RISK FACTORS FOR UNDERIMMUNISATION IN HOSPITALISED PRESCHOOL CHILDREN IN USM HOSPITAL

By

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List of abbreviations

ACIP	American Committee of Immunisation Practice
AFP	Acute flaccid paralysis
BCG	Bacillus Calmette-Guerin
CI	Confidence interval
DPT	Diphteria, pertussis, tetanus
Et al	And others
EPI	Expanded Programme of Immunisation
Hib	*Haemophilus influenza* type B
IPV	Injectable poliovirus
Kg	Kilogram
MMR	Measles, mumps, rubella
OPV	Oral poliovirus
OR	Odds ratio
US	United States
USM	Universiti Sains Malaysia
VAPP	Vaccine associated paralytic polio
WHO	World Health Organisation

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ABSTRAK

Pengenalan:

Pelalian adalah salah satu kaedah yang telah terbukti keberkesanannya dalam mencegah sesetengah penyakit berjangkit. Namun begitu, komplians terhadap jadual pelalian yang disarankan selalunya tidak dipatuhi, terutamanya di kalangan kanak-kanak prasekolah. Ini seterusnya menghadkan keberkesanan pelalian itu sendiri. Pengenalpastian factor-faktor risiko kelewatan / ketidaklengkapan pelalian diharap dapat membantu meningkatkan lagi liputan pelalian.

Objektif:

Menentukan kadar peratusan kelewatan / ketidaklengkapan pelalian di kalangan kanak-kanak prasekolah yang dimasukkan ke wad di Hospital Sains Malaysia (HUSM) dan mengenalpasti factor-faktor risiko berkaitan dengan kelewatan tersebut.

Metodologi:

Kajian hirisan lintang berdasarkan hospital telah dijalankan di Hospital Universiti Sains Malaysia (HUSM) dari bulan Disember 1998 sehingga Disember 2000. Seramai 401 kanak-kanak berusia 1 bulan hingga 2 tahun yang telah dimasukkan ke wad kanak-kanak dikaji. Kanak-kanak tanpa documentasi tarikh pelalian yang diberikan telah dikecualikan dari kajian. Ibubapa atau penjaga telah ditemuramah menggunakan pro forma piawai setelah mendapat persetujuan lisan. Soalan-soalan yang dikemukakan meliputi data demografi kanak-kanak dan keluarga, tarikh pemberian pelalian serta alasan-alasan jika

kanak-kanak tersebut terlewat / tidak lengkap pelaliannya. Faktor-faktor risiko di antara kanak-kanak yang lengkap pelaliannya dengan kanak-kanak yang terlewat / tidak lengkap pelaliannya telah dibandingkan.

Keputusan:

Di kalangan 401 kanak-kanak yang dikaji, 152 (37.9%) daripadanya lengkap status pelaliannya, 108 (26.9%) lagi lewat pelaliannya, manakala 141 (35.2%) lagi pelaliannya tidak lengkap. Liputan bagi vaksin Bacille-Calmitte-Guerin (BCG) adalah yang tertinggi (98.5%), manakala liputan campak adalah yang terendah (78.6%). Julat liputan vaksin bagi ketiga-tiga dos Hepatitis B adalah di antara 81.4%-98.3% manakala bagi ketiga-tiga dos OPV/DPT adalah di antara 78.8%-90.7%. Kanak-kanak prasekolah yang di masukkan ke wad yang mempunyai ibu-ibu yang lanjut usia (≥ 41 tahun) (OR 7.5, 95% CI: 1.6-35.6), yang mengalami kekurangan berat badan semasa lahir (≤ 2.0 kg) (OR 5.7, 95% CI: 1.7-19.4) serta mengalami penyakit yang kronik (OR 4.1, 95% CI: 2.4-7.3) didapati mempunyai perhubungan yang paling kuat dengan risiko kelewatan / ketidaklengkapan pelalian. Salah anggap terhadap kontraindikasi pelalian di kalangan ibubapa (47.4%) dan staf-staf kesihatan (42.7%) adalah alasan utama yang diberikan oleh ibubapa terhadap kelewatan pelalian anak-anak mereka.

Kesimpulan:

Sebilangan besar kanak-kanak prasekolah yang dimasukkan ke wad masih mengalami masalah kelewatan/ketidaklengkapan pelalian, walaupun kempen-kempen pelalian giat dijalankan di peringkat kebangsaan. Faktor-faktor risiko yang dikenalpasti dalam kajian ini diharap dapat mengatasi masalah tersebut dengan mengunakan setiap peluang yang ada dengan sebaik-baiknya untuk memberi pelalian. Liputan bagi vaksin-vaksin yang diberikan pada umur yang lebih kemudian didapati lebih rendah daripada vaksin-vaksin yang diberikan pada awal usia. Penemuan kajian ini diharap memberi lebih kesedaran di kalangan pekerja-pekerja kesihatan untuk mengenalpasti kanak-kanak yang berisiko tinggi untuk kelewatan pelalian serta mengambil langkah-langkah yang sewajarnya untuk mengatasi masalah tersebut.

ABSTRACT

Introduction:

Immunisations have been a very effective means for prevention of diseases. However, compliance with recommended schedules of immunisation in early childhood is not always complete, thus limiting the efficacy of these vaccines. Identification of potential risk factors associated with delayed / incomplete immunisation may help to increase the vaccination uptake.

Objectives:

The aims of this study were to determine the proportion of delayed / incomplete immunisation in hospitalised preschool children in Universiti Sains Malaysia Hospital (HUSM) and to identify risk factors for delayed / incomplete immunisation.

Methodology:

A hospital-based cross-sectional study was conducted at Universiti Sains Malaysia Hospital (HUSM) from December 1998 to December 2000. A total of 401 children aged 1 month to 2 years from the medical paediatric wards were recruited for the study. Children without proper documentation of dates of vaccination were excluded. Parents / guardians were interviewed using a standard pro forma containing questions on demographic data, immunisation status, potential risk factors and reasons for delayed / incomplete immunisation after obtaining a verbal consent. Potential risk factors between children with complete and delayed / incomplete immunisation were compared.

Results:

Among 401 children, 152 (37.9%) had complete immunisation, 108 (26.9%) had delayed immunisation and 141 (35.2%) had incomplete immunisation. The vaccination uptake for Bacillus-Calmite-Guerin (BCG) was the highest (98.5%) while for measles was the lowest (78.6%). The range of uptake for the three doses of Hepatitis B was between 81.4%-98.3% and for the three doses of DPT/OPV was between 78.8%-90.7%. Significant independent risk factors for delayed / incomplete immunisation were elderly mothers (≥ 41 years old) (OR 7.5, 95% CI: 1.6-35.6), low birth weight ≤2.0 kg (OR 5.7; 95% CI: 1.7-19.4) and presence of chronic illness (OR 4.1; 95% CI: 2.4-7.3). Misconceptions to contraindications of immunisation by parents (47.4%) and health personnels (42.7%) was the most common reason given for delayed / incomplete immunisation.

Conclusion:

Despite a national campaign on immunisation, a large proportion of hospitalised preschool children were still underimmunised. Risk factors identified in this study should not lead to underimmunisation if every opportunity is taken to immunise children. Vaccines that were given at a later age were more likely to have lower vaccination uptake. The findings of this study should create more awareness among health care providers to identify children at risk for underimmunisation and to intervene appropriately.

1. INTRODUCTION:

1.1 Background of the study

Immunisations have been a very effective means for prevention of diseases (Tift & Lederman, 1988). It is one of the most cost effective of all public health measures. Each year, millions of children worldwide receive vaccines to protect them from diseases such as measles, diphtheria, tetanus and poliomyelitis, which were highly prevalent prior to introduction of immunisation. Now, in many countries these diseases are rare.

Diphtheria, pertussis, tetanus, oral poliovirus, measles, mumps rubella and Haemophilus influenza b (Hib) vaccines are immunogenic and confer a high degree of protection to children when administered at appropriate intervals (Centers for Disease Control & Prevention, 1994). Although combined vaccines have been in use worldwide for several decades, effective vaccines for hepatitis B and Haemophilus influenzae type B (Hib) have only become available in recent years and have yet to be adopted onto the vaccination programmes of many countries.

Immunisation is a key component of preventive health care in children, as exemplified by the eradication of smallpox and the recent dramatic decline of invasive *Haemophilus influenzae* disease with immunisation (Vadheim, 1994; Gorelick, 1994; Centers for Disease Control & Prevention, 1994a & 1994b). Vaccination has been tremendously successful in decreasing the incidence of vaccine-preventable diseases. For example, the total number of measles cases

among US children dropped from 458,083 in 1964 (the year before widespread use of measles vaccine began) to 89 cases in 1998 (Centers for Disease Control and Prevention, 1997; Zimmerman et al, 2000). Cases of *Haemophilus influenza* type b (Hib) disease among children in United States have also dropped dramatically, from an estimated 20,000 annually (Table 1) before introduction of Hib vaccine to 228 in1998 (Zimmerman et al, 2000).

Table 1. Diseases of children in the years before vaccines were routinely used (adapted from Zimmerman et al, 2000)

Diseases	Year*	No.of cases	No.of deaths	No.of cases in 1998
Hepatitis B	1989	132,000	5820	8651
Haemophilus influenza				228
Invasive disease	1986	13,014	531	
Meningitis		8676	354	
Poliomyelitis				
All types	1954	56,784	0	1
Paralytic		18,308	0	0
Measles	1964	458,083	380	89
Rubella	1970	57,686	0	345

* the year preceding widespread use of the specified vaccine.

There is strong evidence, supporting the benefit of the vaccines for the prevention of diseases (Gershon et al, 1997). Impressive benefit to cost ratios have been shown in the United States for measles (12:1), rubella (8:1) and

pertussis (11:1) vaccines (Nicoll et al, 1989). Measles vaccine is also has been shown to be cost effective in Britain.

Despite the success of the national vaccination programme in the United States in decreasing mortality due to vaccine-preventable diseases, vaccination rates remains sub optimal. In 1999, among children aged 19 to 35 months, 94% had received 3 or more doses of Hib vaccine, 83% had received 4 doses of dipthteria, tetanus toxoid and pertussis vaccine (DPT) or DT, and 78 % had completed 4 doses of DPT, 3 doses of poliovirus vaccine, 3 doses of Hib and 1 dose of measles containing vaccine (Zimmerman et al, 2000).

Compliance with recommended schedules of immunisation in early childhood is not always complete, thus limiting the efficacy of these vaccines (Tift & Lederman, 1988). Immunisation of preschool children is intended to provide early protection to this most vulnerable group. One of the most important features of a successful vaccination programme is acceptability of the vaccines to both children and parents (Dittmann, 1999). A number of factors contribute to delayed completion of childhood immunisation series.

Unimmunised preschool children are at risk for vaccine-preventable diseases and may serve as an important reservoir of infectious disease in the community. Disease transmission in unvaccinated children has been well documented during measles epidemics (Frank et al, 1988; Bennish et al, 1986; Hutchins et al, 1989). The resurgence of measles in the US between 1989 and 1991 was associated with 55,622 reported cases, 11,251 hospitalisation and 166

suspected deaths from measles (Ad Hoc Working Group for development of standards for paediatric immunisation practice, 1993). In a measles outbreak in Dade country, Florida, overall 96 out of 257 cases (37%) were preventable (Hutchins et al, 1989). However, 84% (79) of cases occurred in unimmunised preschool age children who were eligible for measles immunisation and thus preventable (Hutchins et al, 1989).

One of the goals of Healthy People 2000 of US Department of Health and Human Services (1990) is to adequately immunise 90% of children by their second birthday, meaning that they are fully vaccinated with four doses of diphteria, tetanus, pertussis vaccine (DPT), three doses of oral poliovirus (OPV) and one dose of measles, mumps and rubella combination (MMR) vaccine. The US has taken pride in its achievements in immunisation. By the early 1980s, more than 95% of school aged children were completely immunised and incidence rates for vaccine-preventable diseases had fallen by more than 90% from prevaccination era (Cutts et al, 1992). Although the immunisation rate of children at school entry in US approaches this goal of 90% (Zell et al, 1994), only 44 to 60 % of children have received all routinely recommended immunisations by their second birthday (Bobo et al, 1993; Zell et al, 1994).

Most children in the US have received their full vaccination series by the time they enter elementary school because prematriculation vaccination is mandated by law, but many are at risk of disease during preschool years because they do not receive their immunisations according to childhood vaccination guidelines. Immunisation at school entry is not adequate to eliminate measles in densely

populated areas and is too late to prevent diseases of infancy, such as *Haemophilus influenzae* meningitis.

The World Health Organisation (WHO) has set a target for the year 2000 for the protection of all children by immunisation; it argues that a decision to withhold immunisation should be taken only after serious consideration of the potential consequences for the individual child and the community (WHO, 1984).

In Britain, only a handful of health districts have achieved the 90% coverage for measles and no district has reached 90% coverage for dipthteria, pertussis and tetanus vaccination (Nicoll et al, 1989).

In the adult United States population, lack of compliance with immunisation recommendations has been implicated as a significant impediment to the success of pneumococcal and influenza vaccines (Fedson et al, 1984). A promising approach to increase compliance is the establishment of hospital-based immunisation programmes (Ratner et al, 1983).

The key to a successful immunisation programme lies in ensuring a high degree of compliance in children of preschool age. During the first two years of life, the child immunisation schedule recommended in Malaysia specifies that Hepatitis B should be given at birth, 1 and 5 months of age, BCG at 0 month (at birth or before discharge home), DPT and Sabin oral polio vaccine at 3, 4 and 5 months, measles vaccine at 9 months of age and DPT booster at 18-24 months (Recommendations of the National Workshop on Practical Immunisation, 1990).

In Malaysia, the coverage of vaccination had increased from 1986-1998 (Table 2).

Table 2. Vaccination coverage in Malaysia between 1986-1998

Year	BCG	DPT (3^{rd})	OPV (3^{rd})	Hepatitis (3^{rd})	Measles
1986	NA	62.2%	62.2%	NA	NA
1989	NA	84.1%	83.3%	69.0%	60.9%
1990	NA	89.9%	89.6%	86.2%	70.1%
1991	NA	91.6%	91.4%	88.8%	79.8%
1993	NA	90.8%	90.8%	86.5%	81.1%
1994	NA	94.5%	93.8%	89.6%	84.9%
1995	NA	93.7%	93.5%	90.7%	85.5%
1996	NA	92.9%	92.3%	87.4%	84.2%
1997	NA	93.0%	91.4%	88.8%	84.3%
1998	100.0%	93.9%	93.4%	91.1%	86.2%

*data from Malaysian MOH annual report 1990, 1991, 1996, 1997, 1998.

Immunisation status of children is regarded as a hallmark of preventive medicine and health maintenance. Furthermore, some authors considered the vaccination rates as the indicator for adequacy of health care delivery. Rodewald et al (1995) found that underimmunisation was a powerful independent marker for inadequate health supervision in young children.

1.2 Routine childhood vaccination

1.2.1 Hepatitis B vaccine

Between 128,000 and 320,000 persons were estimated to be infected with hepatitis B virus (HBV) annually in the US and approximately 6,000 persons die annually of HBV-related liver disease (Zimmerman et al, 2000). Most of the deaths occur in persons with chronic HBV infection and are due to cirrhosis or primary hepatocellular carcinoma.

This type of infection is much more likely to become chronic when acquired early in life than during adulthood. Chronic HBV infection develops in 90% of those infected as infants, 30% to 60% of those infected before the age of 4 years, and only 5% to10% of those infected as adults (Zimmermann et al, 2000).

Although the endemic areas for hepatitis B infection vary throughout the world, overall it causes a huge economic burden and has a significant impact on health, causing about one million deaths each year (Dittmann, 1999). Furthermore, chronic hepatitis B infection is the most common cause of hepatocellular carcinoma worldwide (Schafer et al, 1999). Despite the seriousness of hepatitis B, 85-95% of cases can be prevented by vaccination (Dittmann, 1999).

Currently, more than 100 countries have introduced hepatitis B immunisation programmes and it has been calculated that in 1997, the programmes

prevented 483,000 deaths in human (Dittman, 1999). In Shanghai, vaccination has reduced the hepatitis B carrier rate from 3-13% to about 1%, and rates in other countries have decreased by 30-40%. In Taiwan, for example, the incidence in children aged 6-14 years has already fallen by about 50% (Chang et al, 1997).

The prevalence of HBV infection and its associated morbidity and mortality have led to the development of a comprehensive hepatitis B vaccination policy that includes recommendations for prevention of perinatal HBV infection, routine infant vaccination, catch-up vaccination of adolescents not previously vaccinated, catch-up vaccination of young children at risk for infection and pre-exposure vaccination of adolescents and adults on the basis of lifestyle or environmental, medical and occupational situations that place them at risk.

In Malaysia, Hepatitis B vaccines are routinely given to all infants regardless the status of Hepatitis B infection of the mother. The Hepatitis B immunisation was integrated into the Expanded Programme of Immunisation (EPI) in 1989. Malaysia is one of the first country in the world to start a national programme for Hepatitis B immunisation (MOH Malaysia annual report 1991). An intensive training programme was carried out to involve the midwives in the programme.

The National Hepatitis Control Programme began in 1989 with the initiation of the National Immunisation Programme for hepatitis B for identified high-risk groups like newborns, health and medical personnel's, intravenous drug abusers and eligible blood donors. The objective of the programme was to

reduce the morbidity and prevent the spread of the disease and the carrier rate (MOH Malaysia annual report, 1997).

The incidence rate of Hepatitis B in Malaysia has decreased markedly from 6.78 per 100,000 population in 1988 to 1.26 per 100,000 population in 1997 (MOH Malaysia annual report, 1997). It was generally associated with the increased in strategies for prevention of hepatitis B and HIV / AIDS.

The Hepatitis B vaccination policy was made because the prevalence of HBV infection was high especially in Southeast Asia, Taiwan and other oriental countries. The other possible reasons to recommend routine infant vaccination against HBV include the following: (1) morbidity and mortality of HBV infection, especially when contracted in childhood; (2) transmission of HBV infection from child to child, although relatively infrequent, has been reported in schools, daycare centers, families and among playmates (Franks et al, 1989; Hurie et al, 1992; Zimmerman et al, 2000); (3) strategies focusing on immunisation of high risk persons have had little impact; (4) no risk factors for HBV infection can be identified in at least 30% of infected persons (Alter et al, 1990; Zimmerman et al, 2000); (5) routine infant hepatitis B vaccination is as cost-effective as other commonly used preventive measures (Zimmerman et al, 2000).

Pre-exposure vaccination results in protective antibody levels in almost all infants and children (>95%) (Zimmerman et al, 2000). The infant hepatitis B vaccination schedule depends on the mother's HbsAg status. For infants born to mothers with positive HbsAg, post exposure prophylaxis including both HBIG

and hepatitis B vaccine should be initiated within 12 hours of birth, regardless of gestational age. These infants should receive their second and third doses of vaccine at ages 1 month and 6 month respectively. For infants born to HbsAg negative mothers, the schedule is 0-2 months for first dose, 1-4 months for second, and 6-18 months for the third dose (Zimmerman et al, 2000).

1.2.2 Pertussis Vaccine

Pertussis is transmitted by respiratory droplets and occasionally by contact with freshly contaminated objects. Pertussis is highly contagious; from 70% to 100% of susceptible household contacts and 50% to 80% of susceptible school contacts will become infected after exposure to a person who is contagious (Zimmerman et al, 2000).

Almost half (47%) of reported cases of pertussis occur in infants, most reported cases (72%) occur in children younger than 5 years (Farizo et al, 1992). The hospitalisation rate is 69% for reported cases of pertussis in infants younger than 12 months (Farizo et al, 1992). The case fatality rate is 0.6% for infant younger than 12 months. Pneumonia occurs in approximately 15% of pertussis cases and is the leading cause of death from pertussis (Farizo et al, 1992).

In Malaysia, since 1984 an average of 100 cases of pertussis have been reported every year until 1987. From 1988 to 1995, the incidence rate has decreased and about 25 cases were reported every year (MOH Malaysia annual report, 1995). The incidence rate of pertussis in 1996 was 3 per 100,000

and there were 3 reported cases of pertussis in 1997 (incidence rate 0.01) but the were no reported fatalities (MOH Malaysia annual report, 1997).

In studies conducted in the US, DPT vaccination was found to be 70% and 90% effective in preventing pertussive disease (Blennow et al, 1990; Zimmerman et al, 2000). Completing the recommended series for DPT is important for optimal efficacy. For example, one study found that the efficacy of whole cell vaccine based on a case definition of a cough of at least 14 days with paroxysms, whoop or vomiting is 36% after one dose, 49% after 2 doses and 83% after 3 doses (Onorato et al, 1992).

The protection afforded by pertussive vaccination wanes with time (Mink et al, 1994). For DTP vaccines, protection against pertussive disease is lost by 12 years after the last dose (Zimmerman et al, 2000).

Accellular pertussis vaccines have been licensed for use in infancy. Studies have shown that it is as efficacious as whole cell vaccine but has lower rates of adverse reactions than whole cell vaccine (Annunziato et al, 1994).

1.2.3 Tetanus Toxoids

The incidence of neonatal tetanus has declined dramatically in industrialised countries owing to the introduction of effective immunisation, improved living standard and the introduction of clean delivery technique (Bart et al, 1990). Historically, neonatal tetanus has been a silent killer in the developing world as

most deaths occurred at home and families often are reluctant to report neonatal deaths, so the problem was underestimated and often overlooked.

The incidence rate of neonatal tetanus in Malaysia was 0.11 per 100,000 in 1996 and 0.07 per 100,000 in 1997 (MOH Malaysia annual report, 1997). In some countries, neonatal tetanus accounts for as much as 50% of all neonatal death and probably accounts for 80% of all preventable death (Bart et al, 1990). To control neonatal tetanus, immunisation of women of childbearing age is recommended (especially pregnant women), and a hygienic delivery and post delivery care should be assured. High coverage with tetanus toxoid has been remarkably successful in preventing neonatal tetanus (Black et al, 1980). Neonatal tetanus serves an important index of the quality and extent of utilisation of maternal health services. The occurrence of even a single case is considered by WHO as failure of the health care delivery system.

In Malaysia, DPT vaccines are given to infants at 3,4 and 5 months and a booster of DPT at 18-24 months. An additional booster of DT is given at standard 1 (7 years old) and a TT booster is given again at form 3 (15 years old). In addition, a TT booster is given to all pregnant women or following minor injury (Practical Immunisation Recommendations, 1990).

Studies done in developed countries revealed that immunisation of an infant with 3 doses of DPT vaccines provide tetanus immunity for 1-3 years. Reinforcing immunisation with a booster dose given between 15–24 months of life prolongs tetanus immunity until 6-7 years of age. A fifth dose of tetanus

toxoid (TT) at school entry provides immunity until 17-18 years of age. An additional dose on leaving school or during military services will ensure sufficient immunity for at least 2 more decades (Christenson et al, 1987).

In certain countries, for example in Tanzania, DPT vaccines are given earlier in infancy at 4, 8 and 12 weeks of age. Aboud et al (2000) studied the levels and avidity of antibodies to tetanus toxoids among 138 apparently healthy children aged 1-15 years in Tanzania. They found that DPT immunisation schedules that were given early in infancy as in Tanzania do provides adequate tetanus immunity for children below 5 years of age. However, about half of the older children (6-15 years of age) had no protection against tetanus.

1.2.4 Diphteria

Since the introduction of Diphteria Immunisation Programme in 1955, there has been a decline of major outbreaks of diphteria (MOH Malaysia annual report, 1991). Only a few states have reported cases, which have been occurring among unimmunised children. The number of diphteria cases has shown a decreasing trend. The incidence rate of diphteria in 1991 was 0.06 per 100,000 population and the incidence rate in 1997 was 0.01 per 100,000 population (MOH Malaysia annual reports, 1991 and 1997).

Low immunisation coverage, poor socioeconomic conditions and occasional reported outbreaks suggest that diphteria remains an important preventable disease in much of the world. In most countries immunisation is carried out

during the first year of life using 3 doses of DPT. Many countries including Malaysia administer a booster dose at 18-24 months and at school entry.

Persons aged 7 years or older should receive adult tetanus and diphteria toxoids (Td), which contain about the same quantity of tetanus toxoid as DPT or peadiatric DT vaccines but only one third to one eleventh as much diphteria toxoid (Zimmerman et al, 2000). Td vaccine should be used for the primary 3-dose series in those receiving the first dose at 7 years or older and for routine booster doses every 10 years.

1.2.4 Poliovirus vaccine

Poliomyelitis is caused by infection with one of the three types of poliovirus. All the three types of poliovirus are capable of causing paralysis. The poliovirus belongs to the enterovirus group. The poliovirus infects only human beings and there is no animal reservoir. Transmission occurs only from person to person, primarily by the fecal-oral route, particularly in areas where sanitation is poor. In countries with a high level of sanitation, polio is transmitted principally by the respiratory route (WHO, 1993). Infants and children less than 5 years of age are most frequently affected (WHO, 1993). Once a person is infected with a specific type of poliovirus, immunity to that type is life-long.

In 1988, the WHO committed itself to the eradication of poliomyelitis from the world by year 2000. Although this goal may seem impossibly difficult, substantial progress has been made and 3 WHO regions (the Americas, Europe

and Western Pacific) appear free of indigenous wild poliovirus transmission (WHO weekly epidemiological report, 2000). Wild poliovirus was last reported in Europe in a child with onset of paralysis in November 1997 (WHO weekly epidemiological report, 2000).

Member countries of South-East Asia region of WHO (Bangladesh, Bhutan, Korea, India, Indonesia, Maldives, Myanmar, Nepal, Sri Lanka and Thailand) began implementation of polio eradication strategies in 1994 (WHO weekly epidemiological report, 2000) and have achieved tremendous progress to date. However, the region contains the largest remaining reservoir of wild poliovirus in the world. In 1999, majority of polio cases globally were still reported from this region, i.e. 48% of reported polio cases and 62% of cases with wild poliovirus isolation (WHO weekly epidemiological report, 2000).

Malaysia has otherwise free from polio in the last 10 years except in 1992 when there were 2 imported cases (MOH Malaysia annual report, 1997). The WHO has identified polio as the second disease after smallpox to be eradicated / eliminated. Strategies have been formulated for all the nations worldwide. The surveillance of acute flaccid paralysis (AFP) is an important activity that needed to be closely adhered according to the Global Polio Eradication Programme.

Two types of polio vaccines are available for prevention of poliomyelitis; oral, live polio vaccine or OPV (Sabin) and injection polio vaccine or IPV (Salk). IPV is inactivated, cannot cause poliomyelitis and thus is safe for immunocompromised persons and contacts of those persons. The

disadvantages of IPV include administration by injection and less gastrointestinal immunity. An all IPV vaccination schedule results in the lowest risk of vaccine-associated paralytic poliomyelitis (VAPP).

OPV has the advantage of easier administration; given by mouth and the cost is relatively low. The most important advantage of OPV is that it produces intestinal immunity thus preventing spread of wild poliovirus to other children. The main disadvantage of OPV is that the oral polioviruses can revert to a more virulent form and cause VAPP. OPV is recommended by the WHO for global eradication efforts and provides the earliest mucosal immunity.

In 1999, 38 countries of European region relied on OPV only for their routine infant vaccination programme, 7 countries used IPV exclusively, and 6 countries used sequential IPV-OPV immunisation schedules (WHO weekly epidemiological report, 2000). Malaysia is still using OPV only for routine vaccination. In developing countries, three doses of OPV are 80-85% effective in preventing paralytic polio (WHO, 1993).

1.2.5 Measles vaccine

Measles is transmitted person to person by respiratory droplets and also by smaller aerosolised droplets that can spread through ventilation systems within a building and are infective for at least 1 hour (Remington et al, 1985). Prodromal symptoms appear 10 to 12 days after exposure and the characteristic rash appears in 14 days. Infected persons may transmit the

disease 4 days before and 4 days after the appearance of the rash (Zimmerman et al, 2000).

Measles is a highly contagious disease. Following measles vaccination, seroconversion rates are 95% for children vaccinated at age 12 months and 98% for children vaccinated at 15 months (Zimmerman et al, 2000). The vaccine induce both humoral and cellular immunity. Antibody persists for at least 17 years and probably lifelong in almost all vaccinated persons who initially seroconvert. Subclinical reinfection may occur following vaccination, but there is no evidence that persons with subclinical disease transmit wild virus to others.

There is significant association between measles vaccination coverage and measles attack rate (Schlenker et al, 1992). Modest improvement in low levels of vaccination coverage among 2 years old confer substantial protection against measles outbreak (Schlenker et al, 1992).

Currently, ACIP in the US recommended a second dose of measles containing vaccine at age 4 to 6 years to provide protection for most of those who did not respond to initial measles vaccination (MMWR 1989). Inadequate protection from the first dose of measles vaccine most probably due to lack of initial seroconversion and waning immunity. In Finland, a comprehensive national vaccination programme was began in 1982 in which two doses of MMR were used, first dose at 14 to 18 months and the second dose at 6 years. Over a 12-year period, an immunisation programme using two doses of MMR has

eliminated indigenous measles, mumps, and rubella from Finland (Peltola et al, 1994).

The incidence rate of measles in Malaysia was 2.78 per 100,000 population in 1997 (MOH Malaysia annual report, 1997). Measles vaccine has been shown to be effective in prevention of the disease. In Malaysia, measles vaccine was incorporated into the routine primary immunisation programme in 1984 (MOH Malaysia annual report, 1987) and it is given at 9 months in Malaysia as opposed to 12-18 months in many western countries. It is because of high prevalence of the disease in our country.

1.2.6 BCG vaccine

Tuberculosis is responsible for over 2 million deaths each year worldwide (WHO, 2001). The situation is further complicated in developing countries by the breakdown in health services, poorly managed programmes, the spread of HIV / AIDS and the emergence of multidrug resistance tuberculosis.

Tuberculosis was declared as a global emergency by WHO in 1993 (WHO, 2001). Control of this disease relies upon prevention through Bacillus Calmette-Guerin (BCG) vaccination, preventive therapy (chemoprophylaxis) and the ascertainment and treatment of cases in particular employing the "directly observed therapy-short course" (DOTS) approach.

BCG vaccine is usually recommended in populations with annual incidence of tuberculosis exceeding 1% (Center for Disease Control, 1988). Since its

introduction in 1928, BCG has appeared to reduce the risk of serious disseminated disease and dreadful complications of primary tuberculosis in children. However, the protective mechanisms of BCG vaccine are not fully understood. Its efficacy around the world is very variable and has remained controversial. Although BCG vaccines are among the most widely used vaccines in the world, policies for their use differ between countries, and there is controversy concerning their efficacy and impact. The protective efficacy of BCG has ranged from 0 to 80% (Colditz et al, 1995; WHO, 2001).

BCG was incorporated into infant vaccination schedule of the Expanded Programme on Immunisation (EPI) in 1974 (WHO, 2001). Approximately 100 million children now receive a BCG vaccine every year (WHO, 2001). BCG vaccination policies differ greatly between countries. The various policies may be broken down into 4 groups:

(1) BCG only at birth (or first contact with health services)

This is the current recommendation of WHO, and it is a policy in most of the world today, in particular in developing countries including Malaysia. WHO emphasized this policy in recent years, because of consistent evidence that BCG protects against serious childhood forms of tuberculosis, even where it may not protect to a high degree against adult pulmonary forms of the disease.

(2) BCG once in childhood

(3) Repeated / booster BCG

(4) No routine BCG

1.3 Reasons for delayed / incomplete immunisation

Recommendations to reduce missed opportunities have been summarised in the *Standards for Pediatric Immunisation Practices* (Ad Hoc Working Group for Development of Standards for Pediatric Immunisation Practice, 1993) which stated that providers should use all clinical encounters to screen and immunise children and follow only true vaccine contraindications when withholding vaccinations. A necessary component of implementation of this recommendation is the ability to assess the immunisation status of children during clinical encounters either during admission or during clinic visits. The immunisation status of the non-sick children accompanying the siblings or parents to health care visit should also be assessed (Ad Hoc working Group for Development of Standards for Pediatric Immunisation Practice, 1993).

Many barriers to immunisation exist. Low immunisation coverage has been attributed to difficulties in reaching certain groups in population (Ewert et al, 1991; McConochie et al, 1992; Wood et al, 1995; Kenyon et al, 1998). Other factors include inaccessibility of clinics and staff to administer the vaccine, high cost of both vaccine and delivery of vaccine, parental attitudes and misconceptions regarding timing, risk and benefit of immunisation (Watson et al, 1996). Parents seeking immunisation for their children face significant barriers and obstacles that impede vaccine delivery.

In addition, many health care personnels fail to recognise and take advantage of all opportunities to immunise them either because of failure to screen the immunisation status of a child during a health care visit or the failure to

administer simultaneously all vaccines for which a child is eligible. This is called **missed opportunities**, which is defined as medical encounters during which a child is eligible but fails to receive an immunisation. Missed opportunities have been shown to occur in several circumstances:

(1) when needed vaccines are not given simultaneously (McConnochie et al, 1992 ; Tift & Lederman, 1988)

(2) in emergency department (McConnochie et al, 1992) and inpatient settings (Tift & Lederman, 1988 ; Riley et al, 1991)

(3) during non emergency visits to health care providers (Loevinsohn et al, 1989; Hutchins et al, 1989; McConnochie, 1992; Szilagyi, 1993).

However, without appropriate documentation of previous immunisations, opportunity to immunise cannot be fully optimised even when the health care provider is acutely aware of the available opportunity. To screen and subsequently immunise patients, the provider must be able to access the patient's medical record or rely on caregiver's recall of immunisation history. In the absence of immunisation documentation, the provider must vaccinate either arbitrarily or not at all.

Opportunities to immunise children often are frequently missed because of lack of immunisation history (Watson et al, 1996). In the study, they found that in one third of their new patients, the opportunities to immunise were missed solely because their immunisation records were not available at the initial visit.

In a busy primary care practice, it may not be easy to eliminate missed opportunities for immunisations. Potential barriers include practice policies to administer immunisations only during scheduled well-child care or nursing visits (Szilagyi et al, 1994); insufficient time to vaccinate children during acute illness or follow-up visits (Szilagyi et al, 1994); knowledge deficits about inappropriate vaccine contraindications during concurrent minor illness (Hutchins et al, 1989; Szilagyi et al, 1994; Hugart et al, 1994) or neurological conditions (Campbell et al, 1994); concerns about multiple vaccinations (Hutchins et al, 1989; Woodin et al, 1995); failure to screen for immunisation status at illness encounters (Szilagyi et al, 1994) and concern about impact of immunising children during acute-illness visits on subsequent compliance with preventive visits (Szilagyi et al, 1994).

Humiston et al (1993) recognised the inability of emergency departments to identify underimmunised patients accurately during acute-care visits. They were unsuccessful in their attempts to derive decision rules that could predict vaccination status and allow for immediate intervention. McConnochie et al (1992) also recognized that at an emergency department visit, where immunisation records were not readily available, accounted for 18% of missed opportunities.

1.4 Risk factors

Bobo et al in 1993 in a large community study of children from Oregon and Washington found that variables such as child's birth order, family income, maternal education and marital status significantly predicted failure to immunise on schedule. Compared with first-born children, later-born children were 1.7 times more likely to be incompletely immunised at 2 years of age. Children of unmarried or poorly educated mothers with low income were more likely to be underimmunised. In Bangladesh, Zeityln et al (1992), also showed similar findings whereby mothers' lack of education and low income were associated with poor compliance to immunisation.

Roper et al (1986), found that low birthweight infants, less than 2000 g at birth have considerable initial delay in uptake of immunisation compared with heavier babies, but by 18 months the coverage was almost identical. In his study, a similar delay was apparent when infants of 37 weeks' gestation or less were compared with babies born full term. Other reasons for delayed immunisation were highly mobile population, lack of motivation and frequent minor illnesses (Riley et al, 1991).

A study done by Mazidah et al (1995) in this community found that social and cultural factors contributed about 31% of causes of delayed immunisation. The majority of children had delayed immunisation because of misconceptions to contraindications to immunisation (59%), 31% by health personnel and another 28% by mothers. Poor health care access contributed about 20%. Another

29.5% were due to poor parental knowledge about immunisation. In the study, missed opportunities contributed about 5% of cases.

In a local pilot study in hospitalised preschool children in the same hospital, Dinesh et al (1996) found that 18.8% of children had incomplete immunisation. They found that risk factors like sex, admission at birth, prematurity, working couples and frequent admissions showed some association with incomplete immunisation but were not statistically significant. A higher average distance of the clinic from residence and a lower maternal age were significantly associated with incomplete immunisation.

Hospitalised preschool children, particularly those with chronic illnesses, have been shown to be underimmunised since the routine sequence of well-child visits for such children tends to be interrupted by visits for specific illnesses (Tift & Lederman, 1988; William et al, 1996). Paediatric subspecialty patients had been shown to be at higher risk of incomplete immunisation than general paediatric patients or surgical subspecialty patients (Tift & Lederman, 1988). This is more so if the hospital, which they visited failed to use the opportunities to immunise them at the time of hospital discharge, despite the lack of contraindications.

Fulginiti (1988) suggest that it would be simple to introduce a policy that all children admitted to hospitals will be screened for their immunisation status and any deficiencies will be corrected there and then, or planned after discharge from hospital. The idea is simple but it applications is difficult. Success would