to create an environment in which personnel can apply their expertise, compassion, and enthusiasm properly (Hall et al, 1992: 465).

The goal in an ICU is to improve the health of the patient. The effectiveness of the unit is evaluated in terms of quality and cost-effectiveness. Significant indicators of effectiveness of the unit are active and personal communication, co-operation, teamwork and organisational pride. All ICU personnel should be well-trained. Managers are also responsible for the co-ordination of the activities of all team members (Hall et al, 1992: 466).

- Medical personnel

The medical director is responsible for the co-ordination of care and the smooth running of the unit. He/she needs to have experience in ICU in order to understand the needs of the patient, family and staff. The director should be a skilled intensivist with a strong presence in the unit.

He/she, together with the nurse manager, is responsible for the co-ordination of activities. The director in collaboration with his/her colleagues is responsible for the establishment of well-defined protocols. These protocols should ensure smooth running of the unit, and if these are clear to all personnel, many problems can be eliminated (Tordres & Fugate, 1996: 696). The medical director, together with hospital administration, should determine the training and credentials required before physicians can be allowed to admit patients to ICU. He/she must also ensure that the physicians are adequately trained, and define policies for required medical education (Hall et al, 1992: 466).

Other medical personnel include the intensivists, the registrars and consultants. Intensivists should work closely together to provide some form of continuity. It is stressful for parents to deal with a life-threatening crisis affecting their child, they cannot therefore develop a relationship with the physician if they have to relate to multiple physicians.

Registrars are those doctors who are engaged in a formal training programme. Their responsibilities include clinical and research and the preparation for administrative duties.

To provide diagnostic and therapeutic care, multiple consultant teams are utilised. These teams work closely with the primary physician/nurse team. The primary intensivists must integrate the selective view of parts as the child/infant into a whole (Tordres & Fugate, 1996: 697).

- Support personnel

Major ICUs should have 24hr access to at least physiotherapists and radiographic services (Oh, 1990:4). There are numerous other services required, namely: other therapists, ward pharmacist, dieticians, social workers and laboratory services. Provision should be made for secretarial and transport staff. The local chaplains or priests are contacted if there is a need for their services (Oh, 1990: 4; Tordres & Fugate, 1996: 698).

- Nursing personnel

The level of staff is determined by the type of ICU. The majority of nurses in major ICUs should be experienced in critical care (Oh, 1990: 4).

The nurse manager or senior nurse has managerial, rather than bedside responsibilities. The organisation and management of the unit is most effective if the nurse manager has experience in the care of critically ill children and infants, is sensitive to technological advances at the bedside and ensures quality nursing care while providing psychological support to staff under stressful circumstances (Tordres & Fugate, 1996: 698). Nurse managers must be skilled in team building, individualised training and in the selection of team members. He/she is responsible for the operational management of the unit, which includes daily operation on all shifts and the co-ordination and collaboration with medical staff and other department managers. The nursing manager is responsible for the identification and solving of problems in clinical and managerial areas (Hall et al, 1992: 468).

The advanced practice nurse refers to the specialised nurse. She utilises a holistic approach and integrates education, research, management and teaching. The primary nurse is the caretaker at the bedside, working closely with the physician team. The nurse's findings are incorporated into the physician's management plans (Tordres & Fugate, 1996: 698). In table 4.3, the different staffs in a ICU are summarised:

Table 4.3 Staff of a major ICU (Oh, 1990: 4)

STAFF OF A MAJOR ICU

MEDICAL

director
staff specialist intensivists
junior doctors

NURSES

charge nurses
nurses
nurse educator

ALLIED HEALTH

physiotherapists
pharmacist
dietician
social worker
respiratory therapists

TECHNICIANS

SECRETARIAL

secretary
ward clerk

RADIOGRAPHERS

SUPPORT STAFF

orderlies
cleaners

- **Personnel requirements**

Stetson & Swyer (1975) state that in order to detect any deviation from biochemical and physiological homeostasis, there should be:

- one nurse for each infant,
- constantly available qualified medical staff,
- constant monitoring of vital signs,
- available biochemistry, and
- continuous available radiological services (Stetson & Swyer, 1975: 5).

It is always compulsory to have one trained nurse per infant, because when the ratio drops to one nurse for two or more infants, the risk increases for a serious incident, eg. extubation, cardiac arrest or apnea, to occur (Stetson & Swyer, 1975: 5).

Halliday et al (1989: 72) recommended five nurses for each ICU cot and 1.5 for each special care cot, although its rarely achieved in the United Kingdom. The nurse's goals are rather to:

- maintain a constant environment,
- non-invasive monitoring of the infant's condition with minimal handling,
- ready access to medical advice, and
- reassurance of patients (Halliday et al, 1989: 72).

According to APIC (1996: 94-4), the personnel should be sufficient with adequate time for hand washing between patients. In a NICU the ratio should be one nurse per one to two infants.

Several economic forces have driven administrators to staff hospitals in a cost-effective manner. According to the National Association of Neonatal Nurses (NANN) (Polin, Yoden & Burg, 1996) the delivery of safe and effective neonatal nursing care requires a sufficient number of qualified registered nurses. When the nursing coverage is less than required, there is a nursing shortage. In better units, it is an uncomfortable, but temporary condition. In units with poor management, the nursing shortage is prominent, and results in dramatically changing conditions, poor planning and leadership (Hall et al, 1992: 468).

Nursing workloads have reached unparalleled highs due to technological advances and an increase in scope of practice. In order to maintain the standard of nursing care, the NICU cannot be staffed with less than two registered nurses with training and expertise in neonatal nursing care. An absolute minimum of two registered nurses is required to respond adequately to resuscitative emergencies. NANN (Polin, Yoden and Burg, 1996), stated that "no age group is more susceptible to asphyxia or is as frequently in need of resuscitation than the neonate".

Errors resulting in complications from nursing practise, can be the result of:

- lack of skill,
- lack of knowledge,
- workload and staffing problems,
- systems problems, and
- simple human error.

Those errors due to lack of knowledge and skills, should be addressed in an aggressive manner by clinical educators. Strategies include:

- an addition to the core curriculum for newly-hired nurses,
- in-service education,
- a program for an individual nurse, and
- improving resources for the nurses.

Human error is difficult to reduce and can be made by staff on all levels. One way of reducing these errors, is by giving information to staff about previously-made mistakes (Kenner et al, 1993:986). The supply of intensive care nurses is already less than the demand. Leaders must be proactive by anticipating and preventing staffing problems before they occur (Hall et al, 1992: 469).

The morale and attitudes of nursing personnel are influenced by:

- the quality of their work,
- the ability to influence operational processes,
- the value of the unit culture, and

- the personnel maintenance activities performed by the unit leadership.

Leaders should ensure three-way communication, support and humor and strive to make the unit an enjoyable place to work in(Hall et al, 1992: 469).

The impending crisis in the nursing profession, especially in the public sector, has led to a national investigation. The shortage of nurses is a global problem with an increase in demand. The recommendations of this investigation were as follows:

- active marketing of the nursing profession,
- the implementation of a ratio of registered nurses to population of 1:416,
- an appropriate increase in student- and lecturer posts,
- an appropriate increase in clinical posts in the different provinces and services,
- motivation for more funds for nursing education,
- an increase in the private sectors' contribution to nursing education, and
- to accelerate the release of enrolled nurses who comply with the necessary requirements for the bridging course (Muller, 1991:41).

A number of factors which are seriously hampering recruitment to and retention of appropriate staff in academic medicine have been identified. These major factors include the following:

- Inadequate remuneration packages;
- Unfavourable staff structures in departments resulting in an increase in staff responsibilities with a decrease in staff numbers, has a negative influence on patient care, teaching and training;
- Lack of money to purchase equipment leads to inability to compete with the private sector in innovative procedures, requiring expensive equipment. There is also a lack of funds to replace standard equipment, inadequate equipment and deteriorating physical facilities;

- Fewer resources available for training and education have resulted in lack of funds for research and post-graduate studies;
 - Fewer clinical cases and opportunities for training;
 - Administrative burdens caused by bureaucratic mechanisms responsible for running health care;
 - Staff morale is deteriorating and is at an unequalled low, resulting in dissatisfaction with salary levels and salary increases, dissatisfaction with overtime issues, lack of promotion opportunities, decrease in number of posts, problems with personnel management, no sense of future for academic medicine, and no government support for or appreciation of tertiary care;
 - Universities are powerless to address issues of concern;
 - Outdated and irrelevant joint staff agreements;
 - The need for cost-effective, decentralised administration, resulting in better administration of funds and sound economic principles and financial management(Nel, 1999: 4).
- **Personnel Planning**

There has been an increase in the number of personnel in general hospitals since 1946, namely from 1.5 employees per patient to 2.0 employees per patient. Approximately 60% of a hospital's entire operating budget is spent on labor costs and 60% of the total personnel expenditure is spent on salaries for nursing personnel. During the years, the government and insurance companies have pressurised health care providers to improve the quality of health care at minimum costs. According to some experts, the highest quality of nursing care occurs when staff and workload are properly balanced.

The quality of nursing care is seriously impaired by understaffing, with the result that overworked staff cannot perform the necessary protective and

therapeutic interventions. On the other hand, overstaffing can also be negative, as it results in excessive socialisation and relaxation of standards. Therefore, understaffing, overstaffing and improper staff mix result in job dissatisfaction for nursing personnel. The end result being staff shortages and financial waste (Gillies, 1989: 219).

- The purpose patient classification systems

Jelinek defined patient classification systems as "a method for grouping patients according to the amount and complexity of their nursing care requirements over a period of time" (Gillies, 1989: 221). Patients are grouped according to their dependency on caregivers or to the time and ability required to provide the care.

The purpose of patient classification systems is to assess patients and give each a numerical score that quantifies the amount of effort required to satisfy the patients' nursing needs. To develop a patient classification system, nurse managers must determine the following:

- the number of categories that patients are to be divided in;
- characteristics of the patients in each category;
- type and number of procedures that the patients require;
- time required to perform these procedures, give emotional support, and to provide health teaching for patients (Gillies, 1989: 221).

- * Characteristics of patient classification systems

Table 4.4 summarises the characteristics that are desirable for patient classification systems.

Table 4.4 Characteristics of patient classification systems
(Swansburg, 1990: 78)

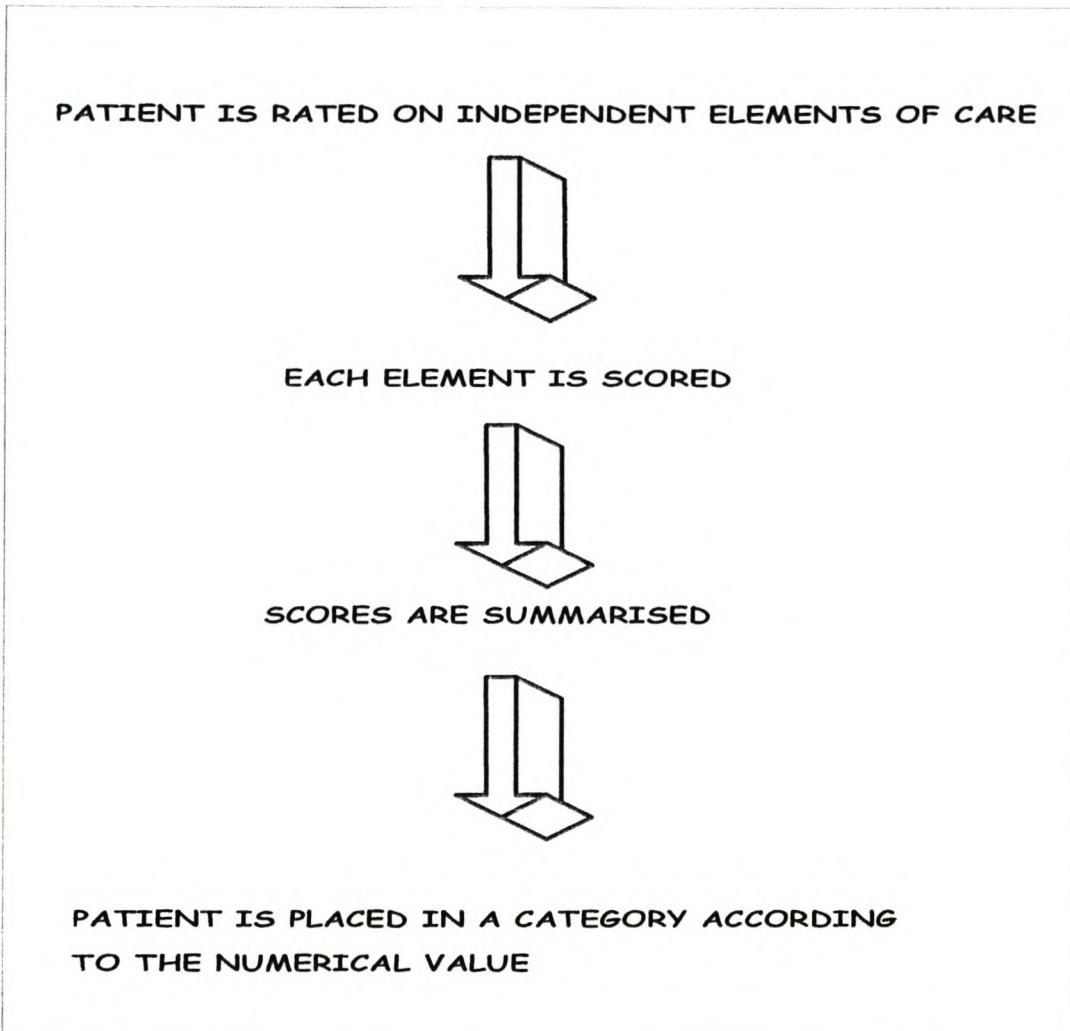
- Differentiate intensity of care among definitive classes.
- Measure and quantify care to develop a management engineering standard.
- Match nursing resources to patient care requirements.
- Relate to time and effort spent on the associated activity.
- Be economical and convenient to report and use.
- Be mutually exclusive, counting no item under more than one work unit.
- Be open to audit.
- Be understood by those who plan, schedule, and control the work.
- Be individually standardised as to the procedures needed for accomplishment.
- Separate requirements for registered nurses and other staff.

* Components of patient classification systems

The first component is the classification categories or the method by which the patients are grouped. According to Adellah & Levine (1979) , there are two methods of categorising patients, namely *factor evaluation* and *prototype evaluation*. With factor evaluation, the patient is rated on independent elements of care, each element is scored, the scores are

elements of care, each element is scored, the scores are summarised and the patient is placed in a category according to the numerical value obtained.

Fig 4.1 Factor evaluation



With prototype evaluation the patient is categorised according to a broad description of his care requirements.

The second factor is a set of guidelines. The guidelines describe the method of classification, the frequency of classification, and the method of data reporting. The third component is the average time period required for patient care in each category. The fourth component is the methods used to calculate the required staffing and required nursing hours. The

the number of patients in that category, plus the indirect care time equals required hours of patient care. Dividing the value by 7.0, results in the number of staff required to work the shift" (Swansburg, 1990, 78; Gillies, 1989: 221).

* Variables affecting staffing

Staffing is usually guided by the nursing service philosophy and objectives, this is also influenced by various patient, staff and environmental factors. These variables are summarised in Table 4.5

Table 4.5 Variables affecting staffing (Marriner-Tomey, 1988: 159; Stevens, 1985: 116)

NURSING ORGANISATION FACTORS

- patient care objectives
- determined levels of patient care
- nursing division/department/unit functions
- services to staff, eg in-service hours allowed

PATIENT CARE FACTORS

- variety of patient conditions
- acuity
- length of stay
- patient numbers
- age groups
- general health status and health goals
- care expectations
- fluctuations in numbers, acuity, variety
- complexity of care

STAFF FACTORS

- job descriptions of the organisation
- educational level of staff
- experiential level of staff
- work ethic of groups of staff
- expectations of staff from the organisation

HEALTH CARE ORGANISATION FACTORS

- financial resources available
- personnel policies, especially regarding work time
- support services within the organisation
- number and nature of interfaces within the total institution
- number of beds per unit
- architecture and functional space layouts, eg floor plan, availability of supplies and equipment

EXTRA-ORGANISATIONAL FACTORS

- staff mix available in the community
- staff number available
- co-ordinating patterns with community health agencies

The following personnel factors may influence the effectiveness of an infection control program, namely:

- Adequate numbers of personnel will allow more compliance with policies and procedures;
- Sufficient staff allows participation in educational programs;
- Cross-training staff can be accomplished with proper infection control education and orientation;
- Outbreak situations may require extraordinary staffing practices.

Most nursing staffing systems are based on patient acuity. Accordingly, nursing personnel assignment is done according to the severity of the patient's condition. Many different models are used, namely:

- **Primary nursing:** One nurse is responsible for one or a group of patients' care;
- **Total patient care:** One nurse provides all the care and treatment for an assigned shift for one or more patients;
- **Team nursing:** A team of nurses care for a group of patients through collaborative and co-operative efforts. One nurse acts as team leader and co-ordinates the activities;
- **Task nursing:** One specific task is assigned to a team of nurses;
- **Patient-centered : care** Routine patient care is provided on the nursing unit, eg ECG; and
- **Case management:** Patient receives standardised care as defined by clinical paths (APIC, 1996: 127-1).

- **Motivation**

Motivation refers to encouragement, and is required to achieve the unit's objectives optimally. When a person enjoys the task he/she is performing, he/she is said to be motivated. In table 4.6 a few principles of motivation according to Muller (1997: 205) are listed.

Table 4.6 Principles of motivation (Muller, 1998: 205)

PRINCIPLES OF MOTIVATION

- **Provide for the physical and physiological needs of the personnel.**
- **Stimulate the intellectual abilities of the personnel.**
- **Cultivate a feeling of pride by delegating the necessary responsibilities.**
- **Create an emotional obligation by giving the necessary recognition to achievement.**
- **Provide favourable working conditions.**
- **Provide the necessary human resources.**
- **Promote teamwork and pleasant relations between personnel members.**
- **Provide job security in the unit.**
- **Encourage ethical debates to discuss differences in ethical convictions.**

Role modelling should be provided by the unit manager.

4.5 MICROLEVEL

4.5.1 The high-risk neonate

Early identification and optimal care of the high-risk fetus and neonate are of utmost importance to reduce perinatal morbidity and mortality. Many high-risk neonates are those having more or less growth and development than the normal neonate. The following terminology is used to describe the high-risk neonate:

- *Low birth weight (LBW) infants*: weigh less than 2500 grams or less at birth, regardless of gestational age.
- *Small for gestation age (SGA) or small for date (SFD) infants*: birth weights that fall below the 10th percentile on intrauterine growth charts.
- *Intrauterine growth retardation (IUGR)*: will result in SGA or small for age (SFA).
- *Large for gestational age (LGA) infants*: weights are above the 90th percentile on intrauterine growth charts.
- *Appropriate for gestational age*: weight is appropriate for gestational age.
- *Premature infants*: delivered before 37 weeks from first date of last menstrual cycle, regardless of birth weight.
- *Full term infants*: born between 37 and 42 weeks of gestation.
- *Postmature infants*: born after 42 weeks.

The term high-risk includes all infants who have a high rate of mortality and morbidity, including infants of diabetic mothers, addicted neonates, and those with infection (Marlow & Redding, 1988: 386; Halliday et al, 1990: 44; Klaus & Fanaroff, 1986: 69)).

4.5.2 Risk factors

A high-risk pregnancy can be described as a pregnancy that is complicated by maternal illness, obstetric disorder or drug therapy, which will result in an ill or immature infant. Early identification of risk factors in the antenatal period is important, and in labour there should be fetal monitoring to detect fetal distress (Halliday et al, 1990: 14). When the health care team is prepared for the birth of a sick neonate, optimal care can be best provided. The necessary equipment and supplies can be assembled beforehand, and the essential members of the team can be present. Infants requiring special treatment at birth can be identified through careful evaluation of the mother's antenatal history. Prenatal risk factors and potential fetal and neonatal complications are listed in Table 4.7 (May & Mahlmeister, 1990: 999; Halliday et al, 1990: 15).

Table 4.7 Prenatal risk factors and potential fetal and neonatal complications. (May & Mahlmeister, 1990: 999; Halliday et al, 1990: 999; Marlow & Redding, 1988: 387).

RISK FACTORS	POTENTIAL COMPLICATIONS
DEMOGRAPHIC FACTORS	
Maternal age	
- under 16 or over 35 years	Small for gestational age (SGA); genetic abnormalities
- primigravida over 30 years	Labor dystocia; birth trauma
Parity	
- grand multiparity (over 5)	Fetal malposition
Substance abuse	
- drug addiction	SGA; neonatal withdrawal syndrome; neonatal HIV
- alcoholism	fetal alcohol syndrome
- smoking	SGA; polycythemia
Multiple sex partners, prostitution	Neonatal HIV
Sex partner IV drug abuser/bisexual	Neonatal HIV
MATERNAL NUTRITIONAL STATUS	
Maternal malnutrition	
- weight less than 100lb	SGA
- weight more than 200lb	SGA; LGA
PREVIOUS PREGNANCY COMPLICATIONS	
Fetal loss at over 28 weeks gestation	Fetal loss
Premature delivery	Prematurity
Abnormal fetal position	Fetal malposition and potential birth trauma
Bleeding in 2nd or 3rd trimester	Recurrent bleeding
Pregnancy-induced hypertension	Recurrent hypertension
Rh sensitization	Erythroblastosis
Fetal distress - unknown origin	fetal distress
Birth of an infant with anomalies	Congenital anomalies
Birth of infant over 10lb	Birth of LGA
Birth of post-term infant	Post-term infant; IUGR
Neonatal death	Neonatal death

RISK FACTORS	POTENTIAL COMPLICATIONS
CENTRAL NERVOUS SYSTEM DISORDERS <i>Hereditary CNS disorders</i> <i>Seizure disorders</i>	<i>Inherited CNS disorder</i> <i>Congenital anomalies</i>
CARDIOVASCULAR DISEASES <i>Chronic hypertension</i> <i>Congenital, congestive heart failure</i>	<i>IUGR; asphyxia</i> <i>Prematurity; inherited defects</i>
HEMATOLOGIC DISORDERS <i>Anaemia</i> <i>Sickle cell disease</i> <i>Haemoglobinopathies</i> <i>Idiopathic thrombocytopenic purpura (ITP)</i>	<i>Prematurity; low birth weight</i> <i>IUGR; fetal demise</i> <i>IUGR; inherited hemoglobinopathies</i> <i>Transient ITP</i>
RENAL DISEASE <i>Chronic glomerulonephritis</i> <i>Renal insufficiency</i>	<i>IUGR; SGA; prematurity; asphyxia</i> " " " "
REPRODUCTIVE DISORDERS <i>Uterine malformation</i> <i>Cervical incompetence</i>	<i>Prematurity; fetal malposition</i> <i>Prematurity</i>
METABOLIC DISORDERS <i>Diabetes</i> <i>Thyroid disease</i>	<i>LGA; hypoglycemia; hypocalcemia; anomalies</i> <i>Hypothyroidism; CNS defects</i> <i>Hyperthyroidism; goitre</i>
MATERNAL INFECTIONS <i>TORCH infections</i> <i>Sexually transmitted diseases</i> <i>Acute cystitis, pyelonephritis</i> <i>Hepatitis</i> <i>AIDS</i>	<i>IUGR; SGA; active infection</i> <i>Congenital syphilis; Ophthalmia neonatorum</i> <i>Prematurity</i> <i>Hepatitis</i> <i>Neonatal HIV</i>

Approximately 10-20% of all women who experienced normal pregnancies will develop intrapartal problems, increasing the risk for neonatal complications. Some of the intrapartal factors, as listed in table 4.6, such as severe intrapartal haemorrhage or infection, can be life-threatening to the neonate (May & Mahlmeister, 1990: 1001; Halliday et al, 1990: 15).

Table 4.8 Intrapartal risk factors and potential fetal and neonatal complications (May & Mahlmeister, 1991: 1001; Halliday, 1990: 15).

RISK FACTORS	POTENTIAL COMPLICATIONS
UMBILICAL CORD	
Prolapsed umbilical cord	Asphyxia
True knot in cord	Asphyxia
Velamentous insertion	Intrauterine blood loss; shock
Vasa previa	Intrauterine blood loss; shock
Rupture or tearing of cord	Blood loss; shock; anemia
MEMBRANES	
Premature rupture of membranes	Infection; prolapsed cord; asphyxia
Prolonged rupture of membranes	Infection
Amnionitis	Infection
Oligohydramnios	Congenital anomalies
Polyhydramnios	Congenital anomalies; prolapsed cord
PLACENTA	
Placenta previa	Prematurity; asphyxia
Abruption placentae	Prematurity; asphyxia
Placental insufficiency	Intra-uterine growth retardation; Small-for-gestational-age-infant
ABNORMAL FETAL PRESENTATIONS	
Breech delivery	Asphyxia; birth injuries
Face or brow presentation	Asphyxia; facial trauma
Transverse lie	Asphyxia; birth injuries; caesarean delivery
LABOUR DYSTOIAS	
Prolonged labor	Asphyxia, birth trauma, infection
Uterine inertia	Complications of prolonged labor
Uterine tetany	Asphyxia
Precipitate labor	Asphyxia; birth trauma
DELIVERY COMPLICATIONS	
Forceps-assisted delivery	CNS trauma; cephalhematoma
Vacuum extraction	Cephalhematoma
Manual version or extraction	Asphyxia; birth trauma; prolapsed cord
Shoulder dystocia	Asphyxia; brachial plexus injury; fractured clavicle
Precipitate delivery	Asphyxia; birth trauma
Undiagnosed multiple gestation	Asphyxia; birth trauma

RISK FACTORS	POTENTIAL COMPLICATIONS
ADMINISTRATION OF DRUGS Oxytocin Magnesium sulfate Analgesics Anaesthetics	Complications of uterine tetany Hypermagnesemia; CNS depression CNS and respiratory depression CNS and respiratory depression; bradycardia

4.5.3 Assessment of the neonate

There are basically three major assessments of the neonate, namely in the delivery room, the nursery and prior to discharge. At birth a physical assessment is done to evaluate adaption to extrauterine life. This is usually done by means of the Apgar score, which measures heart rate, respiratory effort, color, muscle tone and reflex response at one to five minutes. The second assessment is within one to four hours in the nursery. It includes a physical assessment, as well as a gestational assessment. The last assessment is a complete physical assessment prior to discharge, performed by a physician or nurse practitioner (Kenner et al, 1993: 268). Significant observations indicating deviations from normal in the nursing assessment of the neonate are listed in table 4.9 (Marlow & Redding, 1988: 392).

110**Table 4.9 Significant observations indicating deviations from normal in nursing assessment of the neonate.**

AREA OF ASSESSMENT	OBSERVATION
Temperature	Higher or lower than normal axillary temperature in relationship to environmental temperature.
Color	Pallor, florid, jaundice, cyanosis.
Mucous membranes	Dryness of oral tissues, thrush.
Fontanels	Bulging or sunken.
Eyes	Irritation, discharge.
Respiratory	Rate, rhythm, quality of breath sounds, retractions, flaring of ala nasi, labored, grunting, need for suctioning.
Cardiovascular	Heart rate and rhythm, quality of heart sounds, point of maximal intensity, where the heart sounds are the loudest blood pressure, peripheral pulses, central venous pressure
Abdomen	Distention, presence or absence of bowel sounds.
Cord	Inflammation, bleeding, discharge.
Stools	Frequency, characteristics, presence of occult blood.
Urinary output	Frequency, amount, characteristics.
Activity level	Decrease or increase in motor activity, lethargy, hyperactivity, twitching or seizures, presence of reflexes, characteristics of cry: quality, frequency.
Oral feeding	Quality of sucking, acceptance of feeds, vomiting, regurgitation.
PARENTERAL INFUSION	Kind, amount, rate of flow.
Weight gain	Slower or more rapid.

4.5.4 Environmental control

The goal of neonatal intensive care is to establish a controlled, stable environment for the provision of life support and vital signs monitoring. The environment must be clean, warm, friendly and with the parents present in the unit.

- Hygienic environment

The hands of all staff and equipment used, must be clean. On entering the nursery, rings and watches must be removed and the hands and forearms be washed for five minutes. An antiseptic solution, eg chlorhexidine or Betadine should be used. After handling an infant, the hand and forearms should be washed for one minute. There are two factors that influence the risk of cross infection, namely the number of infants in the unit, and the amount of handling by the staff.

Any staff or visitor suffering or recovering from an infection or disease must be excluded from the nursery. There should be a stethoscope for each infant. If staff prefer to use their own stethoscopes, they should be cleaned with alcohol wipes after use. Infected infants should be nursed in isolation and all invasive techniques must be performed under aseptic conditions (Halliday et al, 1989: 62).

- Thermal environment

The high risk neonate is placed in a neutral thermal environment. The temperature is adjusted to keep the infant's temperature between 36.4 and 37 degrees celsuis. The use of a radiant warmer is preferred for evaluations, tests, and procedures that expose the infant. An incubator is effective when the infant requires less intensive care and can be left undisturbed for longer periods.

All oxygen that is administered to the neonate should be warm, because cold air can induce apnea. All wet towels or clothing should be removed and the infant's head should preferably be covered. The nurses' hands must be warm in order to decrease heat loss by conduction.

Cold stress can increase the metabolic rate, increase oxygen consumption, hypoglycemia, and a decrease in surfactant production. It can further breakdown brown fat, releasing acid metabolites into the bloodstream. Preterm and SGA infants have limited amounts of brown fat that is important for heat production (May & Mahlmeister, 1990: 1034).

- Sensory environment

Various studies suggested that sensory stimuli play a major role in neurological and physical maturation. An increase in weight gain and a decrease in apnea attacks in a small premature infant may be due to touching, cuddling and talking to the infant. Due to a shortage of personnel, parents can provide this stimulation.

Phototherapy, used for hyperbilirubinemia, has a profound influence on the infant's biological rhythm. Noise levels are of concern, and may potentiate the damaging effects of ototoxic drugs. The effects of the sensory environment may not only affect weight gain and activity, but also have long term effects, e.g. age of sexual maturation, school performance, and the length of survival (Klaus & Fanaroff, 1986: 107).

4.6 Neonatal infections

4.6.1 Epidemiological History

Neonatal sepsis is a significant cause of mortality and morbidity. In the 1930s-1940s, hemolytic *Streptococcus pyogenes* was often responsible for perinatal infections. The introduction and use of Penicillin resulted in a decrease in the incidence of Streptococcal disease.

Haemolytic Staphylococcus aureus was the predominant neonatal pathogen in the 1950s-1960s. During this period, there were alterations in infant care, i.e. development of antimicrobial agents that are active against penicillinase-producing staphylococci, and the improvement in low-birth-weight survival. Alterations in infant care included practices like, rooming in, ultraviolet lighting, nasal creams, antiseptic bathing, artificial colonisation and barrier nursing. Gram-negative enteric micro-organisms, primarily *Escherichia Coli* appeared in the late 1950s as major neonatal pathogens. During the 1960s,

there was an improved understanding of epidemiology of gram-negative bacterial colonisation and disease, antimicrobial agents were introduced against enteric micro-organisms, and group B *streptococcus* (*S. agalactiae*) was now the principal cause of neonatal septicemia and meningitis (Klaus & Fanaroff, 1986: 262).

In the 1970s-1980s group B *streptococci*, *E. Coli*, and *Listeria monocytogenes* were responsible for the majority of neonatal infections with early onset. In the 1980s *Haemophylis influenzae* and *Staphylococcus epidermidis* emerged as causes of neonatal sepsis (Beaschy & Deacon, 1993: 345). Table 4.10 summarises the epidemiological history of neonatal sepsis.

Table 4.10 Epidemiological History of neonatal sepsis

1930-1940	group A streptococcus
1940-1950	<i>E. coli</i>
1950-1960	<i>Stahpylococcus aureus</i>
1970-1980	group B streptococci <i>E. coli</i> <i>L. monocytogenes</i>
1980s	<i>H. influenzae</i> <i>Staphylococcus epidermidis</i>

4.6.1 Pathogenesis

The neonatal period has the highest incidence of infection, than in any other time in life, even if preterm babies are excluded (Isaacs & Moxon, 1991: 1). The newborn can be infected by various pathways after arrival in the nursery, for example by human carriers, or contaminated equipment and material. In the hospital setting, human sources can include personnel, mothers, and other infants. The methods of transmission may include:

- The spread of droplets from the respiratory tract of other infants or adults.
- Carriage of micro-organisms on the hands of hospital personnel, as hands are not only a means of transmission, but also a significant reservoir of bacteria.
- Suppurative lesions. The spread of staphylococcal and streptococcal infections have been associated with asymptomatic carriers, but the most serious outbreaks have been associated with significant lesions on a member of the medical or nursing staff.
- *Cytomegalovirus, HIV and Hepatitis B* antigens have been identified in mother's milk. It is also possible that these and other agents may be transmitted via this route. Neonatal disease can be caused by pathogens such as *Staphylococcus aureus*, group B *Streptococcus* and *Salmonella* species in infected breast milk. Bacteria, such as *Staphylococcus epidermidis* and *alpha haemolytic Streptococcus*, are components of normal skin flora and are frequently cultured from freshly expressed breast milk, but are unlikely to be of importance to the breastfed infant (Remington & Klein, 1990: 14). In a study done by El-Mohandes et al (1997: [17] 130- 134), it showed an increase in the frequency of *E. Coli* and *Enterococcus sp* colonisation in infants that are fed with human milk. It also revealed that human milk feeding in a NICU has a protective effect against nosocomial sepsis, which is unrelated to its influence on gastrointestinal flora.
- Blood products should be tested for Hepatitis B antigen, HIV antibody and CMV antibody.

Equipment has been identified as a source of infection in nursery outbreaks. The most common factors in the transmission of infection have been contaminated solutions used for nebulization, room humidifiers and bathing solutions. Gram negative bacteria such as *Pseudomonas*, *Serratia marcescens* and *Flavobacterium*, have been called 'water bugs' related to their ability to multiply in aqueous environments at room temperature. New techniques, such as umbilical vein or artery catheterisation, and central venous catheter insertion have been associated with sepsis (Remington & Klein, 1990: 15).

Many studies have shown an increase in the incidence of infection with a decrease in birth-weight and gestation. The single most important independent variable in predisposing to sepsis is a low birth-weight. Reasons for the increase in susceptibility to infection in term neonatal infants can be:

- immaturity of the immune system,
- exposure to micro-organisms from the maternal genital tract,
- exposure to viruses from the mother without antibodies,
- peripartum factors,
- portals of colonisation, and
- the exposure to organisms postnatally.

These reasons are summarised in table 4.11

Fig 4.11 Reasons for the increased susceptibility to infection in term infants (Isaacs & Moxon, 1991: 1).

1. Immaturity of the immune system

- a. poor humoral response to organisms (IgG, IgM, IgA)
- b. relative poor neutrophil response
- c. relative poor complement activity
- d. relative poor T-cell function
- e. possible impaired macrophage function

2. Exposure to micro-organisms from the maternal genital tract

- a. ascending infection via amniotic fluid
- b. transplacental haematogenous spread

3. Exposure to viruses from mother without antibody

- a. antenatal, eg. rubella, CMV, HIV
- b. viraemic spread, eg. chickenpox
- c. perinatal, eg. herpes simplex virus, hepatitis B

4. Peripartum factors

- a. trauma to skin, vessels, etc. during parturition
- b. scalp electrodes and other invasive procedures

5. Portals of colonisation and invasion

- a. umbilicus
- b. mucosal surfaces
- c. eye
- d. skin

6. Exposure of organisms postnatally

Exposure in neonatal unit or lying-in wards to organisms from other babies

- a. overcrowding
- b. understaffing

Reasons for an increase in susceptibility in preterm infants can be:

- immunological,
- exposure to micro-organisms from the maternal genital tract,
- invasive procedures,
- increased postnatal exposure,
- poor surface defences,
- increased risk of conditions predisposing to sepsis, and
- antibiotic pressure.

These reasons are summarised in Table 4.12.

Table 4.12 Reasons for an increase in susceptibility to infection in preterm infants (Isaacs & Moxon, 1991: 2).

1. Immunological

- a. reduced transplacental transfer of maternal IgG
- b. relative immaturity of all immune mechanisms

2. Exposure to micro-organisms from the maternal genital tract

preterm labour may be precipitated by infection (chorioamnionitis)

3. Invasive procedures

- a. endotracheal tubes
- b. intravascular catheters
- c. chest drains
- d. cerebrospinal fluid shunts

4. Increased postnatal exposure

- a. organisms from other babies in NICU
- b. overcrowding and understaffing

5. Poor surface defences

- a. skin thin, easily traumatised

6. Increased risk of conditions predisposing to sepsis

- a. prolonged artificial ventilation
- b. intravenous feeding
- c. necrotising enterocolitis

7. Antibiotic pressures

- a. resistant organisms
- b. fungal infection

4.6.2 Epidemiology

- **Incidence**

Neonatal septicemia is inversely related to gestational age. Therefore, one in 250 premature infants and one in 15,000 term infants suffers from a systemic, bacterial infection within the first month of life. Before the introduction of effective antibiotics, the mortality rate of neonatal sepsis approached 100%. With effective chemotherapy, the mortality rate still remained between 20-30% (Klaus & Fanaroff, 1986: 262). In the United States of America, the incidence of neonatal infection has varied from 1 to 8.1 per 1000 live births. A number of factors influence the incidence of neonatal sepsis:

- organisms
- geographical area
- age
- sex
- multiple pregnancies (Isaacs & Moxon, 1991: 8).

- **Organisms**

Two patterns of illness have been identified in newborns with systemic bacterial infection. They differ with respect to clinical presentation, epidemiology, pathogenesis and prognosis.

Early-onset disease occurs in high risk infants and presents within a few days of life with a very high mortality rate. High risk infants are those born due to premature onset of labour, premature rupture of membranes and intrapartum fever with a mean age at onset of 20 hours. The mortality rate is approximately 50%. The organisms that cause early-onset sepsis, are part of the vaginal flora of pregnant women. The early-onset sepsis can be caused by the following organisms:

- *H. influenza*
- *L. monocytogenes*
- *S. pneumoniae*

- *E. coli*
- *Klebsiella spp*

Late-onset sepsis occurs within the first week of life in infants without perinatal complications. These infections can be a result of invasion from organisms colonising the maternal genital tract or from the environment. Organisms in a NICU that colonise the infants and that cause sepsis, may change with time for no apparent reason, for example:

- 1984-1985: *Pseudomonas aeruginosa*
- 1985-1987: *enterococci*
Klebsiella oxytoca
- 1986-1989: *Staphylococcus epidermidis.*

The involvement of the central nervous system was common, increasing the mortality rate to 20%. Late-onset micro-organisms are diverse and often nosocomially acquired. Other micro-organisms that cause late-onset infections are:

- *S. aureus*
 - *S. epidermidis*
 - *Pseudomonas spp*
 - *Group B streptococci*
 - *L. monocytogenes*
 - *E. coli* (Klaus & Fanaroff, 1986: 267; Isaacs & Moxon, 1991: 8).
- **Geographical area**

In some developing countries, infections with *Salmonella* species are common. Neonatal tetanus is also a worldwide killer of babies due to the application of mud and contaminated materials to the umbilical stump. Regional differences within countries, as well as between hospitals which are geographically close, are evident. This may be due to identifiable environmental factors, such as hygiene or antibiotic pressure.

- **Age**

There is an inverse correlation between gestational age or birth weight and the incidence of *group B streptococcal* infections. Early-onset sepsis is an important determinant, whereas late-onset sepsis shows a similar relationship. The risk for both early and late-onset sepsis increases in very preterm babies with a weight of less than 1000g at birth.

- **Sex**

Early-onset sepsis affects both sexes equally, whereas for late-onset sepsis males have a two-fold higher incidence.

- **Multiple pregnancies**

Preterm twins are at a five times greater risk for *group B streptococcus* infections than other preterm babies. The first-born is at a greater risk, than the second born twin.

- **Mortality and morbidity**

One of the most important factors influencing mortality and morbidity is whether infections are due to early or late onset infection:

In Oxford:

- early sepsis:	28%
- late sepsis:	4%
- 17% amniotic fluid infection:	

4.6.3 Immunity of the neonate

- **Humoral immunity**

B-lymphocytes from the bone marrow, protect the infant against infection, especially bacterial infections. These B-lymphocytes react to foreign antigens by migrating to the lymph nodes and differentiating to plasma cells. They produce most of the circulating immunoglobulins. Immunity of the

newborn depends on different types of immunoglobulin, which is summarised in table 4.13 as immunoglobulin G,M,A and E (Keet, Harrison & Shore, 1987:127; Beachy & Deacon, 1993:346).

Table 4.13 Types of immunoglobulins (Keet, Harrison & Shore, 1987:127; Beachy & Deacon, 1993:346).

IMMUNOGLOBULIN G (IgG)

- a major immunoglobulin found in serum and interstitial fluid
- provides immunity against bacterial and viral pathogens
- placental transfer to the fetus can be active or passive
- it increases gradually until the 40th week of gestation
- preterm infant have decreased levels proportional to their gestational age
- postmature and small-for-gestational-age infants have decreased levels, suggesting inhibition of transfer with placental damage

IMMUNOGLOBULIN M (IgM)

- does not cross the placenta
- synthesis begins early in fetal life, can detect levels at about 30 weeks of gestation
- may have increased levels with intrauterine infection
- serum levels rapidly increase after birth

IMMUNOGLOBULIN A (IgA)

- commonly found in gastrointestinal tract, respiratory tract, human colostrum and breast milk
- does not cross the placental barrier
- intrauterine synthesis is minimal in an uninfected fetus and does not become detectable in the newborn until 2-3 weeks of life
- increase in levels with certain congenital viral infections

IMMUNOGLOBULIN E (IgE)

- small amounts in serum and secretions
- major role in allergic reactions

- **Cellular immunity**
 - Specific cellular immunity

Specific cellular immunity is mediated by T lymphocytes, which enhance phagocytic responses. T lymphocytes are activated by antigens to which they have been sensitised and then become memory or T-cells. T lymphocytes migrate to the thymus where differentiation begins. Three activated T-cells have been identified:

- * cytotoxic: kill foreign or virus infected cells
- * helper: enable B or T cells to respond to antigens and activate macrophage
- * suppressor: repress the responses of T and B lymphocytes to antigens.

Depressed T-cell function may occur due to neonatal viral infections, hyperbilirubinemia, corticosteroid therapy, or maternal medications taken late in pregnancy.

- Nonspecific cellular immunity

Non-specific cellular immunity is an inflammatory response that involves phagocytosis. This process includes neutrophils, monocytes and complement. These three are summarised in Table 4.14 (Beachy & Deacon, 1993:346).

Fig 4.14 The role of neutrophils, monocytes and complement in non-specific cellular immunity (Beachy & Deacon, 1993:346).

NEUTROPHILS

- mature from the bone marrow committed phagocyte stem cell
- first line of defense against bacterial infection
- in a ill neonate, a neutrophil reserve is present and exceeds the circulating pool
- in a septic neonate, the neutrophil reserve pool quickly becomes depleted due to:
 - * decrease in proliferation or reproduction
 - * decrease in the neutrophil storage pool
 - * decrease in the number of neutrophils that reach the site of infection

MONOCYTES

- important in defence against fungal and bacterial infections
- found mainly in connective tissue

COMPLEMENT

- mediator of antigen-antibody reactions
- activated by an antibody-dependent mechanism (classic pathway) or antibody-independent mechanism (alternate pathway)
- serves to:
 - * increase neutrophil mobilisation from the bone marrow
 - * draw neutrophils to the site of infection
 - * opsonise bacteria for improved phagocytosis

Neonatal infection can be divided into three groups, namely:

- antenatally
- perinatally
- nosocomially

Antenatal infections result in death or serious fetal damage. Perinatal infection is usually due to the mother being the asymptomatic carrier of the pathogenic organisms. Nosocomial infection may lead to long term problems, and organisms such as staphylococci and salmonella may cause disease weeks or months later.

Neonatal infections have the following characteristics:

- the newborn, especially the preterm, is immuno-deficient,
- the newborn is associated with the environment of another individual, the mother,
- the newborn infant is bacteriologically sterile before birth, and
- in the NICU, the neonate is subjected to various invasive procedures and antibiotics (Tarlow, 1994:43).

- **Antenatal infections**

Infections producing more severe or long-lasting problems include toxoplasmosis, rubella, congenital cytomegalovirus and varicella-zoster virus infections.

- **Toxoplasmosis**

Toxoplasmosis is a congenital infection that is caused by the protozoan parasite *Toxoplasma gondii*. The transplacental infection of the fetus is associated with the maternal infection, especially in the first and second trimesters of pregnancy (Beach & Deacon, 1993: 498).

Transmission: Toxoplasmosis, a zoonosis, was first identified in 1908 in rabbits and rodents. The parasite is common in cats, dogs, pigs, sheep and cattle and has therefore a high prevalence in regions with a large number of stray cats and a preference for undercooked meat (Isaacs & Moxon, 1996: 175; Tarlow, 1994: 44).

Incidence: After first trimester infection, approximately 90% of infants born will be unaffected. With maternal infection in the last few weeks before delivery, approximately 90% of infants born will be infected (Tarlow, 1994: 44). In the United Kingdom, it is estimated that 0.2/1000 pregnancies will be infected with Toxoplasmosis. In the United States of America and in Europe, prospective studies have shown that 2-12/1000 pregnancies will be infected (Isaacs & Moxon, 1991: 175).

Clinical features: The most common feature is chorioretinitis (Beachy & Deacon, 1993: 498). Other features include hydrocephalus, intracranial calcifications, hepatosplenomegaly, jaundice and deafness. Late onset clinical features are chorioretinitis, hearing deficit and psychomotor retardation (APIC, 1996:47-7).

Laboratory diagnosis: The following methods are used for the diagnosis of toxoplasmosis, namely:

- mother: seroconversion: IgM antibody
- newborn: documentation of a rising Toxoplasma-specific IgG titers over the first four to six months of life;
direct demonstration of tachyzoites in infant or placental tissue;
culture of Toxoplasma from infant blood, cord blood, placenta,
cerebrospinal fluid (CSF) and amniotic fluid (APIC, 1996: 47-7;
Reese & Betts, 1996: 85).

Treatment: The suggested treatment is a combination of pyrimethamine (1mg/kg) and sulfadiazine or trisulfapyrimidine (75-100mg/kg/day in two doses) with folic acid (5mg intramuscular every three days). Folic acid prevents bone marrow toxicity. Corticosteroids may be added for patients suffering from active macular chorioretinitis (Betts & Reese, 1996:85).

Prevention: Pregnant women should be counselled to avoid undercooked meat and direct hand contact with cat faeces or soil. Uncooked fruits and vegetables must be washed before being eaten. In areas with a high incidence of congenital toxoplasmosis, serologic screening in pregnancy is advised. Pregnant women with seroconversion, should be treated (APIC, 1996:47-7).

- **Rubella**

The Rubella virus was isolated in a tissue culture for the first time in 1962. This led to the development of vaccines which can effectively eliminate congenital rubella syndrome. The combination of deafness and blindness resulted in the 'lock-in syndrome', as it is most distressing to care for these children (Issacs & Moxon, 1991: 179).

Epidemiology: In unimmunised populations, young children between five and nine years of age are affected. Infection is most common in late winter and spring. Primary maternal rubella is transmitted via the placenta and results in intra-uterine infection (Issacs & Moxon, 1991: 180).

Transmission: Maternal acquisition of rubella is from persons suffering from acute rubella, by means of respiratory droplets and airborne route. Transmission of the newborn occurs during acute maternal infection. In the first trimester there is a high risk of transmission (81%) resulting in severe congenital disease in the fetus (85%). In the second trimester the risk of transmission is 39% with a lower risk of congenital defects. The third trimester has a high risk of transmission, up to 100% in the last month, but disease is rare with transient symptoms (APIC, 1996:47-5). Health care workers are at great risk contracting the disease and especially pregnant nurses, as preventive measures are not adhered too.

Clinical features: Up to 68% of neonatal infections are subclinical. The classical presentation of an infected newborn is a small, full term, "blueberry muffin" baby with thrombocytopenia, purpura, cataracts, cardia lesion and hepatosplenomegaly (Betts & Reese, 1996:86). The clinical manifestations are summarised in table 4.15

Table 4.15 Clinical manifestations of congenital rubella syndrome (Isaacs & Moxon, 1991:181)

ORGAN	DEFECT
EYE	CONGENITAL CATARACTS CLOUDY CORNEA GLAUCOMA CHOROIDORETINITIS MICROPHTHALMIA
EAR	SENSORINEURAL DEAFNESS
HEART	PULMONARY ARTERY STE- NOSIS/HYPOPLASIA PATENT DUCTUS ARTERIOSUS
CNS	MICROCEPHALY ACTIVE ENCEPHALITIS
GROWTH	INTRAUTERINE GROWTH RETARDATION
RETICULO-ENDOTHE- LIAL	HEPATOSPLENOMEGLY LYMPHADENOPATHY
LUNG	INTERSTITIAL PNEU- MONITIS
SKIN PURPURA	THROMBOCYTOPENIC
BONE	RADIOLUNCENCIES

Diagnosis: Maternal infection is diagnosed by showing seroconversion or a rising titer of IgG antibodies of rubella. This is measured by haemagglutination inhibition, single radial haemolysis, ELISA or radioimmunoassay. Reinfections are diagnosed by the presence of specific IgM in

haemagglutination inhibition, single radial haemolysis, ELISA or radio-immunoassay. Reinfections are diagnosed by the presence of specific IgM in who previously had a high-titre IgG antibody. Congenital rubella is diagnosed by detecting IgM in serum or cord blood. Nasopharyngeal aspirates, eye swabs, urine, faeces and CSF are the best specimens for virus isolation (Isaacs & Moxon, 1991: 183).

Treatment: Treatment therapy is symptomatic.

Prevention: In countries where women have been immunised with the MMR (measles, mumps and rubella) vaccine, congenital rubella syndrome has virtually disappeared. APIC (1996: 47) advises that all children be immunised to eliminate rubella from the population.

- **Cytomegalovirus**

Cytomegalovirus (CMV) infections is the most common virus in neonates. It occurs in up to two percent of neonates, with the highest incidence among those of low socio-economic status. CMV is a herpes virus and can cause persistent infection and be reactivated. At least two serotypes have been identified (Isaacs & Moxon, 1991:185; Tarlow, 1994: 45).

Transmission: CMV can be transmitted between adults by sexual activity or kissing, as it can be found in cervical secretions, semen and saliva. The virus can cross the placenta and infect the fetus prenatally. It can also be acquired from cervical secretions, breastmilk or infected bloodtransfusions. Although CMV is devastating in preterm babies, it is rarely life-threatening in term babies. Prenatal infection with CMV has major long-term effects (Isaacs & Moxon, 1991: 185). CMV disease has a high risk of transmission to susceptible health care workers.

Clinical features: Five to ten percent of babies with congenital CMV experience symptoms at birth. Early onset clinical features include hepatosplenomegaly, jaundice, petechiae, pneumonia, microcephaly and intracranial calcifications. Late onset features include hearing deficits, psychomotor retardation and learning disabilities (APIC, 1996:47-4; Isaacs & Moxon, 1991: 187).

Diagnosis: In the first week of life a urine, throat swab or nasopharyngeal aspirate are positive for CMV by culture, indicated a congenital infection. Other means of diagnosis include a persistent high complement fixation titers and persistent high IgM fluorescent antibody assay (Betts & Reese, 1996: 86; Isaacs & Moxon, 1991: 189).

Treatment: According to Isaacs & Moxon (1991), two drugs are confirmed effective against CMS, namely ganciclovir and foscarnet. Neither have been evaluated in babies. Handwashing and secretion precaution with symptomatic treatment is advised by Betts & Reese (1996:86).

* Prognosis

Mortality is 12% in those with disseminated disease. Those that survive, may develop chorioretinitis, periventricular cerebral calcifications and deafness (Betts & Reese, 1996: 86)

* Chicken pox

Congenital varicella syndrome occurs in approximately two percent of newborns of mothers suffering from varicella in the first/early second trimester. Infants may appear normal at birth, but develop shingles later in infancy. Severe disseminated neonatal varicella may occur if maternal varicella develops five days before or two days after delivery. The mother will transmit the virus, but not the antibodies.

Clinical features: Congenital varicella syndrome can result in limb hypoplasia and cutaneous scarring, ocular defects, cortical atrophy and mental retardation. In the neonatal period, vesicular skin and mucosal lesions, pneumonia, hepatitis and meningoencephalitis may be evident (APIC, 1996: 47-5; Tarlow, 1994:46).

Laboratory diagnosis: Diagnosis is made by examination of vesicle scrapings or immunofluorescence for intracellular inclusion bodies, although it is rarely required. Other means of diagnosis are through viral culture, seroconversion and specific IgM antibodies.

Treatment: Acyclovir

Prevention: Susceptible pregnant women should avoid exposure to varicella or herpes zoster. Varicella-zoster immunoglobulin (VZIG) can be

administered to newborns of mothers with acute varicella of onset from five days before to two days after delivery (APIC, 1996: 47-4).

Table 4.16 Summary of antenatal infections (Wenzel, 1997: 1022)

MICROORGANISMS	RESERVOIR	TRANSMISSION	PREVENTION
CYTOMEGALO-VIRUS	infected humans blood products	transfusion secretion contact	avoid reservoir
RUBELLA VIRUS	infected humans	secretion contact airborne	immunisation
TOXOPLASMOSIS	cat faeces rare meat	ingestion ?airborne	avoid reservoir
VARICELLA	infected humans	airborne secretion contact lesion contact	immunisation avoid reservoir zoster immuno-globulin

- **Perinatal infections**

Perinatal infections usually infect the infant from the mother's genital tract during birth. A wide variety of organisms may be present in the mother's birth canal or in maternal blood, but only a few are significant causes of disease, particularly chlamydia trachomatis, syphilis, gonorrhoea, herpes simplex and hepatitis B (Tarlow, 1994: 46). The usual and normal flora includes gram negative Enterobacteriaceae, gram positive anaerobic and aerobic cocci, specifically streptococci and fungi, specifically *Candida albicans* (Wenzel, 1997: 1022).

- **Chlamydia trachomatis**

Infections are acquired from a mother with chlamydial cervicitis. About 50% of babies born to mothers who are colonised with chlamydia trachomatis, will develop the disease. The infant will develop symptoms

between 5 and 14 days of age. Symptoms vary from mild conjunctivitis to intense edema of the eyelids with purulent discharge (Beachy & Deacon, 1993: 489). Most infants develop conjunctivitis, but a minority have chlamydial pneumonia (Tarlow, 1994:46). The infection is diagnosed by means of cultures of conjunctival scrapings, identification of chlamydial antigens and Giemsa stains of conjunctival scrapings. Oral erythromycin is the therapy of choice, since topical therapy alone is inadequate (Beachy & Deacon, 1993: 490).

- **Syphilis**

Syphilis, caused by *Treponema pallidum*, may be asymptomatic or present at birth. The majority of cases is associated with lack of maternal antenatal care. Congenital syphilis presents with petechiae, skin lesion, hepatosplenomegaly, respiratory distress, CNS involvement, rhinitis and periostitis of long bones. The disease is diagnosed in the neonate by a high VDRL (Venereal Disease Research Laboratory) titer, reactive RPR (Reactive Plasma Reagins), serum IgM level greater than 20mg/dl and confirmed with a positive fluorescent treponema antibody absorption test. Penicillin G is the treatment of choice (Beachy & Deacon, 1993: 362; APIC, 1996: 47-8).

- * **Herpes simplex**

Most herpes simplex virus (HSV) infections in the neonate occur with genital (type 2) virus. Transmission to the newborn increase with maternal primary infection. The risk factors are a high virus load and lack of maternal antibodies in the primary infection. Transplacental transmission is rare, but it can cause severe infection. Prolonged rupture of membranes increase the risk to the infant, possibly by allowing ascending infection from the cervix. Other risk factors are premature delivery, maternal cervical lesions at delivery and the usage of scalp electrodes. Most infected infants are symptomatic. About 10% of neonatal HSV infections are acquired either earlier or later than the majority of infections.

HSV infection can be classified into local, encephalitis without other involvement and disseminated infection involving multiple sites. Clinical features associated with transplacental transmission include

hydranencephaly, microcephaly, ocular malformations, cutaneous scarring and intracranial calcifications. Clinical features associated with intrapartum or postnatal transmission include mucocutaneous lesions, encephalitis (seizures, irritability, coma) and disseminated disease (hypoperfusion, pneumonia, coagulopathy). Encephalitis occurs in about 30% of infected babies. About half of these die and most of the survivors are brain damaged.

Diagnosis is made by means of a viral culture of the mother's skin lesions or cervix or from the infant's skin lesion, mouth, eye, CSF or urine. The treatment of choice is acyclovir (Tarlow, 1994: 48; APIC, 1996: 47-4).

- Hepatitis B

The Hepatitis B virus (HBV) has a unique natural history in newborns. These infants have a high probability to becoming chronic carriers of the virus. Infection at birth occurs either through abrasions on the infant's skin or mucosa or by small materno-fetal bleeds across the placenta that occur during labour. Most infections in the neonate are asymptomatic. Fulminant hepatitis rarely occurs in the first few months of life. Infants that are infected perinatally, are at 75-100% risk of becoming chronic carriers of the HBV. Chronic carriage is associated with cirrhosis and liver cancer in adulthood.

Diagnosis is made through serology for the hepatitis B surface antigen. There is no specific treatment for this infection. Prevention is by vaccination of adults and in childhood, and universal screening of pregnant women for hepatitis B surface antigen. If the result is positive, hepatitis B immunoglobulin can be administered (APIC, 1996: 47-6; Tarlow, 1994: 48).

Table 4.17 Summary of organisms and their prevention (Wenzel, 1997: 1022)

ORGANISM	PREVENTION
<i>Chlamydia Trachomatis</i>	<ul style="list-style-type: none"> - erythromycin eyedrops
<i>Hepatitis B</i>	<ul style="list-style-type: none"> - screening of all mothers - Hepatitis B immunoglobulin - Hepatitis B vaccine
<i>Herpes simplex</i> type 2	<ul style="list-style-type: none"> - cesarean section delivery - antiviral therapy
<i>Neisseria gonorrhoeae</i>	<ul style="list-style-type: none"> - silver nitrate eyedrops - erythromycin eyedrops - chemoprophylaxis to infants born to positive mothers

4.6.7 Nosocomially-acquired infections

Nosocomially-acquired infections can be defined by their occurrence after the first 48 hours of life. There is a difference in nosocomial infections in normal, full-term infants and those in NICU's. Minor and superficial skin infections, often associated with *Staphylococcus aureus*, are typical in term infants. These infections are minor, and only occasionally does severe sepsis occur. Gram-positive bacteria are common pathogens in nosocomial bacteremias, pneumonias and urinary tract infections (Payne, Schilling & Steinberg, 1994: 41). In NICUs invasive disease is common including Gram-negative bacteria, coagulase-negative staphylococci and fungi (Tarlow, 1994: 48).

The prevention and control of hospital infections are still a global health problem. Several reasons for this are:

- In many countries, especially the third world, uncontrolled use of antibiotics has led to new resistant bacterial strains.
- The rapid spread of HIV infection.
- There is a greater awareness of the potential pathogenicity of organisms of low virulence, that were previously regarded as contaminants.

In countries where effective infection control programmes are implemented, the incidence of nosocomial infections are low. A well-structured infection control programme can reduce mortality, morbidity and costs to the patient and the hospital (Pearse, 1997: 5).

A variety of factors can increase the risk of nosocomial infections, namely the micro-organism, patient risk factors, the environment and equipment, and the treatment. These are summarised in table 4.18

Table 4.18 Factors that increase the risk of nosocomial infections

FACTORS THAT INCREASE THE RISK OF NOSOCOMIAL INFECTIONS	
MICRO-ORGANISMS	<ul style="list-style-type: none"> - intrinsic virulence - infective dose - antimicrobial sensitivity or resistance
PATIENT RISK FACTORS	<ul style="list-style-type: none"> - extremes of age - immune status - underlying disease, eg. renal failure - presence of foreign bodies - disruption of host barriers - length of stay in hospital
ENVIRONMENT AND EQUIPMENT	<ul style="list-style-type: none"> - environment - equipment - contaminated disinfectants
TREATMENT	<ul style="list-style-type: none"> - procedures which disrupt the natural host's defence mechanisms - medication, eg. antibiotics

* **Routes of transmission**

Various routes of transmitting of hospital infections have been identified, namely direct contact, indirect contact, airborne route and common vehicle spread. These various routes are summarised in Table 4.19

Table 4.19 Routes of transmission (Pearse, 1997: 7)

ROUTES OF TRANSMISSION OF HOSPITAL INFECTIONS	
DIRECT CONTACT	<ul style="list-style-type: none"> - hands - clothes of staff - bedclothes and personal items - faeco-oral transmission (<i>Shigella</i>)
INDIRECT CONTACT	<ul style="list-style-type: none"> - contaminated instruments (salmonellosis) - shared non-clinical equipment (bedpans)
AIRBORNE ROUTE	<ul style="list-style-type: none"> - droplet spread - droplet nuclei - dust particles - skin squames - aerosols
COMMON VEHICLE	<ul style="list-style-type: none"> - contaminated hospital blood - HIV, HBV and HCV in blood and blood products - <i>Pseudomonas</i> in disinfectants - Gram-negative organism contaminating infusats, irrigating solutions

The most important mode of transmission in the NICU is directly by medical and nursing personnel. Occasional outbreaks occur due to contaminated equipment. Hand washing is therefore essential to any infection control process. Other factors that increase the risk of infection are low-birth-weight, length of stay, invasive procedures, overcrowding, understaffing and the frequent use of antibiotics (Tarlow, 1994: 48). The non-specific signs of nosocomial bacterial infection are summarised in table 4.20.

Table 4.20

The non-specific signs of nosocomial bacterial infection (Payne, Schilling & Steinberg, 1994: 41)

PHYSICAL EXAM	LAB FINDINGS	RADIOGRAPHIC FINDINGS
hypothermia	positive blood or body fluid culture	intestinal ileus
fever	neutropenia	new pulmonary infiltrates
hypotension	increase number of	
poor skin perfusion	immature polymorphonuclear leukocytes	
apnoea/bradycardia	leukocytosis	
tachycardia	thrombocytopenia	
lethargy	metabolic acidosis	
abdominal distension	hyperglycemia	
feeding intolerance	glucosuria	
	hypoglycemia	
	elevated CRP	

* Gram-positive organisms

Group B Streptococci: This organism has become the most common cause of bacteraemia in many nurseries. It can be acquired intrapartum from the female genital tract and colonise the skin, upper respiratory and gastro-intestinal tracts of the neonate (Betts & Reese, 1996: 72). The infection may be asymptomatic or present as septicaemia, pneumonia or meningitis.

Group B Streptococcal infection can be classified into early and late onset. Fulminant disease is acquired by vertical transmission and occurs within the first 72 hours of life. The neonate will present with respiratory distress, hypotonia, poor feeding, hypoxemia and shock. Late onset occurs after seven days of age and usually presents as sepsis, meningitis or another localised infection (Betts & Reese, 1996: 73; Beachy & Deacon, 1993: 354).

Staphylococcus aureus: Very small numbers of staphylococci are required to colonise the neonate. The major source of infection is hospital personnel, but is also associated with umbilical catheters, endotracheal tubes and central lines.

S. aureus infection cause skin infections, pneumonia, endocarditis, bacteraemia and osteomyelitis. This infection is transmitted by means of contact and airborn route (Beachy & Deacon, 1993: 79; Tarlow, 1994:48).

Methicillin and oxacillin are antibiotics which are used in the laboratory to test the sensitivity of *S. aureus*. If *S. aureus* is resistant to methicillin and oxacillin, it is also resistant to penicillins and cephalosporins. The endemic strain of methicillin resistant *S. aureus* (MRSA) is only sensitive to vancomycin, chloramphenical, fusidic acis and rifampicin. These antibiotics have many side-effects and are very expensive. Staff that are nursing and exposed to MRSA-positive patients, are at risk of becoming carriers (Pearse, 1997: 80).

If an outbreak of disease occurs, APIC (1996: 47-12) recommends the following measures:

- Hand washing and other routine infection control measures should be emphasised.
- Contact precautions (gloves, gowns, hand washing) should be taken for infants with known or suspected infection.
- New admissions should be separated from exposed infants.
- Post-discharge surveillance for recently-discharged infants should be instituted.

- Cultures from the umbilicus and nares of infants, as well as the hands of personnel should be obtained to determine the extent of colonisation.
- Determine whether an epidemic strain is present.
- Term infants should be bathed with hexachlorophene and antimicrobial agents applied to the cord.
- Application of mupirocin in paraffin base to the cord and nares of an infant has been used to control an MRSA outbreak.
- Personnel identified as carriers should be removed from patient contact and receive intranasal or oral antibiotics.
- Follow-up care infants is advised.

Staphylococcus epidermidis: This organism is often regarded as a contaminant, but *coagulase-negative staphylococci* may be important pathogens. The following are important infections caused, namely central venous catheter-related sepsis, prosthetic-device infections, bacteraemia and endocarditis. *S. epidermidis* is transmitted in skin squames via slothing, linen and dust. Vancomycin is the most effective antibiotic as NICU strains are frequently resistant to Beta-lactam antibiotics (Pearse, 1997: 81; APIC, 1996: 47-13).

Enterococci: This organism causes late-onset bacteremia, soft tissue abscesses, pneumonia and meningitis in the NICU. Bowel resection and central venous catheters increase the risk for infection. *Enterococci* are relatively resistant to antibiotics, and *enterococci* resistance to vancomycin have been reported (APIC, 1996: 47-13).

Listeria monocytogenes: This organism is a short Gram-positive rod which is acquired transplacentally or from the vaginal canal of a colonised mother. It can cause fulminant, disseminated disease with multi-organ involvement. Clinical features include hypothermia, lethargy, poor feeding and a salmon-colored rash which is well treated with ampicillin (Beachy & Deacon, 1993: 355).

* Gram-negative organisms

Escherichia coli: This is the most common Gram-negative organism in the neonatal period. These Gram-negative bacilli are components of the infant's stool flora that are acquired either from the mother or the NICU (APIC, 1996: 47-13). They are the most common cause of urinary tract infection and neonatal meningitis. It is transmitted via hands, poor food handling techniques, contaminated equipment and poor nursing techniques. It is prevented by hand washing, correct aseptic technique, correct food handling and sterile equipment (Pearse, 1997: 100).

Pseudomonas aeruginosa: These organisms can survive and replicate within the hospital environment. They colonise sinks, hospital distilled water systems and even disinfectants (Grundman, 1993: 943). *Pseudomonas* can cause the following infections namely urinary tract infection, intravenous line sepsis, bacteremia, wound infections and pneumonia. Infection can be transmitted by nebulisers, humidifiers, ventilators and aerosols. Soaps and water-based solutions can easily be contaminated (Pearse, 1997:93). Indirect contact transmission occurs through inadequate decontamination of patient care equipment, such as resuscitation equipment, suction devices and blood-gas analysers. It was even isolated from the water-bath used to thaw fresh frozen plasma (Muyldermans, 1998: 309). Prevention is by means of hand washing, isolation and environmental control (Pearse, 1997: 97).

Klebsiella: These pathogens are present in the respiratory tract and faeces of healthy people. There are two species namely *K. pneumoniae* and *K. oxytoca*. *K. pneumoniae* is known to cause pneumonia and urinary tract infections. It is transmitted via hands, contaminated fluids and equipment. It is prevented by hand washing, sterilisation of equipment and protection of fluids (Pearse, 1997: 98).

Serratia marcescens: This is a common opportunistic hospital pathogen, known to cause bacteraemia, pneumonia and endocarditis. Transmission is via hands and contaminated equipment and can be prevented by hand washing, sterilisation and isolation.

* Fungal infections

Candida albicans: This pathogen can cause localised disease in any organ. Risk factors include prematurity, immunocompromised infants, neonates who are receiving TPN or who have been on broad-spectrum antibiotics. Frequent sites of candidiasis include the lungs, kidneys, liver, spleen and brain. Acute pseudomembranous and cutaneous candidiasis are also common forms of candidiasis in the newborn (Beachy & Deacon, 1993: 357).

4.7 INFECTION CONTROL PROCESS

The purpose of infection control is to prevent and control hospital associated infections. The Infection Control Programme is guided by an Infection Control Committee and implemented by the Infection Control and Epidemiology Department. Stanford Health Services recommend the following infection control programme (Stanford Health Services, 1997):

Prevention and control of nosocomial infections are fundamental responsibilities facing all health care facilities. Moral, financial and legal factors demand high standards and protection for patients and hospital personnel. The increased complexity of medical care, and the concern about patient and personnel exposures, stressed the need for comprehensive, cost-effective infection control measures.

The primary goal of infection control is to ensure a safe environment for patients, personnel and visitors. The current programme includes surveillance, education and consultation activities. The manager and staff of the Infection Control and Epidemiology Department are responsible for surveillance, education and consultation as they relate to the identification and prevention of nosocomial infections.

The basis of an infection control programme is adequate surveillance of nosocomial infections in patients and personnel. Without surveillance, neither problems and nosocomial infections, nor the effectiveness of infection control activities, can be evaluated. Focused surveillance is important for the identification and tracking of nosocomial infections, as well as the monitoring for the necessary corrective actions. Surveillance is done by the Infection Control Department to determine the types and

frequency of targeted nosocomial infections, and to identify procedures and practices associated with high risk for acquiring infections.

An educational programme is to ensure the implementation of infection control measures and to provide feedback to health care workers regarding nosocomial infections. The educational programme includes classes for medical, nursing, and para-medical personnel, as well as patient education.

Consultation services should be available to all departments, regarding the principles and techniques pertinent to infection control. Preventive and problem solving techniques are utilised.

The Infection Control Department assists the different hospital patient care units with the design and implementation of the appropriate infection control policies. This process incorporates guidelines/ regulations/standards of associated agencies and organisations (for example the Centers for Disease Control and Prevention) into department-specific infection control policies and procedures. All department managers and their staff are responsible for knowing and implementing the policies and procedures designed to facilitate the infection control programme.

The infection control programme includes written policies and procedures for infection surveillance, prevention and control for all patient care departments and services. These policies and procedures should address the following:

- the required method for handling all blood and body fluids to reduce the risk of transmission of potentially infectious micro-organisms from patient to patient and between patient and healthcare worker. Such methods include hand washing, use of gloves, use of barriers, handling of sharps and disposal of materials soiled with or containing blood and/or body fluids;
- the required practices to reduce the risk of transmission of airborne infectious agents, including the assignment of rooms and/or roommates;

- the required indications for specific precautions to prevent transmission of infection, including the requirement that adequate infection control devices and supplies be available in patient care areas and filled waste containers be disposed of in a timely manner;
- the required provisions for the education of personnel. The programme provides for training of each new employee with regard to infection control policies and procedures. Documentation of training will be maintained by the department manager;
- the required plan for surveillance, prevention and control of nosocomial infections and procedures for investigation and management of outbreaks;
- the required definitions of biohazardous materials.

The infection control department should provide that designated patient care support departments such as housekeeping and laundry services, be available to assist in prevention and control of infections and be provided with adequate direction, staffing, and facilities to perform all required infection surveillance, prevention and control functions. There should be specific written policies and procedures applying when conducting decontamination and sterilisation activities. All sterilising activities in the hospital should be monitored.

The responsibilities of the infection control committee are as follows:

- Evaluates and approves the type and scope of surveillance activities.
- Approves actions to prevent or control infection.
- Reviews nosocomial infections where there is a potential for prevention or intervention to reduce the risk of future occurrence.
- Reviews and approves all policies and procedures related to infection surveillance, prevention, and control programme.

- Assists employee health in formulating and evaluating policies and procedures regarding exposures and communicable diseases among employees.
- Reviews and evaluates plans for renovation of existing facilities and plans for construction of new facilities to incorporate sound infection control principles into the design and to promote implementation of aspergillosis prevention policies and monitoring compliance systems in all phases of construction/ renovation of plans.

4.8 RISK FACTORS

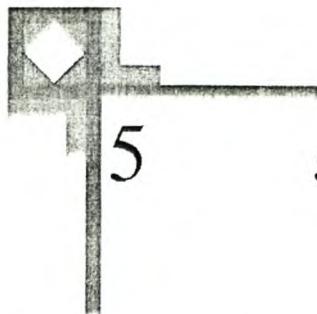
The following factors have been identified from the literature study, as being able to influence the implementation of an effective infection control process in a NICU. These factors can be categorised according to macro-, meso-, and micro-levels, and include:

- * Macro-level
 - environmental hygiene
 - sufficient equipment and facilities
 - personnel ratio of 1:1 or 1:2, according to acuity levels
 - standard infection control precautions
- * Meso-level
 - a mission statement
 - an infection control programme, under supervision of the infection control nurse
- * Micro-level
 - antenatal programme for mothers
 - prudent use of antibiotics.

These factors correlate with those identified from the narrative.

4.9 SUMMARY

The literature study has been described in this chapter. The literature study was done on neonatology, infections and infection control. Factors were identified from the literature as being able to influence the implementation of an effective infection control process in a NICU, and were described on macro-, meso-, and micro-level. In Chapter Five, a summary and recommendations will be described.



5

SUMMARY AND RECOMMENDATIONS

5.1 Introduction

Due to the rising health care costs, it is essential that all nursing activities should be geared towards optimal usage of scarce resources, such as nursing personnel and supplies, including antibiotics. Nurses should be aware of nursing activities that can increase the cost to the neonate. The ultimate goal of nursing is quality nursing. Quality nursing includes cost-effective nursing, and cost-effective nursing implies that basic nursing procedures such as the proper handwashing technique should be implemented to prevent the spread of nosocomial infections.

In Chapter One of the study, an overview was given regarding the factors influencing the implementation of an effective infection control process in a NICU. A brief description of the research methodology that was to be followed was included. In Chapter Two, the research methodology, which included the case study method, was described. A description of the narrative was done in Chapter Three, and various factors were identified that had an effect on the infection control process. These factors were identified on a macro-, meso- and micro level. A literature study, in Chapter four, included neonatal intensive care nursing, microbiology and infection control.

In this chapter, conclusions, recommendations and a summary will be described.

5.2 Purpose of the study

The purpose of this study was to identify factors influencing the implementation of an effective infection control process in a NICU.

The objectives were:

- to explore the literature and the environment on
 - * effective infection control programmes
 - * nosocomial infections in NICU's
- to identify factors influencing the implementation of an effective infection control process in a NICU.

These objectives were met, as described in the chapter layout in 5.1.

5.3 Central theoretical assumption

The identification of factors influencing an effective infection control process in a NICU will facilitate:

- an awareness for quality infection control nursing and the
- prevention of nosocomial infections in the neonate.

5.4 Research design

In this study an exploratory and descriptive design with a qualitative orientation, was implemented. The case study design was defined as an in-depth analysis of a single unit of study, in this case the NICU, implemented under natural conditions. The researcher spent a day in the NICU to observe nursing and other health care activities. Factors were identified after the description of the narrative and the literature study.

5.5 Recommendations

Recommendations forthcoming out of this study will be described on macro-, meso- and micro levels. These recommendations regarding the factors influencing the implementation of an effective infection control process in a NICU, should serve as a guideline for hospital management, nursing staff and other health care personnel. Recommendations refer to quality circles, hand hygiene and antibiotics, recognition of personnel and in-service education.

5.5.1 Macro level

The following factors were identified, namely cleanliness of the unit; the open door; no wall mount for the hibiscrub soap; only one refrigerator used for blood and medication; warming of bottles with expressed breast milk in one container; no masks with visors for suctioning; not all equipment, necessary for infection control is in working order; insufficient numbers of nursing personnel.

*** Quality circles**

The researcher recommends that the concept of a quality circle be implemented to resolve the above problem. A quality circle will include a top-down approach that is hospital management, nursing personnel, medical doctors and housekeeping personnel. It is voluntary participation during working hours at specific times. Members are asked to identify problems and solutions to the problems. Feedback must be given during circle meetings, which is held on a regular basis. This is determined by the group and the type of problem. Recognition should be given, monitored and published in local communication circulars. Publication in accredited journals is essential, as it provides recognition of a job well done. The person presenting the quality circles, must be an expert in facilitating quality circles. He/she must be acceptable for all the group members.

*** Hand hygiene and antibiotic usage**

Hand hygiene and antibiotic usage are global problems. The following recommendation are made:

Improving the compliance to hand hygiene, requires a long-term approach. The first step is to evaluate the existing structures. Factors, not conducive to compliance, must be identified through a survey. Examples of these factors can be insufficient numbers of equipment or poor quality of products.

The next step is to select the most appropriate products, to improve the quality and distribution to the products, and to promote the use of alcoholic

handrubs. Finally, create staff awareness and active participation in promoting hand hygiene. The following interventions can improve hand hygiene, namely:

- education
- performance feedback
- modification
- improvement of equipment
- improvement of skin products
- modification of policies and procedures
- attempts to increase staff interest
- commitment by role modelling.

The effective interventions to improve compliance will not only involve the application of behavioural therapy, but also organizational commitment, standard setting and effective enforcement strategies. See annexure 1 for the programme on handwashing.

Gloves are an important part of hand hygiene and should be regarded as such. Infection control guidelines were introduced in the 1980s as body and blood substance precautions. The increased use of gloves had a definite impact on handwashing resulting in a decrease in compliance. A few guidelines to implement:

- pick the right glove, to ensure that latex allergy do not become a problem
- use a high quality glove, as this will lower the risk of latex allergy from gloves
- never re-use gloves
- wash hands after removing gloves
- change gloves if any defects are noticed on the glove
- keep nails short and do not use rings under gloves.

In developing countries, gloves are often re-used, because of minimal resources. Local guidelines, quality assessment of the policies for re-use, plans for glove life cycles, procedures for washing, disinfection and sterilisation, is required. An increase in glove use compliance can be measured by audit and feedback. Guidelines for the use of gloves and a policy on the re-use of gloves is a must in every country. In-service education is a very important part of quality infection control nursing. The

presenter must be creative in order to obtain the necessary interest of personnel. Personnel must be motivated to attend congresses, or the local infection control society's workshops.

Despite the existence of numerous antimicrobial agents, a person can still die from a multiresistant bacterial infection. A few examples of the multidrug resistant pathogens are:

- penicillin-resistant *pneumococci*
- vancomycin-resistant *enterococci*
- methicillin-resistant *staphylococci*
- *pseudomonas aeruginosa*
- *acinetobacter baumannii*
- *enterobacter cloacae*

According to studies, about one-half of all antibiotic use is 'inappropriate'. Six lines of evidence have linked antimicrobial misuse or over-use with antimicrobial resistant bacteria:

- antimicrobial resistance is more evident in nosocomial bacteria than in community acquired organisms;
- patients with resistant strains are more likely to have prior antibiotic exposure;
- changes in antimicrobial use contribute to parallel changes in the prevalence of resistance;
- the longer duration of exposure to antimicrobial agents, the better the likelihood of colonisation/infection with resistant bacteria;
- superinfection or colonisation with resistant organisms is enhanced by inadequate dosages of antimicrobials (Giamarello, 1997: 40)

A tertiary University Hospital in Athens, have applied an antibiotic restriction policy, with the following results:

- an audit program can contribute in the decrease of antibiotic resistance rates and promote cost containment;
- such a program requires continuous audit and follow-up, because doctors are pressured with the newest and expensive antibiotics,
- the involvement of an infectious disease physician is indispensable since surgeons and clinicians are not eager to obey the recommendations of microbiologists;
- it is essential that there should be co-operation between the pharmacy and the microbiology laboratory, and
- education of doctors should be ongoing and is proved to be successful in small group format (Giamarellou, 1997: 40)

According to Betts & Reese (1996), a series of ten important questions can and should be routinely addressed before selecting a specific antibiotic. See Table 5.1

Table 5.1 Questions for the administration of antibiotics (Betts & Reese, 1996: 1060)

IMPORTANT QUESTIONS TO ANSWER ROUTINELY BEFORE SELECTING AN ANTIBIOTIC
1. Is an antibiotic <i>indicated</i> ?
2. Have appropriate <i>specimens</i> been obtained, examined, and cultured?
3. What <i>organisms</i> are most likely?
4. If several antibiotics are available, which is best?
5. Is an antibiotic <i>combination</i> appropriate?
6. What are the important <i>host factors</i> ?
7. What is the best <i>route of administration</i> ?
8. What is the appropriate <i>dose</i> ?
9. Will initial therapy require <i>modification</i> after culture data are returned?
10. What is the optimal <i>duration</i> of treatment, and is development of <i>resistance</i> during prolonged therapy likely to occur?

* **Recognition of nursing personnel**

It is the responsibility of the unit manager to evaluate the level of motivation in the unit in view of internal and external environmental variables. A motivational diagnosis must be made by the unit manager, and can be either positive or negative. When motivation is high, co-operation in the unit is good, the morale is high and productivity in the unit is positive. The end result will be quality nursing care. Low motivation results in conflict in the unit, gossiping among personnel and poor treatment by the leader. The result will be poor nursing care.

in the unit, gossiping among personnel and poor treatment by the leader. The result will be poor nursing care.

After the assessment and diagnosis, a motivation strategy must be planned. This should preferably be done in a participative manner with the personnel. Muller (1996: 205) suggest a few motivation principles that can be utilised in a motivation strategy:

- Provision in the physical and physiological needs of the personnel, such as periods of rest in the form of suitable shifts, or meals and tea/coffee.
- Stimulation of intellectual abilities of the personnel by means of training and the promotion of critical thinking.
- Cultivating a feeling of pride by delegating responsibilities according to their knowledge and skills.
- Creating emotional obligation by giving the necessary recognition to achievement, as well as reprimand when the set standard are not met. Give recognition, eg. merit motivation, when a personnel member truly deserves it, without unleashing behaviouristic behaviour.
- Providing favourable working conditions. This includes sufficient supplies, equipment and other technological resources. Avoid rules and regulation which could create resistance. Identify frustrations in the unit, and make an effort to eliminate these.
- Providing the necessary human resources. This include sufficient personnel, according to the patient acuteness levels and the principle of reasonableness.
- Promoting teamwork between personnel members.
- Providing job security in the unit.
- Treating personnel like human beings.

- Maintaining positive mutual relations between personnel members through open communication of different values, holding regular climate meetings, positive handling of conflict, and the utilisation of the most relevant leadership style by the unit manager.
- Role modelling by the unit manager is a strong incentive to the personnel in the unit.

When nursing personnel find their work enjoyable, the productivity is high and more cost-effective.

5.5.2 Meso level

Factors identified on meso level were no philosophy or mission statement in the unit, infection control file with no relevant information with regard to neonatal infections and the infection control file was not easily accessible. Recommendation will be on the mission statement and the infection control manual.

*** Mission statement**

To turn a vision into results, a leader needs assistance from others. Others need to see their own hopes and dreams in this vision. Peter Senge wrote:

"A shared vision is not an idea. It may be inspired by an idea, but once it goes further - if it is compelling enough to acquire the support of more than one person - then it is no longer an abstraction....It is, rather, a force in people's hearts, a force of impressive power. Few, if any, forces in human affairs are as powerful as a shared vision. At its simplest level, a shared vision is the answer to the question. What do we want to create? Just as personal visions are pictures or images people carry in their heads and hearts, so too are shared visions pictures that people throughout an organisation carry. They create a sense of communality that permeates the organisation and gives coherence to diverse activities."

Hersey & Blanchard (1996:557) suggest the following guidelines:

- Define a purpose or mission, alone or with a team, and communicate this purpose to the different members to create a shared vision.
- Make strategic choices to create peak performances by ensuring the availability of the required human, technical and financial resources.
- Set challenging performance goals, communicate your expectations and place rigid demands on oneself and on others.
- Create and activate positive mental models. Use this model to stimulate, guide and encourage organisational members beyond their comfort zone.
- Build strong performance ethics by using personal and position power and by creating disciplined work processes in order to ensure the work processes and rules are implemented.
- Help team members grow by defining clear roles, delegating tasks, giving support and care, and help them develop through direct and honest feedback.

If all members of the team are focused and directed toward a shared vision, fantastic results can be accomplished.

* **Infection control manual**

The infection control manual should contain relevant information and be "user-friendly" with regard to neonatal infections. This manual must be readily available so that all personnel can use it as a verbal guideline to ensure quality infection control. An infection control committee should give input regarding the policies and procedures in the infection control manual and therefore both the impact of the infection control committee and the infection control manual on nosocomial infections should be evaluated.

5.5.3 Micro level

Antibiotic guidelines must be implemented as described under the macro level.

5.5.4 Future research

Recommendations for future research include:

- Structure standards for all aspects of standard infection control precautions, including hand washing and gloving.
- The effectiveness of a Quality Circle with regard to the implementation of an effective infection control process in a NICU.
- Effective personnel allocation in a NICU in order to implement an effective infection control process.
- A comparison of NICU's in the private and public sector.
- The impact of an infection control committee on nosocomial infections in a health care facility.

5.6 Summary

Nurses are being held responsible and accountable for the quality of nursing care, which includes effective quality infection control nursing, they provide. This change in accountability has been brought about by the need to reduce the ever escalating costs of health care. During the 1980's, health care services created a demand for high-quality, efficient, cost-effective and competitively priced health services. In order to provide these services, health care organisations are forced to consider new strategies. This is a process that produces outcomes. Quality improvement methods, which include infection control, help organisations to produce these outcomes.

Donabedian (1980) defined high-quality care as "that kind of care which is expected to maximise an inclusive measure of patient welfare, after one has taken account of the balance of expected gains and losses that attend the process of care in all its parts" (Grossman, 1998: 43). Quality improvement in infection control is the activities employed to improve the performance of a process, and include the process of planning and control.

Management is responsible and accountable to provide resources in order to implement quality infection control nursing care.

The purpose of this study was to identify factors influencing the implementation of an effective infection control process in a NICU.

An exploratory and descriptive design with a qualitative orientation was implemented. It consisted of a narrative and a literature study through which factors have been identified to influence the implementation of an infection control process in a NICU. The case study design, an in-depth analysis of a single unit of study, was utilised in this study as part of the data-gathering process.

Recommendations were made on the macro, meso and micro levels, which included quality circles, hand hygiene and antibiotic usage, inservice education, recognition of personnel, mission statement and the infection control manual. The shortage of human and physical resources in nursing is a global problem. In S.A. there has been no previous study to emphasise the importance of an effective infection control process, and therefore no solutions to the problem have been suggested. The Japanese view with regard to quality circles is recommended.

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ANNEXURE ONE

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A simple hand hygiene exercise

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Abstract

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In an illustrative sequence of exercises, we teach our students how to don, use, and take off sterile gloves correctly and how to wash hands properly. During this sequence, the effect of a good handwashing technique as well as the effect of failures in aseptic technique with gloves is made directly visible by the use of finger paints. This technique helps medical staff to visualize microbial contamination of the hands and to increase the awareness of breaks in aseptic technique. (AJIC Am J Infect Control 1999;27:370-2)

Not only from our personal experiences, but also from recent literature,¹⁻³ it is evident that compliance with hand hygiene rules is not particularly good in medical institutions. This lack of compliance occurs despite exhaustive scientific proof for the merits of hand hygiene in preventing nosocomial infections⁴⁻⁷ and despite increasing legal pressure for compliance with hand hygiene standards.⁸ We feel a great need for enhanced and unequivocal appreciation of hand hygiene by all the professions that work in medical institutions.

Taylor^{9,10} described a method to detect failures in handwashing technique with the use of dye. Based on this knowledge, a standard handwashing technique was designed by Ayliffe et al.¹¹⁻¹³ This technique has been included in the European standards for handwashing and hand disinfection.^{14,15} Our aim was to include this knowledge into practical teaching for students of all medical professions.¹⁶ Therefore, we formulated the sequence of exercises that we describe in this article, which cover donning and use of sterile gloves, washing techniques, and direct visualization of the effects of breaks in aseptic techniques.

MATERIALS

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- sterile latex rubber gloves of suitable sizes, in pairs and wrapped in sterile paper sheets (the sleeves of the wrapped gloves must be inverted to present the rubber surface, which later touches the skin of the volunteer)
- plastic aprons
- plastic waste bag in rack with pedal-driven lid

- dye of creamy consistency (“finger paint” as used in kindergartens) in an open tub
- open tub with about $\frac{1}{2}$ L of tap water
- table of sufficient size for the actual number of volunteers (about $1/4\text{ m}^2$ per person)
- single use table cloth

PREPARATION

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The table is “laid out” with the table cloth, the sterile gloves in sterile wrappings are placed at each position, and the dye and the water tub is placed in the center of each table. The waste bag is positioned near the table. One supervisor guides a group of 2 to 10 volunteers. Sleeves are rolled up, rings, watches, and bracelets are taken off, and plastic aprons are donned.

EXERCISE

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Part 1: Don sterile glove

1. Open the glove wrapping without touching the glove or the inside of the wrapping; the gloves should now lie in the correct position in front of the volunteer: right glove in right position, left glove in left position, glove fingers pointing toward the opposite volunteer. Paper wrap must be slightly bent to keep the wrap open.
2. Pick up the inverted part of the sleeve of the left glove with your right thumb and index finger.
3. Lift the glove and insert the pointed fingers of your left hand.
4. Pull the sleeve to the wrist while gently rotating your left arm; release the sleeve smoothly.
5. Point and insert fingers 2 to 5 of (now gloved) your left hand under the inverted sleeve of the right glove and lift the right glove—avoid moving the glove across the wrapping paper because its edges could be contaminated.
6. Carefully insert the pointed fingers of your right hand into the right glove—avoid touching the gloved left thumb with the ungloved fingers of your right hand.
7. Pull the sleeve to your wrist while gently rotating your right arm and release sleeve smoothly.
8. Now correct misfittings of the gloves and fingers.
9. While waiting for the next step, avoid touching anything (eg, clothes, hair, or nose) with sterile hands; keep your elbows against your thorax and your hands together and away from your body.

Part 2: “Wash” hands with creamy dye in ordinary style (dye will imitate liquid soap)

1. Take approximately 5 mL of creamy dye from tub.
2. Close your eyes and distribute dye on gloved hands by using your ordinary technique (ie, “social handwash”).
3. Open your eyes and check your hands—which parts have been missed by the dye? Point to those parts and describe.

Part 3: Perform correct washing technique

Follow the washing movements (5 strokes backward and 5 strokes forward) exactly as presented by the supervisor.

1. Palm to palm
2. Rotational rubbing of right palm over left dorsum
3. Rotational rubbing of left palm over right dorsum
4. Fingers interlaced and palm to palm
5. Fingers interlaced right palm over left dorsum
6. Fingers interlaced left palm over right dorsum
7. Back of left fingers to right palm with fingers interlocked, rubbing fingertips to palms of opposing fingers
8. Rotational rubbing with clasped fingers of right hand in palm of left hand
9. Rotational rubbing with clasped fingers of left hand in palm of right hand
10. Rotational rubbing of right thumb clasped in left palm
11. Rotational rubbing of left thumb clasped in right palm

Moisten hands with water whenever the dye gets too dry.

At the end of the washing, check whether hands are evenly painted; if not, repeat the appropriate movement to achieve uniform cover with dye. As already mentioned by Taylor,⁹ the tips of the thumb and index finger and the interdigital spaces are most often missed.

Part 4: Remove “soiled” gloves without touching your clothes, the skin of your hands and arms or other parts with your painted fingers/hands.

1. Move to waste bag, open pedal driven lid, and keep hands above the opening of waste bag.
2. Pick the sleeve of the left glove with the thumb and index finger of your right hand, hook your third finger underneath, and invert proximal sleeve.
3. Gently peel off the sleeve toward your fingertips, but do not remove the glove completely. Leave the fingers of your left hand covered with the inverted sleeve (soiled surfaces of the left glove should now be hidden under the inverted glove).
4. Repeat the same procedure on the right glove with your (still gloved) left fingers: pick the right sleeve, hook your third finger under the sleeve, and tear the glove gently from your right hand.
5. Drop both gloves into waste bag. Experienced persons manage to drop both gloves simultaneously.
6. Inspect hands, forearms, clothes, and work area for dye stains.
7. Wash hands carefully.

We find that this exercise is a very good opportunity to practice hand hygiene in a protected and stress-free atmosphere. Much too often professionals confront us with the argument that what we teach them is impossible in emergency situations. Our argument is that good hand hygiene techniques are proven and essential for good results in modern medicine. Therefore, hand hygiene abilities that are automated and function in all situations should be requested from all (sich von..zu Eigen gemacht werden) by all medical professions. From laboratory handwashing experiments, we have decisive evidence that the volunteers who adhere to a good handwashing technique produce much better and consistent reductions of skin bacteria than do unexperienced volunteers.

This exercise is part of the compulsory hygiene practice for medical students at Vienna University; it is very well accepted and is constantly scored high by our students. Last but not least, this exercise is a kind of teaching that is fun for both faculty and students—and funny situations give longer lasting engrams. We observe that our participants begin to criticize improperly equipped handwashing and disinfecting facilities. Indeed, handwashing facilities in some medical institutions tend to lag behind those in modern hotels or public institutions. We hope that in their future professional lives, our students will trigger some necessary changes in hospitals.

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Practice Forum articles should address infection prevention and control practices and related applications of epidemiology. Items should be limited to 2 to 5 typed double-spaced pages. Please send items to the Editor, Elaine L. Larson, RN, PhD, FAAN, CIC, Columbia University School of Nursing, 630 W 168th St, New York, NY 10032.

Publishing and Reprint Information

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