Nurses make a difference in immunisation service delivery

AUTHORS

Natalie Desmond
RN, MPH,
Immunisation Advisory Centre, School of Population Health, University of Auckland.
natalie.desmond@adhb.govt.nz

Cameron C. Grant
Department of Paediatrics, School of Medicine University of Auckland.

Felicity Goodyear-Smith
Department of General Practice and Primary Health Care, School of Population Health University of Auckland.

Nikki Turner
Department of General Practice and Primary Health Care, School of Population Health University of Auckland.

Helen Petousis-Harris
Department of General Practice and Primary Health Care, School of Population Health, University of Auckland.

Acknowledgements
The authors wish to acknowledge the contribution of all of the participating primary care practices and in particular the nurses who were interviewed. Thanks also to the members of the stakeholders committee and Associate Professor Margaret Horsburgh.

KEY WORDS

Vaccination; immunisation; family practice; primary health care; primary health care nurse

ABSTRACT

Objective
The study aimed to determine nurse characteristics associated with childhood immunisation coverage and timeliness in the New Zealand primary care setting.

Design
In 2005-2006 a survey of randomly selected practices and health providers was conducted, with multiple regression analysis to establish significant determinants of coverage and timeliness. The multivariate analysis adjusted for social deprivation, region, practice governance and the age of the children registered at each enrolled practice.

Setting
The study was conducted in family practices in two regions in New Zealand, where approximately 66% of the national population reside.

Subjects
One hundred and fifteen practice nurses employed in the primary care setting.

Main Outcome Measures
Nurse characteristics, knowledge and attitudes associated with immunisation.

Results
Immunisations were delivered by 95% of practice nurses. Factors associated with higher practice immunisation coverage and less delay were a lower ratio of nurses to children - in the practice (1:1 to 1:74 (85)1:75 to 1:1290 (30) coverage P=0.04, timeliness P=0.03), nurse comfort with their own immunisation knowledge (Yes (105), No (4) coverage P<0.001, timeliness P=0.01) and their perception of parental apathy (Yes (56) No (53) coverage P=0.01, timeliness P=0.02), or fear (Yes (66) No (43) coverage P=0.01), as a barrier to immunisation.

Conclusion
Higher coverage and more timely immunisation delivery is achieved at practices where the nurse to child ratio is lower, where nurses are confident in their immunisation knowledge and are perceptive of parental attitudes which can be barriers to immunisation.

INTRODUCTION

New Zealand (NZ) experiences outbreaks of vaccine preventable diseases as a result of mediocre immunisation coverage (Ministry of Health 2007). Infant pertussis hospital admissions in NZ are 3-6 times those in the United Kingdom (UK), United States (USA) and Australia (Grant et al 2003).

Improving the uptake and timeliness of immunisations are necessary to make gains in disease prevention. There is strong evidence for the use of provider level strategies to improve immunisation coverage (Briss et al 2000, Shefer et al 2001).

Contraindications to vaccinations are well documented (Ministry of Health 2006). However, there are significant grey areas and myths that influence a provider's recommendations. It has been shown that in 34-80% of cases where children attend a clinic and do not receive appropriate vaccines it was due to professionals misapplying contraindications, or missed opportunities (Gamertsfelder DA et al 1994, Mafi et al 2002).

Health professional recommendation has been closely related to vaccine uptake (Gustafson and Skowronski 2005). Trusted professionals can regain parental confidence after exposure to anti-immunisation rhetoric (Leask et al 2006).

It has been estimated that NZ nurses administer 93% of all immunisations given in the practice setting (Petousis-Harris et al 2004) and 80% of practice nurses administer immunisations independently without doctor referral (Kent et al 2005). Considering this level of responsibility, there is a surprising paucity of published, critical assessment of the nurse contribution to immunisation uptake.

Evolution of the practice nurse role has been described as 'changed from that of an administrator needing a few nursing skills, to a nurse needing a few administrative skills' (Halcomb et al 2004). NZ, the UK and Australia are implementing policies to strengthen service delivery in primary care including enhancing the practice nurse role (Halcomb et al 2004, Ross et al 1994).

The aim of this study was to explore characteristics, behaviours, attitudes and knowledge of nurses working in the general practice setting that may influence the completeness and timeliness of childhood immunisations.

METHOD

This study was part of a broader project that sought to determine the relative contribution that health care system factors make to immunisation coverage and timeliness, including practice characteristics (Grant et al 2009), knowledge and attitudes of medical (Goodyear-Smith et al 2009) and nursing staff and parental perceptions of the quality of care received by children less than two years of age and missed opportunities for immunisation (Turner et al 2009). The design was a survey of randomly selected practices and health providers, with multiple regression analysis to establish significant determinants of coverage and timeliness. This paper reports on the contribution of nursing to these determinants.

The study was conducted 2005 to 2006 in family practices in two regions in NZ, in which approximately 66% of the national population reside.

Participants

The sample involved 124 randomly selected practices, 72 from the Auckland region and 52 from the Midlands region. A random sample of practices with stratification by region and over-sampling of Māori governance practices (independent Māori health providers which target services primarily towards Māori and have a Māori management and governance structure) were recruited (Ministry of Health 2004a). Māori governance practices are focussed on improving health care delivery to NZ's indigenous Māori population. Māori children have lower immunisation coverage and higher rates of vaccine preventable diseases (Ministry of Health 2006, Somerville et al 2007).

The sample size calculations estimated that a sample of 125 practices was sufficient to yield 80% power to show statistical significance at the 5% level for a health professional characteristic associated

with higher immunisation coverage or more timely immunisation if this characteristic was present in 20 to 25% more of the practices with higher coverage.

Data collection

Practice coverage was measured by electronic audit of each practice's primary care management system. The measure of immunisation coverage used, was the proportion of the registered children at each practice who had received all of their scheduled immunisations. The measure of timeliness, was the proportion of children who were not delayed for any of their immunisations. An immunisation was defined as delayed if it had not been received within four weeks of the first due date for the six week immunisations and within six weeks for the three, five and 15 month immunisations (Ministry of Health 2004b).

Coverage estimate was based on the third dose assumption where if the third dose in a series of vaccine doses has been recorded as being given, then the previous two doses are assumed to have been received, whether or not they are recorded. Such an assumption results in a small overestimate of coverage but this is of a smaller magnitude than the underestimation of coverage that results if this assumption is not use (Hull et al 2003).

Knowledge and attitudes of nurses were elicited using a computer assisted telephone interview (CATI) with one randomly selected nurse from each practice. Nurse knowledge and attitudes were measured using a questionnaire previously used in NZ (Petousis-Harris et al 2005) adapted from a UK questionnaire (Peckham et al 1989).

The nurse survey measured practice nurse characteristics, immunisation practices, knowledge and attitude towards immunisation, the barriers practice nurses perceived to improving immunisation, their attendance at professional immunisation education courses, their sources of immunisation information and areas about which they would like more information or support.

Ethical considerations

Ethics approval was obtained from the Regional Ethics Committee. Participants were provided with information sheets which guaranteed their confidentiality and written consent was obtained.

Analysis

The distribution of variables across practices was determined and where necessary summarised to enable statistical analysis. Nurse characteristics, knowledge and attitudes were defined at the practice level. Descriptive analyses were performed, of immunisation coverage and timeliness, and of the variables describing nurse characteristics, knowledge and attitudes. Regression analysis was used to determine associations of each of the nurse variables with practice immunisation coverage and timeliness. These associations were adjusted for region (Midland and Auckland), practice governance (Māori and non-Māori governance) and for the social deprivation of population registered at each practice. Social deprivation was measured using the 2001 NZ index of social deprivation which divides households in New Zealand into 10 socioeconomic deprivation deciles (Salmond and Crampton 2002). For the multivariate models of nurse determinants of immunisation coverage and timeliness a base model was created that included region, practice governance, socioeconomic deprivation, and the median age of the children registered at each practice. To this base model were added the variables describing nurse characteristics that were identified as potentially important based upon previous published research and upon the results of the univariate analyses. The regression analyses were performed in SAS-PC 9.1 using proc GLM (General Linear modelling) (SAS Institute, Cary, NC, USA).

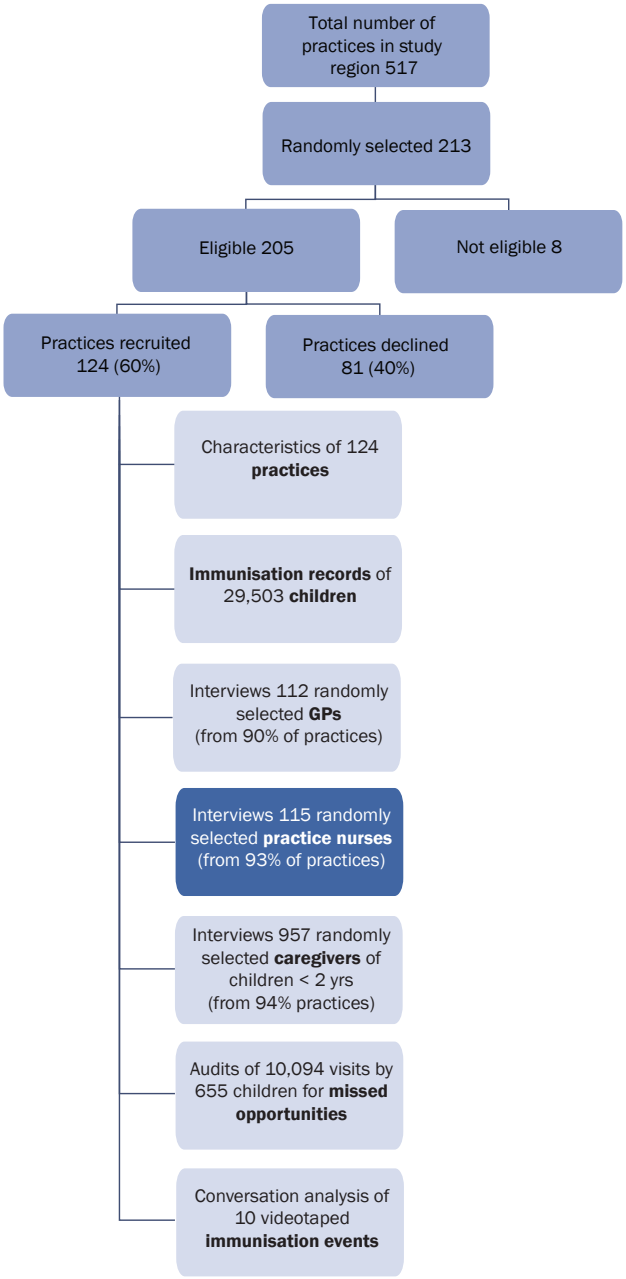
FINDINGS

Participant characteristics

There were 517 practices in the study region. Two hundred and thirteen (41%) were randomly selected, 108 (31%) in Auckland and 105 (61%) in Midland. A small number of practices were ineligible; mainly because they did not provide well-child care and 39% of selected practices declined to participate. The percentage of practices that declined was higher in Midland than Auckland (45% versus 30%, P=0.015)

One nurse from each of 115 of the 124 enrolled practices was interviewed (figure 1). From the full practice sample, four practices did not have nurses and two nurses covered two practices each. Nurses from three practices declined to participate.

Figure 1: Summary of data sets in overall study



Sixty-seven nurses were from practices in Auckland and 48 from the Midland region. All were female. The majority of the nurses were aged 40 and over (n=79/115, 69%) and 47/115 (41%) had been working as practice nurses for 10 to 19 years. This is representative of NZ primary health care nurses (Ministry of Health 2003b).

The number of registered children under the age of two per nurse full time equivalent (FTE) varied widely across the 124 practices ranging from 0 to 290 children (mean=60) per nurse FTE. Seventy two (63%) of the nurses had dedicated time for immunisation follow-up and most (109/115; 95%) were exclusively responsible for delivery of immunisations.

Nurses' preferred source of information (n=111/115; 97%) was the Ministry of Health Immunisation Handbook. Most nurses (n=100/115; 87%) sought further information from practice nurse colleagues and 89/115 (77%) would go to GP colleagues for information. The most frequently requested information was that relevant to current issues in the media (n=89/115; 77%).

The majority of nurses (100/109; 96%) felt comfortable with their immunisation knowledge. Despite this, significant gaps were shown. With respect to contraindications to measles, mumps, rubella (MMR) vaccine, 61/115 (53%) correctly identified that a rash after eating eggs was not a contraindication to MMR immunisation, 23/115 (20%) stated they would delay MMR if the child had rhinorrhoea and low grade fever.

Nurses' opinions varied considerably on barriers to patients accessing services. Parental apathy or ambivalence was considered a barrier by 58 (47%) and parental fear by 68/109 (59%). The following factors were not identified as significant barriers: poor Ministry of Health direction (n=72/115; 62%) lack of provider funding (n=87/115; 76%), time (n=83/115; 72%) or provider knowledge (n=92/115; 80%). Of the 77 nurses who offered other suggestions, 22 (30%) considered anti-immunisation misinformation to be a significant barrier for parents.

Nurse characteristics associated with coverage and timeliness

After adjustment for region, Māori governance, social deprivation of the practice population and median age of the children registered at each practice, higher practice immunisation coverage was associated with: a lower ratio of nurses to children registered with the practice (P=0.03), nurse perception of increased parental apathy (P=0.005) or fear (P=0.008) as a barrier and her comfort in her knowledge about immunisation (P=0.0004) (table 1).

Table 1: Significant associations of practice nurse characteristics with immunisation coverage at the practice

Variable (number of practices)	Median practice immunisation coverage % (25th, 75th centile)				
Region	***Auckland***		***Midland***		
Governance	Māori	Non-Māori	Māori	Non-Māori	*p* value*
	n=7	n=61	n=14	n=36	
Practice infrastructure relevant to delivery by nurses					
Ratio of practice nurses to children (115)					
1:1 to 1:74 (85)	51% (36,64)	73% (64, 77)	58% (46, 63)	75% (71, 82)	*p*=0.03
1:75 to 1:1290 (30)	24% (24, 24)	67% (52, 71)	49% (47, 52)	75% (73,79)	
Nurse has dedicated time for immunisations (108)					
Yes (67)	47% (36, 58)	70% (62, 77)	62% (56, 65)	78% (67, 81)	*p*=0.07
No (41)	22%(20,24)	70% (45, 74)	52% (46, 59)	74% (70, 77)	
Nurse professional experience as practice nurse					
Five or more years of experience (107)					
Yes (81)	36% (20,58)	70% (63, 77)	59% (46, 65)	75% (73,80)	*p*=0.50
No (26)	24% (24, 24)	68%(45, 74)	59% (58, 62)	65% (55, 78)	
Nurse attitudes					
Perceives parental apathy as a barrier to immunisation (109)					
Yes (56)	58% (58,58)	70% (63, 75)	62% (43, 63)	78% (73, 82)	*p*=0.005
No (53)	24% (20, 36)	68% (52, 77)	57% (49, 67)	72% (62, 75)	
Perceives parental fear as a barrier to immunisation (109)					
Yes (66)	36% (20, 58)	71% (57, 79)	58% (46, 62)	75% (71, 81)	*p*=0.008
No (43)	24% (24, 24)	67% (62 ,74)	62% (56, 76)	74% (55, 78)	
Nurse knowledge					
Comfortable with own level of knowledge (109)					
Yes (105)	30% (22, 47)	70% (61, 77)	58% (40, 63)	75% (71, 80)	*p*=0.0004
No (4)	(-)†	75% (5,82)	(-)†	70% (70, 70)	

* Adjusted for region, practice governance and socioeconomic deprivation of the registered population and age of children<2 years old

† No practices in this category

After adjustment for these same four variables more timely practice immunisation delivery was associated with; a lower ratio of nurses to children registered with the practice (*P*=0.007), nurse perception of increased parental apathy as a barrier (*P*=0.003) and her comfort in her knowledge about immunisation (*P*=0.049), (table 2).

In the multivariate analysis of nurse determinants of practice immunisation coverage, four factors were independently associated with higher practice immunisation coverage (table 3). The factors positively associated with higher coverage were lower ratio of nurse to children (*P*=0.04), nurse's increased perception of parental apathy (*P*=0.01) or fear (*P*=0.01) as a barrier to immunisation and the nurse's comfort in her immunisation knowledge (*P*<0.001). Three factors were independently associated with more timely practice immunisation delivery (table 3). These were lower ratio of nurses to children (*P*=0.03), nurse's increased perception of parental apathy (*P*=0.02) as a barrier to immunisation and the nurse's comfort in her immunisation knowledge (*P*=0.01).

In the multivariate models of coverage and timeliness the nurse variables accounted for an additional 12% of the variance in the coverage model and 11% of the variance in the timeliness model over and above that explained by region, practice governance, social deprivation and age of the children.

Table 2: Significant associations of practice nurse characteristics with immunisation timeliness at the practice

Variable (number of practices)	Median practice immunisation coverage (%) (25th, 75th centile)				
Region	***Auckland***		***Midland***		
Governance	Māori n=7	Non-Māori n=61	Māori n=14	Non-Māori n=36	*p* value*
Practice infrastructure relevant to delivery by nurses					
Ratio of practice nurses to children (115)					
1:1 to 1:74 (85)	37% (30, 46)	60% (47, 68)	44% (25, 57)	59% (47, 63)	*p*=0.007
1:75 to 1:1290 (30)	17% (17, 17)	52% (44, 66)	36% (31, 40)	61% (56, 64)	
Nurse attitudes					
Perceives parental apathy as a barrier to immunisation (109)					
Yes (56)	47% (47, 47)	60% (49, 68)	50% (36, 60)	60% (49, 63)	*p*=0.003
No (53)	23% (17, 32)	55% (40, 66)	42% (28, 54)	58% (36, 66)	
Nurse knowledge					
Comfortable with own level of knowledge (109)					
Yes (105)	28% (20, 40)	59% (44, 66)	44% (28, 57)	59% (47, 63)	*p*=0.05
No (4)	-†	76% (11, 78)	-†	47% (47, 47)	
A cold is not a contraindication (107)					
Yes (83)	23% (17, 32)	58% (43, 66)	44% (28, 50)	60% (47, 64)	*p*=0.10
No (24)	47% (47, 47)	65% (49, 75)	62% (40, 67)	58% (35, 61)	
Completed a vaccination training course (109)					
Yes (102)	23% (17, 47)	58% (44, 66)	43% (25,52)	59% (47,63)	*p*=0.09
No (7)	32% (32, 32)	69% (58, 75)	64% (64, 64)	58% (58, 58)	

* Adjusted for region, practice governance and socioeconomic deprivation of the registered population and age of children<2 years old
† No practices in this category

Table 3: Multivariate analysis of practice nurse association with practice immunisation coverage and timeliness

	Association with coverage	Association with timeliness
R-squared for model	0.54	0.39
Number of practices in model	98	100
Region	<.0001	0.102
Social deprivation	<.0001	<.001
Median age of children registered at the practiced	<.0001	NS
Māori practice governance	0.039	0.056
Ratio of nurse to children in the practice	0.04	0.03
Nurse perceives parental apathy as a barrier to immunisation	0.01	0.02
Nurse perceives parental fear as a barrier to immunisation	0.01	-*
Nurse comfortable with own level of knowledge	<0.001	0.01

* This variable not included in multivariate model of practice immunisation timeliness

Study limitations

One nurse from each practice was interviewed and their responses may not reflect those of all the nurses in the practice. Immunisation coverage and timeliness was assessed as a 'one-off' measure and the precision would be lower for practices with fewer children under two years of age. Coverage and timeliness were assessed based on data obtained at the practice via the computerised query, thus they are dependent on the quality of data entry at the practice level. Data quality has been shown to vary depending on the practice management system used and the manner in which data is entered (Goodyear-Smith et al 2008).

Study strengths

The authors obtained a random sample of nurses with a high level of participation (93%). Data were collected and analysed maintaining the nurse data set as a distinct entity within the primary care variables. An independent, standardised and rigorous assessment of coverage and immunisation timeliness was used.

DISCUSSION

Practice nurses fulfil the principal role in immunisation delivery within primary care in NZ.

Nurse to child ratios

Nurses were responsible for immunisations in 95% of practices and are critical for successful program delivery. The nursing workforce is relatively mobile and NZ is affected by global nursing shortages (Kent et al 2005). Nurse to patient ratios have been associated with mortality rates in the hospital setting (Aiken et al 2003). It was found that practices with relatively more nurses, particularly experienced ones, were able to immunise their population more completely and in a timelier manner.

Nurse knowledge

Nurses were more likely to seek information from practice nurse colleagues than GPs suggesting a high level of expertise. Most nurses were confident in their knowledge despite significant gaps being shown. Lacking confidence was associated with lower practice coverage and more delay.

The wide variance in correct answers in this study is concerning. Knowledge gaps create the opportunity for conflicting advice that in turn leads to parental confusion delayed decision-making and delayed immunisations.

An often cited barrier to role expansion of the practice nurse includes inadequate education programs (Patterson et al 1999, Minto 2006, Ministry of Health 1998). A previous NZ study has shown that vaccinator training is associated with higher immunisation coverage (Petousis-Harris et al 2005). The finding that nurse comfort in immunisation knowledge is a predictor of better practice immunisation delivery, emphasises the importance of continued education.

Nurse Attitudes

It was found that nurse attitudes and increased perceptiveness around the parental barriers of apathy to, and fear of, immunisation were associated with higher uptake and timeliness. As attitudes are related to decision-making and depend on situational context (Prislin et al 2002), these perceptions may prompt the nurse to recommend immunisations more frequently and with greater empathy.

CONCLUSIONS

Nurses may be considered the immunisation leader in many practices, where their knowledge is sought after; they administer almost all childhood immunisations and invest a substantial amount of time with caregivers. Higher immunisation coverage is due, in part, to having an adequate number of nurses who are experienced, knowledgeable and can communicate well with caregivers. Improving nursing performance in general practice may contribute to further improvement in NZ immunisation coverage.

Investing in and retaining nursing staff needs to be considered in strategies to achieve and maintain high immunisation coverage. The nurse/child ratio could be explored as a useful practice management measure.

Further research could incorporate assessment of nurse understanding and communications on vaccine safety and efficacy.

FUNDING

This project was funded by the New Zealand Health Research Council and Ministry of Health, reference number IRS 03/15.

CONFLICT OF INTEREST

No conflict of interest has been declared by the authors.

REFERENCES

Aiken, L.H., Clarke, S.P., Silber, J.H. and Sloane, D. 2003. Hospital nurse staffing, education, and patient mortality. *LDI Issue Brief*, 9(2):1-4.

Briss, P.A., Rodewald, L.E., Hinman, A.R., Shefer, A.M., Strikas, R.A., Bernier, R.R., Carande-Kulis, V.G., Yusuf, H.R., Ndiaye, S.M. and Williams, S.M. 2000. Reviews of evidence regarding interventions to improve vaccination coverage in children, adolescents, and adults. The Task Force on Community Preventive Services. *American Journal of Preventive Medicine,* 18(1 Suppl):97-140.

Forrest, J.M., Burgess, M.A. and McIntyre, P.B. 2000. Factors influencing vaccination uptake. Workshop report. Current Australian research on the behavioural, social and demographic factors influencing immunisation, Royal Alexandra Hospital for Children, Sydney, March 1998. *Communicable Diseases Intelligence,* 24(3):51-3.

Goodyear-Smith, F., Grant, C., Petousis-Harris, H. and Turner, N. 2009. Immunization champions: Characteristics of general practitioners associated with better immunization delivery. *Human Vaccines,* 5(6):403-411.

Goodyear-Smith, F., Grant, C., York, D., Kenealy, T., Copp, J., Petousis-Harris, H., Turner, N. and Kerse, N. 2008. Determining immunisation coverage rates in primary health care practices: a simple goal but a complex task. *International Journal of Medical Informatics,* 77(7):477-485.

Grant, C., Roberts, M., Scragg, R., Stewart, J., Lennon, D., Kivell, D., Ford, R., Menzies, R. 2003. Delayed immunisation and risk of pertussis in infants: unmatched case-control study. *British Medical Journal,* 326(7394):852-3.

Grant, C., Turner, N., York, D., Goodyear-Smith, F. and Petousis-Harris, H. 2009. *Successful systems: characteristics of general practices influencing immunisation coverage and timeliness.* British Journal of General Practice, In press.

Gustafson, R. and Skowronski, D.M. 2005. Disparities in varicella vaccine coverage in the absence of public funding. *Vaccine,* 23(27):3519-25.

Halcomb, E., Davidson, P., Daly, J., Yallop, J. and Tofler, G. 2004. Australian nurses in general practice based heart failure management: implications for innovative collaborative practice. *European Journal of Cardiovascular Nursing,* 3(2):135-47.

Hull, B., Lawrence, G., MacIntyre, C. and McIntyre, P. 2003 Estimating immunisation coverage: is the 'third dose assumption' still valid? *Communicable Diseases Intelligence,* 27:351-361.

Kent, B., Horsburgh, M., Lay-Yee, R., Davis, P. and Pearson, J. 2005. *Nurses and their work in primary health care: The national primary medical care survey* (NatMedCa): 2001/02 In Report 9Ministry of Health, Wellington.

Leask, J., Chapman, S., Hawe, P. and Burgess, M. 2006. What maintains parental support for vaccination when challenged by anti-vaccination messages? A qualitative study. *Vaccine,* 24(49-50):7238-45.

Mafi, D., Toafa, V.M. and Grant, C. 2002. Missed immunisation opportunities among Tongan children in Auckland, New Zealand. *Pacific Health Dialog,* 9(2):203-8.

Ministry of Health. 1998. *Report of the Ministerial Taskforce on Nursing: Releasing the potential of nursing.* Ministry of Health, Wellington, pp. 103.

Ministry of Health. 2003a. *Immunisation in New Zealand: strategic directions 2003-2006.* Ministry of Health, Wellington, pp. 21.

Ministry of Health. 2003b. *Primary Health Care and Community Nursing Workforce Survey – 2001.* Ministry of Health, Wellington, pp. 52.

Ministry of Health. 2004a. *Māori Providers: Primary health care delivered by doctors and nurses: The National Primary Medical Care Survey* (NatMedCa): 2001/02. In Report 3 Ministry of Health, Wellington, pp. 26.

Ministry of Health. 2004b. *Overview of the National Immunisation Register.* Ministry of Health, Wellington, pp. 10.

Ministry of Health. 2006. *Immunisation Handbook 2006*, Ministry of Health, Wellington.

Ministry of Health. 2007. *The National Childhood Immunisation Coverage Survey 2005.* In Public Health Intelligence Occasional Bulletin No. 39Ministry of Health, Wellington, pp. 82.

Minto, R. 2006. The future of practice nursing. *New Zealand Family Physician,* 33(3):169-172.

Pascoe, T., Foley, E., Hutchinson, R., Watts, I., Whitecross, L. and Snowdon, T. 2005. The changing face of nurses in Australian general practice. *Australian Journal of Advanced Nursing,* 23(1):44-50.

Patterson, E., Del Mar, C. and Najman, J. 1999. A descriptive study of nurses employed by general practitioners in south-east Queensland. *Australian Journal of Advanced Nursing,* 17(2):13-20.

Peckham, C., Senturia, Y. and Ades, A. 1989. *The Peckham report: National immunisation study - factors influencing immunisation uptake in children.* Department of Paediatric Epidemiology, Institute of Child Health, London, pp. 46.

Petousis-Harris, H., Goodyear-Smith, F., Turner, N. and Soe, B. 2004. Family physician perspectives on barriers to childhood immunisation. *Vaccine,* 22(17-18):2340-2344.

Petousis-Harris, H., Goodyear-Smith, F., Turner, N. and Soe, B. 2005. Family practice nurse views on barriers to immunising children. *Vaccine,* 25:2725-2730.

Ross, F.M., Bower, P.J. and Sibbald, B.S. 1994. Practice nurses: characteristics, workload and training needs. *British Journal of General Practice,* 44(378):15-8.

Salmond, C. and Crampton, P. 2002. *NZDep2001 Index of Deprivation.* Department of Public Health, Wellington School of Medicine and Health Sciences, University of Otago, Wellington.

Shefer, A.M., Luman, E.T., Lyons, B.H., Coronado, V.G., Smith, P.J., Stevenson, J.M. and Rodewald, L.E. 2001. Vaccination status of children in the Women, Infants, and Children (WIC) Program: are we doing enough to improve coverage? *American Journal of Preventive Medicine,* 20(4 Suppl):47-54.

Turner, N., Grant, C., Goodyear-Smith, F. and Petousis-Harris, H. 2009. Seize the moment: missed opportunities to immunise at the family practice level manuscript. *Family Practice,* 26(4):275-278.