What are the beliefs and perceptions of practice nurses' influence about the uptake of the Measles, Mumps and Rubella vaccine? An integrative literature review

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Conflict of interest

The authors have no conflicts of interest to declare.

Funding

No grant support was received by the authors in relation to this article.

ABSTRACT

Aim. To ascertain the beliefs and perceptions of practice nurses' influence about the uptake of the Measles, Mumps and Rubella vaccine.

Background. Immunisation decision making for parents is a complex process. Principle health professionals involved in immunisation programmes are health visitors, general practitioners and practice nurses. There is evidence that health visitors and general practitioners influence parental immunisation decision making. However, there is a lack of evidence about the influence of the practice nurse despite their well-documented role in immunisation.

Design. Integrative Literature Review

Data sources. A systematic search of electronic databases, including: CINAHL; Medline; PubMed; Google Scholar; Science Direct and Scopus from February 1998 - April 2017. Hand searching and reviewing of secondary references were also undertaken.

Review methods. Two reviewers independently screened records on title and abstract. Studies where the beliefs and perceptions of practice nurses regarding the Measles, Mumps and Rubella vaccine were explored and were published in English were included. The data were analysed using the integrative review processes.

Results. Twelve studies were included; these studies were principally descriptive and were of variable methodological quality. Four themes were identified: parental immunisation influencing factors; practice nurse characteristics; information & communication and personal views and concerns. While this review provides an excellent baseline for this information, more recent research conducted in the current policy environment is urgently needed to determine if these views persist.

Conclusion. Immunisation training and annual updates are essential for practice nurses to keep abreast with the evidence base underpinning national immunisation programmes.

Key words: practice nurse, perceptions, beliefs, influence, uptake, MMR, measles, mumps, rubella, vaccine.

SUMMARY STATEMENT

Why is this review needed?

- The integrative review provides a unique insight into the beliefs and perceptions of practice nurses where there is currently limited research about their influence on the uptake of the Measles, Mumps and Rubella vaccine**.**
- At a time where there is an increasing incidence of measles particularly in Europe since 2017, exploring the role of the practice nurse is important in ascertaining their sphere of influence from a public health perspective.
- Given the challenges of maintaining herd immunity for measles, mumps and rubella, understanding the sphere of practice nurse influence on the uptake of MMR is crucial.

What are the key findings?

- Four themes emerged that characterised the beliefs and perceptions of practice nurses influence about the uptake of the Measles, Mumps and Rubella vaccine which were: parental immunisation influencing factors, practice nurse characteristics, information & communication and personal views and concerns.
- Practice nurses described a lack of consistent and current immunisation training, particularly concerning vaccine safety.
- There is a paucity of research focused on the role and influence of practice nurses in measles, mumps and rubella vaccination activities.

How should the findings be used to influence policy/practice/research/education?

- A strong evidence base regarding the factors that influence practice nurse and parental immunisation decision making related to immunisation is essential.
- Practice nurses considered they had variable and often inadequate levels of immunisation relevant education. Sources of information should be developed and disseminated to reflect when changes occur to national immunisation programmes.
- The views of practice nurses need to be investigated to explore their current beliefs on multiple vaccine administration to maximise their contribution concerning the uptake of the Measles, Mumps and Rubella vaccine.

INTRODUCTION

Immunisation is a proven tool for controlling and eliminating life-threatening infectious diseases and is estimated to avert between 2 and 3 million deaths worldwide annually (World Health Organisation, 2016). Furthermore, immunisation is the most important way of protecting people from vaccine preventable diseases (World Health Organisation, 2017). Developed countries, such as the United Kingdom (UK) have different immunisation programmes, which continue to evolve with the introduction of new vaccines (Kennedy, Gray Brunton, & Hogg, 2014).

The United Kingdom has a structured national immunisation programme and parents are recommended to immunise their children (University of Oxford, 2017). Many of the vaccines in the national immunisation programme are combined vaccines, of which the Measles, Mumps and Rubella (MMR) vaccine is one such vaccine, which is recommended to be administered when an infant is 12 months and again at approximately pre-school entry age. All national immunisation programmes recommend a two dose schedule of the MMR vaccine. Since 2008, the World Health Organisation (WHO) has recommended that all countries adopt a two dose MMR schedule to ensure immunity and prevent outbreaks, as it is contended that approximately 15% of vaccinated children fail to develop immunity from the first dose of MMR (World Health Organisation, 2010). The UK national immunisation programme is not mandatory, unlike in other European countries, as identified in the Vaccine European New Integrated Collaboration Effort (VENICE) network 2010 survey (Haverkate *et al.*, 2012). The authors of this survey of countries in the European Union, as well as Iceland and Norway concluded that a national healthcare system should promote those vaccines that have been proven to be safe and effective. The research concluded that there needed to be consensus amongst health care professionals in promoting their national immunisation programme to increase vaccine uptake (Haverkate *et al.*, 2012).

Background

No single factor determines parental immunisation decision making. Several factors have been identified including: location and access to services; relationships with health professionals; perception of information sources; social class and ethnicity (Austin, Campion-Smith, Thomas, & Ward, 2008; Casiday, Cresswell, Wilson, & Panter-Brick, 2006; Macdonald, Henderson, & Oates, 2004; Mixer, Jamrozik, & Newsom, 2007; Wilson, 2000).

The principle health professionals involved in the promotion and administration of the national immunisation programme in the UK include general practitioners; health visitors and practice nurses. There is evidence to suggest that general practitioners and health visitors sometimes influence parents immunisation decision making (Evans et al., 2001; Harrington, Woodman, & Shannon, 2000; Mixer et al., 2007; Smailbegovic, Laing, & Bedford, 2003). However, there is inconsistency regarding the influence of health professionals (Poltorak, Leach, Fairhead, & Cassell, 2005; Pulcini, Massin, Launay, & Verger, 2014; Walsh, Thomas, Mason, & Evans, 2015). The importance of health care professionals having a consistent approach in promoting vaccines in national immunisaiton programmes has been endorsed by the VENICE survey (Haverkate *et al.,* 2012). Practice nurses have been identified as the principle immuniser in some areas in the UK (Maconachie & Lewendon, 2004). Research to date is sparse on the influence of practice nurses on parental immunisation decision making, as are practice nurse beliefs and perceptions regarding the MMR vaccine. Therefore, it is important to explore how practice nurses perceive their beliefs and perceptions concerning their influence on the uptake of the MMR vaccine to inform development of strategies to improve practice in this field. This information is particularly important in the context of their documented role in the administration of and promotion of national immunisation programmes.

THE REVIEW

Aim

The aim of this integrative review was to ascertain the beliefs and perceptions of practice nurses' influence about the uptake of the MMR vaccine.

Design

An integrative review method that included diverse methodologies was conducted (Pluye & Hong, 2014; Whittemore & Knafl, 2005). This method was considered the most appropriate method as it allowed for the combination of diverse methodologies, thereby, not limiting the type of and breadth of data incorporated.

Search methods

Searches were conducted using CINAHL; Medline; PubMed; Google Scholar; Science Direct and Scopus databases from February 1998 - April 2017. Records were identified from different sources into one database and duplicates were removed. Additional searches were undertaken through hand searching and secondary referencing. Searches were limited to articles that were peer reviewed, published from February 1998 and in the English language. The Medical Subject Headings (MESH) that were applied were: Practice Nurse; MMR; influence; experiences; attitudes; perceptions; uptake.

Search outcome

Articles were selected in two stages. This first stage with the application of MESH terms revealed 1,108 records (Figure 1). The inclusion criteria used for the searches were: primary

research; practice nurses as participants; English language articles only and published from February 1998. At this time, a further nine records were identified through other sources, such as by hand searching and secondary referencing. Fourteen duplicates were removed with a total of 1,103 records. All the 1,103 records were screened by reading either the title or the title and abstract by two independent reviewers to identify eligibility (MH and either LA or DS). The main reasons for exclusion were that participant population or the vaccine of interest did not meet the inclusion criteria. After applying the inclusion and exclusion criteria, 1056 records were excluded leaving 47 full text articles

The second stage involved MH and either LA or DS independently reviewing and assessing the 47 full text articles. In this stage, the full text article had to address the review question. Thirty five articles were excluded (Figure 1) with 12 articles remaining for inclusion in the final synthesis. Throughout the selection process, any discrepancies were resolved by discussion until a consensus was reached.

Quality appraisal

Critical Appraisal Skills Programme (CASP) tools were used to appraise the 12 included papers (Nadelson & Nadelson, 2014). All eight quantitative and mixed methods studies were assessed for their domains of bias, which examined the selection of cohort; ascertainment of exposure; assessment of outcomes and adequacy of follow up for each of these studies (Table S1). Quality was not used to include or exclude studies from the review, however, the findings from the quality assessments were incorporated into the synthesis of studies.

Data extraction and synthesis

All 12 papers were read several times to grasp the content in its entirety. Convergent qualitative synthesis was used to draw together the data from the 12 papers (Pluye & Hong, 2014). The results from the qualitative (QUAL) (N = 3); quantitative (QUAN) (N = 7) and mixed methods (MM) (N = 2) studies were transformed into QUAL findings using the processes outlined by Whittemore and Knafl (Whittemore & Knafl, 2005). A constant comparison method was used to guide the analysis process. The use of this method is compatible with an integrative review that includes studies with varied data and methodologies to analyse and synthesize (Whittlemore & Knafl, 2005). In other words, initial codes for results in each paper were identified through the extraction of themes from the 12 papers. Codes were drawn from the data without attempting to make them conform to pre-existing sets of concepts, with patterns and relationships relevant to the review identified using an iterative process (Choi & Van Riper, 2017; Coombs, Parker, Ranse, Endacott, & Bloomer, 2017). These were then compared using an integrative process to identify commonalities, inconsistencies and patterns; relationships between the initial codes were also identified. The initial process was conducted by one author (MH), then explained, justified

and refined through a series of conversations with all review authors to develop themes. Initial codes were then rechecked to ensure they were all represented in the final four themes that were identified.

RESULTS

Twelve studies met the criteria for inclusion in the review. A range of research approaches including quantitative methods, qualitative methods and mixed methods were used. Studies that were included in this review were primarily descriptive in nature and were of variable methodological quality. Of these studies eight were conducted in the UK, two in New Zealand, one in Australia and one in the Republic of Ireland (Table 1, Table S2). In every study, practice nurses were either identified as the sole participant group (Desmond, Grant, Goodyear-Smith, Turner, & Petousis-Harris, 2011; Lamden & Gemmell, 2008; Petousis-Harris, Goodyear-Smith, Turner, & Soe, 2005) or a discrete group in the sample (BMRB Social Research, 2008; Cotter, Ryan, Hegarty, McCabe, & Keane, 2003; Kennedy et al., 2014; Leask et al., 2008; Macdonald et al., 2004; Smith, McCann, & McKinlay, 2001; van Bekkum & Hilton, 2013a; van Bekkum & Hilton, 2013b). Four themes addressing the question guiding this integrative review were identified, which were: parental immunisation influencing factors; practice nurse characteristics; information & communication and personal views and concerns (Figure 2).

Parental immunisation influencing factors

Practice Nurses perceived several factors influencing parents decision making in relation to immunisation, most notably the impact of socio economic status and concerns about vaccine safety. Views about the impact of socio economic status were complex (Kennedy *et al.*, 2014;

Lamden & Gemmell, 2008; Cotter *et al.,* 2003). While practice nurses in a UK study reported that parents from more affluent socio-economic groups tended to be more critical and challenging in their questioning about the MMR vaccine (Kennedy *et al.,* 2014), practice nurse colleagues from Ireland highlighted how hard to reach groups such as single parents and travellers were less likely to have their child immunised (Cotter *et al.,* 2003). It is not possible to draw strong conclusions from these studies, given the small numbers of participants interviewed and the heterogeneity of the communities served. Consistent with the complexity of this issue, the uptake of MMR was not correlated with practice deprivation scores in a UK survey study, but was strongly correlated with the Index of Multiple Deprivation domain connected to housing and services (Lamden & Gemmell, 2008). Practice nurses perceived parental safety concerns about the MMR vaccine continued to be influenced following the publication of the Wakefield et al study in 1998 (Desmond et al., 2011; Kennedy et al., 2014; Petousis-Harris et al., 2005). While this study did not prove a link between autism and bowel disease, the researchers reported that eight out of the twelve children's parents or physicians in this study had linked the onset of behavioural problems with the MMR vaccine. Consequently, parental safety concerns persisted about the safety of the MMR vaccine despite the retraction of this study by the majority of authors, which practice nurses have to work hard to dispel.

Practice nurse characteristics

Practice nurses perceived several characteristics of their own professional group as influencing MMR vaccination practice. There were discordant views about the role of the ratio of practice nurses to patients (Desmond *et al.,* 2011; Lamden & Gemmell, 2008). While Desmond et al's 2011 work in New Zealand suggested higher ratios of nurses to patients led

to higher immunisation uptake, no association between MMR uptake and the number of practice nurses was found in a UK study (Lamden & Gemmell, 2008).

Education and training was considered an important factor by practice nurses in their consultations (Petousis-Harris *et al.,* 2005; Petrovic *et al.,* 2001). Lack of immunisation knowledge about both contraindications and the rationale for a second dose of MMR vaccine has been associated with lower coverage of this vaccine (Petousis-Harris *et al.,* 2005; Smith *et al.,* 2001). This is despite further education and training being reported as key to understanding the rationale behind the introduction of the second dose of MMR (Petrovic *et al.,* 2001).

The challenges for practice nurses keeping up to date with immunisation knowledge was consistent across multiple settings, with nurses in both the UK (Kennedy *et al.,* 2014) and Australia (Leask *et al.,* 2008) indicating this as a problem. The impact of poorer immunisation knowledge is concerning given that a now dated UK survey revealed 45% of practice nurses had not received any formal immunisation training (MacDonald *et al,* 2004). However, a more recent study in the UK has reported that 94% of practice nurses indicated they were aware of immunisation training, with 72% having attended between 1 – 2 immunisation sessions in the previous 2 years (BMRB Social Research, 2008). Keeping up to date with immunisation knowledge was an important factor identified in an Australian survey, where the majority of practice nurses' could correctly identify when to immunise a child who presented with low grade fever or who had been prescribed a course of antibiotics (Leask *et al.,* 2008). A key factor that has an impact on practice nurses consultations is the access to and availability of immunisation training. Without contemporary immunisation knowledge, practice nurses ability to address parental immunisation concerns is compromised.

Information and communication

Practice nurses reported using different sources of information to inform their consultations, as identified in over half of the included papers (BMRB Social Research, 2008; Cotter et al., 2003; Leask et al., 2008; Macdonald et al., 2004; Petrovic et al., 2001; van Bekkum & Hilton, 2013a; van Bekkum & Hilton, 2013b). Different sources of information accessed included the media; TV; the immunisation co-ordinator; the Department of Health website; the '*Green Book'* (This is an online publication that has the latest immunisation information for vaccine preventable diseases in the UK) and Chief Medical Officers' letters or updates on immunisation (BMRB Social Research, 2008). In both the UK and Australia health department circulars and newsletters were identified as their main sources of information (Leask *et al.,* 2008; MacDonald *et al.,* 2004), with UK nurses also using the 'Green Book'. Of note, only 8% of UK practice nurses indicated they used peer-reviewed journals as an information source (MacDonald *et al.,* 2004). The different sources of information that practice nurses reported using were not always contemporary. Although now dated, a survey of 239 practice nurses in the UK revealed that 14% had not received the Health Education Authority's factsheet on MMR (Petrovic *et al.,* 2001). Nevertheless, of those who had received the factsheet, 98% stated they found it extremely or moderately useful (Petrovic *et al.,* 2001). Practice nurses reported limited access to contemporary and rigorous sources of information that influenced their ability to provide evidence based advice to parents.

Challenges were reported by practice nurses about how they communicated information to parents, especially from the media. The importance of communicating evidence and information was explored in two studies of 18 primary care nurses in the UK of whom nine

were practice nurses (van Bekkum & Hilton, 2013a; van Bekkum & Hilton, 2013b). These studies revealed how the media influenced both patients and health care staff involved in national immunisation programmes (van Bekkum & Hilton, 2013a; van Bekkum & Hilton, 2013b). Three themes emerged from their telephone semi structured interviews: communicating evidence to the critically minded patient; confidence in communicating evidence and maintaining the integrity of the patient practitioner relationship (van Bekkum & Hilton, 2013a). The participants also identified how the mass media influenced front line health care in relation to their impact on patients and nurses, in particular nurses ability to develop media literacy to support patients understanding (van Bekkum & Hilton, 2013b). However, there was not always consensus about the usefulness of the media. While practice nurses in a UK survey reported they were most likely to refer parents to the internet or other websites (BMRB Social Research, 2008), practice nurses in an Irish study viewed the media as either a positive or a negative influence (Cotter *et al.,* 2003).

Personal views and concerns

In half of the included studies there were concerns about the safety of the MMR vaccine (BMRB Social Research, 2008; Kennedy et al., 2014; Leask et al., 2008; Macdonald et al., 2004; Petrovic et al., 2001; Smith et al., 2001). Concerns were raised repeatedly about the necessity of providing two doses of MMR (Kennedy *et al.,* 2014; Petrovic *et al.,* 2001; Smith *et al.,* 2001). Other concerns raised by practice nurses included being uncomfortable administering two injections in a consultation, overloading the child, the complexity of and changes to national immunisation programmes, as well as the difficulty of keeping up to date with these changes (BMRB Social Research, 2008; Leask *et al.,* 2008). In some instances, 29% of UK practice nurses recommended that single vaccines should be provided by the NHS as an alternative to the MMR vaccine (Macdonald *et al.,* 2004). Safety concerns about

the MMR vaccine revealed lack of knowledge - 33% of practice nurse respondents in a UK survey considered there was an association between the MMR vaccine and Crohn's disease and 27% believed there to be an association with autism (Petrovic et al., 2001). While the personal views and concerns in these studies are not based on evidence and while concerning are rare, may not reflect current practice nurses attitudes to the MMR vaccine.

DISCUSSION

Four themes regarding the beliefs and perceptions of practice nurse' influence about the uptake of the MMR vaccine emerged in this integrative review. These included parental immunisation influencing factors, practice nurse characteristics, information & communication and personal views and concerns. More specifically, practice nurses beliefs and perceptions were influenced by the parents' socio economic status, sources of information available to inform decision making, their ability to accurately determine vaccination status and concerns regarding multiple vaccinations.

There were differences in the way practice nurses perceived how parents' social status could have an impact on their immunisation decision making. Whilst some practice nurses contended that there were differences in the sources of information that parents from different socio economic groups accessed, others viewed parents who did not attend appointments such as single parents and travellers as problematic, rather than focusing on their social class (Cotter *et al.,* 2003). Previous research has either supported or refuted whether a parent's socio economic status is a predicate for immunisation decision making. Low levels of immunisation were found in a UK survey as the majority of their non-immunisation parents were from a more affluent population (Macdonald *et al.,* 2004). Similar results were found in four focus groups of either parents of completely immunised children or parents of

incompletely immunised children where low levels of immunisation were associated with a more affluent population in the UK (Austin *et al.,* 2008). However, in a mixed methods study in north west London, the relationship between uptake of the MMR vaccine and socio economic status was not significant, as the classification of a mother's socio economic status was made on the ward of the borough where they lived leading the authors to contend that the socio economic status assigned to the mother may not be accurate (Mixer *et al.,* 2007). Likewise, a survey of general practices in the UK revealed that the relationship between parental social class and MMR uptake was not significant (Lamden & Gemmell, 2008). Based on this body of work, it can be argued that practice nurses perceive a range of factors that influence parental immunisation decision making with practice nurses perceiving that no single factor determines a parent's final choice on whether to immunise their child with the MMR vaccine.

Practice nurses use an array of different information sources to inform their immunisation consultations. However, this is not uniform and whilst there have been endeavours to standardise immunisation training, it is unknown if all practice nurses involved in immunisation programmes have access to standardised immunisation training and update courses. In addition, it is unknown if they do not have access to immunisation training from whom they seek information from. In other specialities in international settings, registered nurses have indicated they rely on colleagues for information (Marshall, West, & Aitken, 2011; Marshall, West, & Aitken, 2013). However, in a more recent exploratory study in Norway, research was identified as the most important source of information for nurses (Bringsvor, Bentsen, & Berland, 2013).

Practice nurses themselves are a source of information. In a mixed methods study in Ireland practice nurses perceived themselves as one of the factors that influence parents in their

immunisation decision making (Cotter *et al.,* 2003). A feasibility study in London revealed that parents of children who were immunised with the MMR vaccine identified the practice nurse as a useful source of information who in part influenced their decision making, but did not wholly determine it (Hill & Cox, 2013). Similar results were found for general practitioners. In a UK study, many general practitioners found that parents had already decided to immunise their child with the MMR vaccine, whilst other parents sought their support, rather than their advice (Poltorak *et al.,* 2005). The limited and inconsistent evidence about what information sources practice nurses use to inform their own practice, as well as unclear detail regarding how practice nurses influence parental immunisation decision making raise questions. It is unclear whether practice nurses influence the uptake of the MMR vaccine as well as countering misinformation in the media.

The importance of practice nurses being able to accurately determine vaccination status was also apparent in the literature (Cotter et al., 2003; Petousis-Harris et al., 2005). One study identified the need for a central reporting system for immunisation to confirm immunisation status (Cotter *et al.,* 2003). In this instance, it was argued that this would enhance confirming vaccination status and would assist in following up parents who did not attend appointments. It has been contended that lack of information regarding immunisation status made it difficult for practice nurses to be certain about vaccination status. Inconsistency in immunisation data collection has been cited in the literature as an issue that hampers the ability to manage immunisation programmes (Ronveaux *et al.,* 2005). It has been recommended that the establishment of a national immunisation register would be beneficial (Petousis-Harris, Goodyear-Smith, Turner, & Soe, 2004). This raises the importance of ensuring that a recording system is accurate and contemporary to minimise the resource required in following up those who do not attend for appointments (Cotter *et al.,* 2003). While practice nurses rely on accurate recording systems, there is guidance on how to deal with

consultations when there is uncertainty about an individual's immunisation status. In the UK, Public Health England (PHE) has produced guidance for health professionals when faced with individuals with an undocumented immunisation history (Public Health England, 2018). In this instance, PHE recommend that when there is no reliable history of previous immunisation, then it should be assumed that individuals are unimmunised and the full or part thereof, of the schedule should be followed (Public Health England, 2018). However, it is unknown if guidance such as this is standardised in other national immunisation programmes.

Practice nurses described a cautious approach to administering the MMR vaccine. This reticence could lead some parents to question the safety of this vaccine and hence, have an impact on their immunising decision making (Kennedy *et al.*, 2014). This raises questions how immunisation training courses are delivered to meet national programmes, as well as having systems in place where competence can be tested. In the UK, PHE has sought to standardise immunisation training for all health professionals involved in the national immunisation programme since 2005 (Public Health England, Royal College of Nursing 2015a,). Although immunisation training is not mandatory, this is the first time that a national immunisation training programme and a competency tool has been implemented in the UK (Public Health England Royal College of Nursing 2015b,). Having robust educational programmes with regular updates would assist in mitigating practice nurse views and concerns as identified in this integrative review by ensuring that clinical practice is contemporary in its evidence base.

Practice nurses expressed concerns about the administration of multiple simultaneous vaccinations (BMRB Social Research, 2008; Leask et al., 2008). There has been discourse in the literature about the immune system's ability to respond to vaccines administered to infants with the prediction that if 11 vaccines were administered to infants at one time,

approximately 0.1% of the infant's immune system would be used (Offit *et al.*, 2002). More contemporary studies have examined the perceptions of health care professionals relating to immunisation (Bakhache et al., 2013; Mameli et al., 2014). While an Italian survey sought to elicit the views of both health care providers (HCP) and parents attitudes towards the administration of a new vaccine, the results for the HCP revealed that 26% agreed with the concomitant administration of the meningococcal serogroup B vaccine with routine infant immunisations (Mameli *et al.*, 2014). While nurses consisted of 27% of the overall HCP sample for this survey, it cannot be determined that all these nurses or what proportion were practice nurses (Mameli *et al.*, 2014). However, it does reveal that these nurses were hesitant in recommending multiple vaccines, which could influence parental immunisation decision making. Likewise, an earlier survey of HCP and parents in seven countries showed that 83% of HCP supported administering multiple vaccines relative to their country's national immunisation programme (Bakhache *et al.*, 2013). While the majority of HCP supported multiple vaccines, only 24% of the overall HCP sample were currently administering three injections. The majority of parents (86%) in this survey accepted the vaccines in their national programmes with 75% trusting their HCP judgement about vaccine choices (Mameli *et al.*, 2014). Although the number of multiple vaccines is increasing in national programmes, the practice of administering multiple simultaneous vaccines is not a new phenomenon.

IMPICATIONS FOR FURTHER RESEARCH, PRACTICE AND EDUCATION

There is a need to explore practice nurse perceptions about administering multiple vaccines. This is particularly important given the complexity and increasing number of vaccines in national immunisation programmes. When immunisation training is available to practice nurses, does this address their ability to deal with immunisation issues highlighted in the media? This is unknown. In addition, considering that research has identified practice nurse

reluctance on the need for a second MMR vaccine and safety concerns about this vaccine, further research could explore their current beliefs about this vaccine, considering the plethora of research that has demonstrated the safety of this vaccine.

Peer support from experienced practitioners for those practice nurses new to the field of immunisation is imperative to develop competence and skill in immunisation practice. Furthermore, assessment of immunisation competence should follow all training. Employing organisations should ensure that this is built in to their policies to ensure their practice nurses are supported in their clinical development.

Education and training need to be tailored to meet changes to national immunisation programmes. This is to ensure practice nurses are equipped with the most contemporary evidence to inform their clinical practice.

Strengths and Limitations

This is the first integrative literature review that has sought to explore the beliefs and perceptions of practice nurses influence on the uptake of the MMR vaccine and has generated key findings and implications for policy makers. Use of an integrative review framework has enabled inclusion of studies using a range of research methods to provide a broad summary of this topic. However, this review is limited by the minimal number of studies found and may be biased because statistically significant results are more likely to be published. In addition, some of the studies included in the review were more than 10 years old and therefore, may not reflect opinions in the current policy environment.

Although this review provides an excellent baseline for this information, more recent research conducted in the current policy environment is urgently needed to determine if these views and beliefs persist.

CONCLUSION

Practice nurses are involved in the administration of national immunisation programmes. In this integrative review using qualitative, quantitative and mixed methods, four themes related to practice nurses' beliefs and perceptions were identified. These included parental immunisation influencing factors, practice nurse characteristics, information & communication and personal views and concerns. Although this review provides an excellent baseline for this information, more recent research conducted in the current policy environment is urgently needed to determine if these views persist.

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Impact Statement

- Practice nurses are one of the key health professionals involved in the administration of national immunisation programmes.
- Given the challenges of maintaining herd immunity of MMR, they can play an important role in the promotion of this vaccine through evidence based practice to dispel misconceptions and misinformation about this vaccine.
- Central to their ability to influence parental immunisation making is their access to contemporary sources of research and literature to inform their consultations.
- This integrative review identifies four themes that characterise the beliefs and perceptions of practice nurses influence about the uptake of the MMR vaccine namely: parental immunisation influencing factors, practice nurse characteristics, information & communication and personal views and concerns.
- Although this review provides an excellent baseline for this information, more recent research is necessary considering that many of the studies were over 10 years to determine if these views persist.

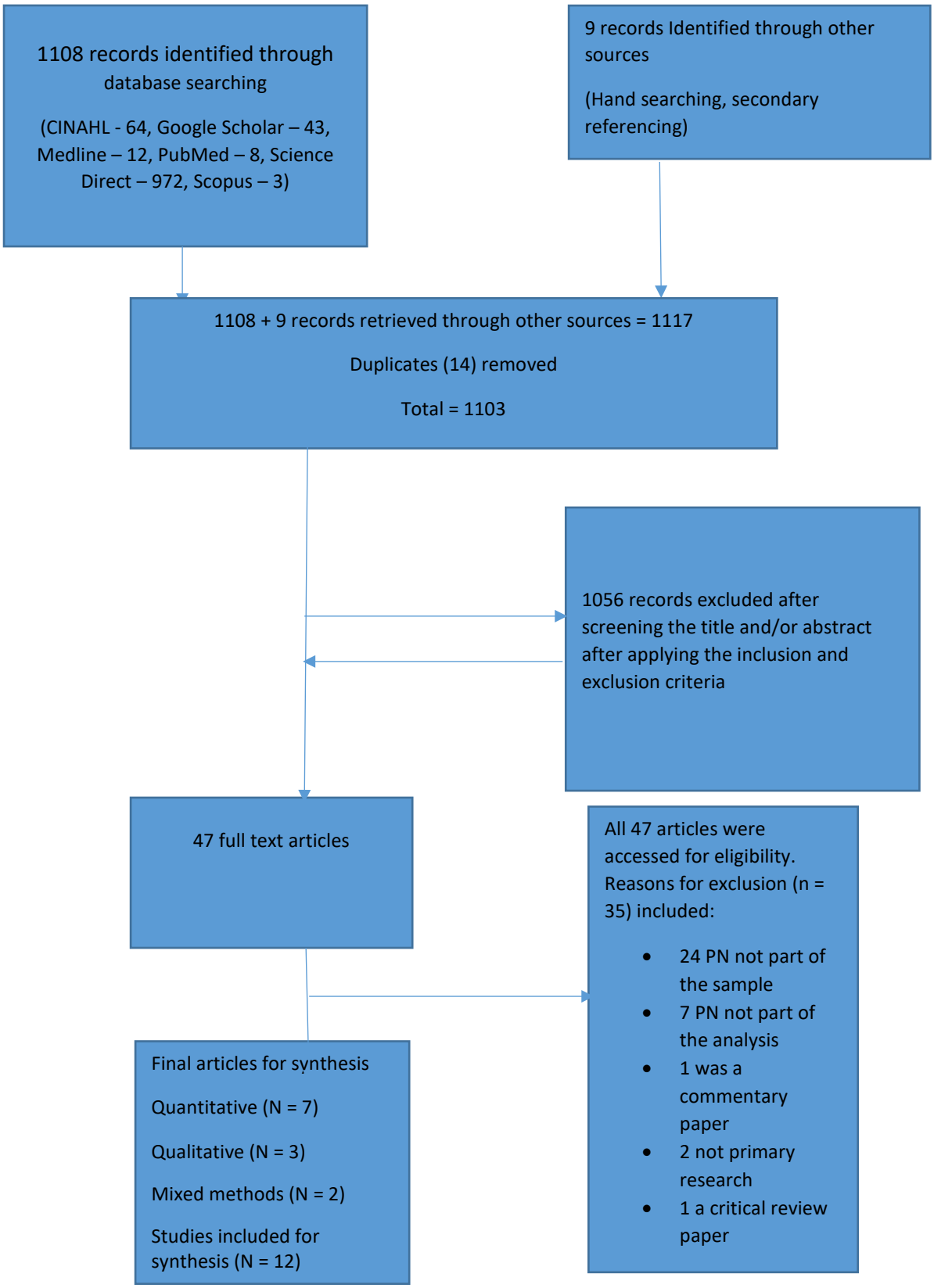

Figure 1 Summary of the selection throughout the selection process

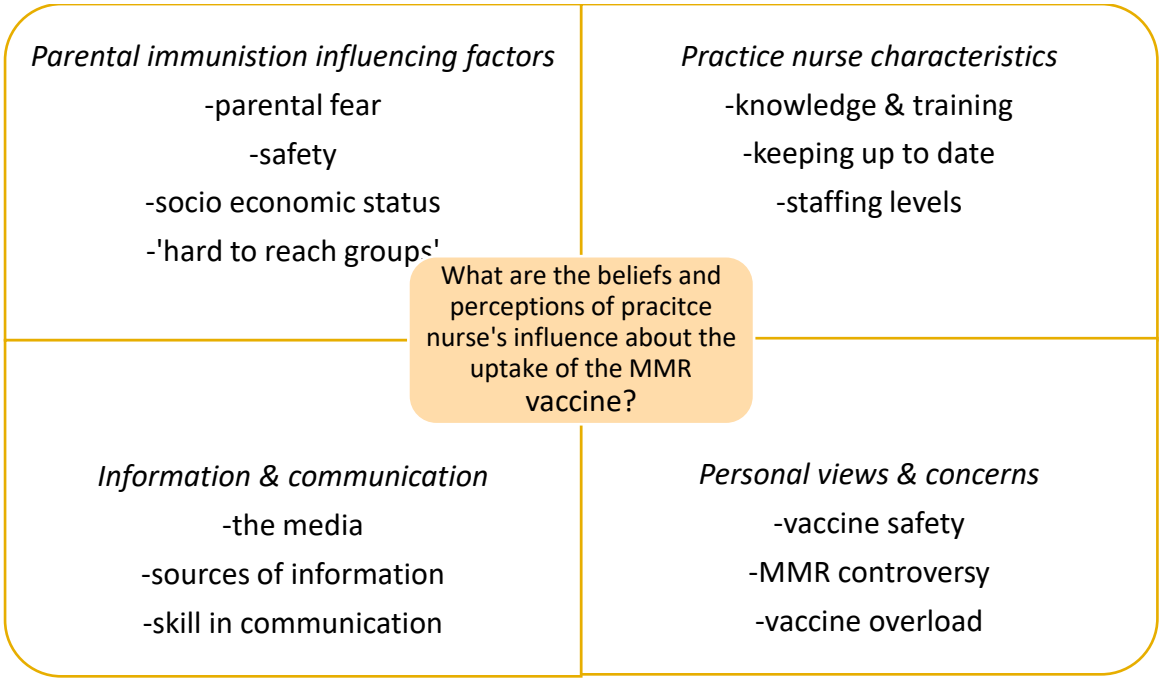

Figure 2 The beliefs and perceptions of practice nurses' influence about the uptake of the Measles, Mumps and Rubella vaccine.

Table 1. Summary of methodology; main findings of papers

First author & year of publication	Participants	Aim/s & Method	Results (Practice nurse results reported)
BMRB Social Research (2008)	1,267 GP, HV & PN	Survey to assess the information needs of GP, HV & PN	• PN attended 1 – 2 immunisation sessions • PN used multiple sources of information to inform immunisation decision making
Cotter (2003)	253 GP, Parents, PHN, Midwives, PN	Mixed methods to determine factors influencing vaccination rates	• PN identified factors that prevented parents vaccinating their children
Desmond (2011)	115 PN	Survey to determine nurse characteristics associated with childhood immunisation coverage	• Factors were identified that were associated with higher practice immunisation coverage
Kennedy (2014)	51 PN, Parents and teenage girls	Qualitative interviews & focus groups to explore vaccination views	• Two main themes were identified: vaccine risks and vaccine responsibilities
Lamden (2008)	257 general practices	Survey to identify general practice factors associated with high MMR vaccine coverage	• No association between MMR uptake and practice size or between the number of practice nurses
Leask (2008)	434 GP, nurses and midwives, including PN	Survey to describe differences in attitudes and immunisation knowledge amongst professional groups	• PN reported being significantly more confident in answering questions about immunisation
MacDonald (2004)	683 GP, HV, PN & parents	Survey to identify contributing factors for low uptake of immunisation	• Many PN had not received formal education about immunisation
Petousis-Harris (2005)	150 Family PN	Mixed methods to understand the immunisation issues confronting PN	• PN identified parental fear as the greatest barrier to achieving immunisation uptake
Petrovic (2001)	593 HV, PN & GP	Survey to determine the knowledge, attitudes and practices among health professionals	• PN identified their knowledge, attitudes and practice concerning the need of a second dose of MMR varied
Smith (2001)	412 GP, PN & HV	Survey to determine whether health professionals' confidence in the MMR vaccine was affected	• Not all PN considered the second dose of MMR to be necessary
Van Bekkum (2013a)	18 PN & HV	Semi-structured interviews to explore how primary care nurses (PCN) negotiate the	• PCN identified how communicating evidence maintained the integrity of the patient practitioner relationship

		challenges of communicating health information and research	
Van Bekkum (2013b)	18 PN & HV	Semi-structured interviews to explore primary care nurses (PCN) experiences how mass media influences frontline healthcare	• PCN recognised how the mass media influences both patients and nurses

Key: PN – practice nurses; HV – health visitors; GP – general practitioners; MMR – measles, mumps and rubella

Table S1 – Assessment of bias assessed in cohort studies (n = 8)

Study	Acceptability of cohort selection	Ascertainment of exposure: minimised bias?	Assessment of outcomes: accurate and consideration of confounding factors	Adequacy and completeness of follow up:
BMRB 2008	Yes. The authors sampled health professionals rather than general practices. The sample of health professionals was from the Dendrite Health care database. This database is used by the Department of Health for sending out publications to doctor and is updated every two weeks through updates from the General Medical Council's official listing and additionally by the health professionals as well, should there be a change of address. It would appear that the cohort sampled were representative of a defined population of health professionals. Furthermore, the database was stratified by the Strategic Health Authority before selection to ensure that the sample correctly represented eth regional distribution. The authors identified the percentage of health professionals (i.e. providing a breakdown for each of the three groups) who refused to participate in the survey.	Yes. The authors used objective measurements. They piloted their study on 3 December 2007, prior the main survey which took place between 21 January and 7 March 2008.	Yes. The outcome was accurately measured to minimise bias. The results were objective measurements (i.e. descriptive statistics). There were occasions where the results for practice nurses and health visitors were grouped as one group. The response rates for these two professional groups were the same and it could be argued did not affect these results. However, it cannot be known if these two professional groups answered the questions the same. It is unclear if the authors identified all-important confounding factors. The authors sought to elicit the views of three professional groups focused on the surveys aims. In order to do so, they sampled across Strategic Health Authorities to aim to capture samples that were representative of a diverse client population. However, the authors did not make explicit other confounding factors, such as the age of the professional groups, their exposure to training ad length of years in practice. They have taken account of the confounding factors in the design and/or analysis. The	It is unclear if the follow up of subjects was complete enough. The overall response rates for all 3 groups was identified (GP – 31%; HV – 63% and PN – 63%). The response rates of GPs and PNs had increased in comparison to the previous year's survey (26% and 55%). The response rate of HVs had fallen by 10%. The follow up of subjects was not long enough. This is unknown for the reasons as outlined in the precious comment. It is unknown if the authors followed up the participants with a repeat request.

	The authors summarised reasons for refusal and identified ways in which they could address this for future surveys.		summary of results was aligned to the three aims and one objective of this survey.	
Desmond et al, 2011	Yes, the sample of practice nurses was randomly selected from 2 different regions in New Zealand.	Yes, the researchers used objective measurements. Practice nurses were randomly selected. It is unclear whether the interview schedule of questions had been piloted.	Yes, the outcome was accurately measured to minimise bias. The results were objective measurements. It is unclear whether the interview questions had been piloted. The authors had calculated that a sample of 125 practices was sufficient to yield 80% power to show statistical significance a at the 5% level for a health professional characteristic associated higher immunisaiton coverage or more timely immunisation if this characteristic was present in 20% - 25% of the practices with higher coverage. No, the authors have not identified all important confounding factors? The authors focused on nurse characteristics associated with childhood immunisation coverage a timeline only and not other variables, such as ethnicity and sources of information. It is unknown, if they have taken into account the confounding factors in the design and/or analysis, as the full range of questions has not been included to determine this.	The follow up of subjects was complete enough. Ninety three percent of practice nurses agreed to participate from the 124 general practices. It is unclear if the follow up of subjects was long enough.
Lamden and Gemmell, 2008	Yes, questionnaires were distributed to the 257 general practices in Cumbria and Lancashire from General practices from eight of the 13 Primary Care Trusts (PCTs)	It is unclear whether the survey had been piloted. It would	No. The outcome was not accurately measured to minimise bias. The results were objective measurements and the researchers provided justification for their use (i.e. Chi squared tests,	Yes, the follow up of subjects was complete enough. The overall response rate for all

	whose Director of Public Health agreed to participate were included. The study area was identified as being socially and geographically diverse with some PCTs having higher ethnic populations.	have been useful if the researchers had included the survey questions as a table. Not all general practices were included in Cumbria and Lancashire and those that were excluded were due to not having a practice nurse. Although, the researchers state that the survey was of practice nurses, it is unclear if practice nurses always completed the survey.	Odds ratios, t-tests and Pearson's correlation coefficient). It is unclear whether the survey has been validated. Over 90% uptake of the MMR vaccine was achieved by 28% of general practices with over 5% of general practise achieving an uptake of 95%. The data which the researchers would have relied on was the data that was inputted on the general practice systems and hence, if this was not accurate would have biased the outcome (i.e. .uptake of the MMR vaccine). Not all general practices in Cumbria and Lancashire were included in this survey. No power calculation was undertaken; therefore, it is unclear whether the results of the questionnaire could be generalised. Yes, the authors have identified all important confounding factors. The authors focused on general practice factors associated with high MMR vaccine coverage. They additionally considered factors such as ethnicity, geographical location and socio demographics on influencing uptake of the MMR vaccine. Yes, the authors have taken account of the confounding factors in the design and/or analysis. The aim of the study was to examine practice demographical structural and immunisation process factors in an attempt to identify characteristics of practices achieving	groups was 75.9%, which is a very good response rate for a questionnaire. No, it is unknown if the follow up of subjects was long enough. It is unknown whether the authors followed up this questionnaire with a repeat request.

			the Department of Health MMR target of 90% coverage.	
Leask et al, 2008	Yes, the cohort was recruited in an acceptable way. Each professional group (of which there were six) were randomly selected from records kept by public health units.	Yes, the exposure was accurately measured to minimise bias. The researchers used objective measurements. The use of a survey was appropriate for this study. Health Professionals, including practice nurses were recruited to the study following random. Many of the questions in the survey were adapted from a 2002 unpublished survey of health care workers in Western Sydney. The survey was	Yes, the outcome was accurately measured to minimise bias. The researchers used objective measurements and these are described in the Methods section. The choice of a survey was appropriate for the aim of the study. The measurement methods were similar in all six groups. Many of the questions in the survey were adapted from a 2002 unpublished survey of health care workers in Western Sydney. The survey was pre tested on a sample of 11 health professionals' form each AHS. No, the authors have not identified all important confounding factors. The authors did not cite the education level of the participants (e.g. Diploma/BSc/MSc) as an important confounding factor that may have influenced these participants' views concerning their immunisaiton attitudes and knowledge. Yes, the authors have taken account of the confounding factors in the design and/or analysis. The authors have considered the design of the survey and have used: Their own expert knowledge on immunisation as delineated in the publication and data extracted from a previous unpublished study to aid with their survey design. This assisted in their development of the content of the survey, which was pre-tested.	Yes, the follow up of subjects was complete enough. The overall response rate was 47%. However, there were differences amongst the six professional groups regarding response rates. No, it is unknown if the follow up of subjects was long enough. It is not clear when this follow up occurred. The authors identify the poorer response rates of GP and Midwives, which limited the extent to which they could generalise findings for these professionals. It is unclear why the response rates were low in these two groups.

		pre-tested on a sample of 11.		
MacDonald et al, 2004	Yes, all general practitioners, health visitors and practice nurses were invited to be part of the survey undertaken in the Highland area of Scotland. Parents were identified form the Standard Immunisation Recall System and were evenly grouped into parents of immunised and non-immunised children.	No, the exposure was not accurately measured to minimise bias. The researchers used objective measurements. It is unclear whether the survey had been piloted. It would have been useful if the researchers had included the survey questions as a table. Practice nurses who were not involved in immunisation were excluded. It is unclear if the researchers excluded any health visitors.	No, the outcome was not accurately measured to minimise bias. The results were objective measurements. It is unclear whether the survey has been piloted. As, no power calculation was undertaken; therefore, it is unclear whether the results of the questionnaire could be generalised. No, the authors have not identified all important confounding factors. This is unclear. The authors identified factors associated with low uptake of immunisation such as family size, lone parenting and access to transport. They did not include other factors associated with low uptake of immunisation, such as ethnicity and sources of information. It is unclear whether the authors have taken account of the confounding factors in the design and/or analysis. The researchers' do outline (i.e. in the introduction to their article) factors associated with low uptake of vaccines and make reference to work by Smailbegovic et al (2003) in East London with emphasis on parental beliefs. They do not make reference to other factors that could influence parental beliefs, such as sources of information and ethnicity.	Yes, the follow up of subjects was complete enough. The response rates are cited, with 73% of general principals, retainers and associated responding. While 87.5% of health visitors responded, 60.2% of practice nurses did. Interesting, only 45.28% of practice nurses could be included in the final analysis, as only this percentage were involved in the childhood immunisation programme. However, overall, the response rates were good for a postal survey for all three groups even taking into consideration the reduction in the numbers of practice nurses' responses that could be analysed. In

				relation to the parents, the response rates of parents of completely immunised children was 64% (i.e. the controls) and the response rates of parents of incompletely immunised children was 54.3% (i.e. the cases). Again, for postal questionnaires, these response rates were good.
Petousis-Harris et al, 2005	Yes, the general practices that were approached were computer generated randomly selected practices. The researchers continued contacting practices until they had recruited 150 practice nurses to the study.	Yes, the exposure was accurately measured to minimise bias. The researchers used both subjective and objective measurements. The use of mixed methods was appropriate for this study. The design of the questionnaire was based on areas identified in	Yes, the outcome was accurately measured to minimise bias. The researchers used both subjective and objective measurements and these are described in the Methods section. The choice of mixed methods was appropriate for the aim of the study. It is unclear whether the researchers piloted their questionnaire. However, their study was conducted at the same time with a similar survey of New Zealand family physicians. All practice nurses in New Zealand could have been part of this study, due to the random selection of their general practices. No, the authors have not identified all important confounding factors. The authors did not cite the education level of the practice nurse (e.g. Diploma/BSc/MSc) as an important	Yes, the follow up of subjects was complete enough. The response rate was 89.3%, which is a very good respond rate. The follow up was compete enough as the authors reached the sample size of 150. Yes, it would appear that the follow up of subjects was long enough, as the study was conducted over five months.

		the literature as barriers to immunisation. Furthermore, the questionnaire explored nurses' educational needs and preferred sources for immunisation information, their confidence and their knowledge related to immunisation. Practice nurses were recruited to the study following random selection of their general practice, so they were classified using the same procedure.	confounding factor that may have influenced the family practice nurses' views on barriers to immunising children; their educational needs and preferred sources for information and finally their confidence and knowledge relating to immunisation. Yes, the authors have taken account of the confounding factors in the design and/or analysis. The authors based the design of the questionnaire on the barriers to immunisation. The analysis was in two stages. Firstly, quantitative data analysis was undertaken using EpiInfor 2000 where differences between groups were sought. The qualitative data that was collected involved free form answers to questions including other perceived barriers to immunisation, sources of information concerning immunisation and identification of adverse reactions following immunisation. The analysis regarding the free form data response used a general inductive approach to identify sub themes. The data was then organised into categories. Finally, themes were determined following discussion and consensus amongst the authors.	
Petrovic et al 2001	Yes, the authors mailed out an anonymous self-administrated questionnaire to all the health visitors and practice nurses in the Health Authority and to a 50% random sample of general practitioners.	It is unclear if the exposure was accurately measured to minimise bias.	It is unclear if the outcome was accurately measured to minimise bias. The results were objective measurements with emphasis on descriptive statistics. This was useful in comparing and contrasting the responses of the three professional groups. The 95% confidence interval (CI) was used to	Yes, the follow up of subjects was complete enough. The overall response rates for all 3 groups was identified (GP – 80%; HV – 95% and PN – 85%), which

		The researchers used objective measurements. It is unclear whether the survey consisting of 16 questions with an opportunity to make open comments had been piloted. It would have been useful if the researchers' had included all the survey questions as a table. The researchers aimed to include all practice nurses and health visitors in the Health Authority as all were targeted to receive the anonymised self-administered questionnaire. They additionally targeted general practitioners,	estimate the precision of the odds ratio (OD). A large CI indicates a lower level of precision of the OR, whereas a small CI indicates a higher precision of het OR. In this instance, the small CI indicated a higher precision of the OR. It was unclear whether the survey had been piloted. It is unclear whether the authors have identified all important confounding factors. The researchers sought to elicit the views of three professional groups about the MMR vaccine. While it can be determined that the researchers aimed to reach a wide as sample as possible for these three professional groups, the socio demographic and geographical make up of the population of the Health Authority is unknown as are the levels of deprivation, affluence or ethnic diversity. In additional it is unknown what the characteristics' of the practice nurses were in terms of education year of practice as a practice nurse and number of children in their children in their general practice. It is unclear whether the authors have taken account of the confounding factors in the design and/or analysis. This is unknown as the full range of question has not been included. However the results follow the aims of the survey, which was to determine the knowledge, attitudes and practices among health professionals (i.e. health visitors, practice nurses' and general practitioners) regarding the	was a very good respond rate for an anonymised self-administered questionnaire. Yes, the follow up of subjects was long enough. The researchers followed up a reminder one month after the initial mailing. At the second mailing the authors selected a 50% random sample of general practitioners. It is unclear why they did so, as they did not for the PNs or HVs. This may account for the lower response rate from GPs.

		although they did not explain why they randomly selected only 50% of general practitioners.	MMR vaccine, with emphasis on the second dose of MMR.	
Smith et al, 2001	Yes, anonymised questionnaires were distributed via the Health Authority internal mailing system. The sample size consisted of: 238 general practitioners'; 121 practice nurses' and 53 health visitors.	No, the exposure was not accurately measured to minimise bias. The authors wished to assess the impact that 2 publications had on the 3 groups of health professionals (general practitioners, practice nurses and health visitors), with the first article published in 1995 and the second four months prior to when they undertook the survey in June 1998. There may have been other	No, the outcome was not accurately measured to minimise bias. The results were descriptive statistics, with 20% of the data randomly validated. However, the authors do not expand upon, or clarify what they mean by how the data was randomly validated. There was variability of responses amongst the 3 different health professional groups. It is unclear why this has occurred and this was not explored further. It is unclear whether the authors have identified all important confounding factors. The authors focused on the impact that two publications may have had on the three health professional groups related to their confidence in the MMR vaccine. They did ask (i.e. in Question eight in the questionnaire) to identify which of five variables they considered influenced vaccine uptake. However, this list did not include other factors, such as ethnicity and access to address this section. However, the authors did cite that although 94% of the sample were responsible for giving advice about the MMR vaccine, 24% were not directly involved in administering the vaccine. It is unclear from this article if the authors did control for the role differences (i.e.	Yes, the follow up of subjects was complete enough. The overall response rate for all groups was 62%, which is a good response rate for a questionnaire. Yes, the follow up of subjects (identified as four months) was long enough. Initially, the response rate for all groups was 47%. After which (i.e. in the follow up four month period), the response rate increased to 62%.

		variables that could have influenced these health professionals, other than these 2 publications. It is unclear whether the authors piloted their questionnaire. However, the authors targeted all the 3 health professional groups in the Health Authority.	those health professionals' who immunise versus those who do not). It is unclear whether the authors have taken account of the confounding factors in the design and/or analysis. The design of the questionnaire reflected the stated aims of the research from the information in the accompanying tables. However, it is unclear whether the authors considered other confounding Factors that may have impacted on the design and/or analysis of this questionnaire such as: number of years in clinical practice; access to immunisation education; geographical location and socio demographics of the population.	

Table S2. Summary of methodology; main findings of papers, including strengths and limitations

1st author, year & country	Participants	Aim/s relevant to practice nursing	Method	Results [Practice nurse results reported]	Strengths & Limitations
BMRB Social Research (2008) United Kingdom	272 GP 422 HV 573 PN	To provide information for improved support for health professionals To assess the information needs of GP, HV & PN	Survey	The response rates for the 3 groups were: GP – 31%, HV – 63% & PN – 63% • The majority of PN attended 1 – 2 immunisation sessions in the previous 2 years • PN used multiple sources of information to inform immunisation decision making with some raising concerns about the number of vaccines scheduled; complexity of the schedule and difficulty keeping up to date with the changes to the schedule	Strengths A contemporary survey about 3 health professional groups views about the childhood immunisation programme Limitations It is not always clear what professional group are being referred to in the results section and consequently, this does not identify the information and support needs for PN
Cotter et al (2003) Republic of Ireland	147 GP Focus groups consisting of 47 Parents 23 PHN 14 Midwives 12 PN	To determine factors influencing vaccination rates in the Southern Health Board region in the Republic of Ireland	Mixed methods (Survey & Focus groups)	PN identified a number of factors that prevented parents vaccinating their children, such as fear and side effects of vaccines, forgetting to vaccinate and not realising the importance of vaccination	Strengths This mixed methods study sought the views of both health professionals and parents on the determinants influencing vaccine uptake, with emphasis on the MMR vaccine. Limitations The characteristics of the PN, who participated in the two focus groups are unknown. They were self-selected and all employed as PN in 2 counties in the Republic of Ireland.

					It is not possible to determine whether these findings are generalisable, particularly the postal survey of GP. In addition, while the focus groups identify themes related to each focus group, this mixed methods study reveals the views and opinions of these parents and allied health professionals only. It cannot be determined if these views are held by other groups of health professionals and/or parents
Desmond et al (2011) New Zealand	115 PN	To determine nurse characteristics associated with childhood immunisation coverage and timelines in two different regions (Auckland and Midland)	Survey	The response rate was 93% • Immunisations were delivered by the majority of PN. Factors associated with higher practice immunisation coverage and less delay were a lower ratio of nurses to children; nurse comfort with their immunisation knowledge and their perception of parental fear as a barrier to immunisation • PN (97%) preferred source of information was the Ministry of Health Immunisation handbook. Other sources of information were seeking out information from other PN colleagues (87%) and seeking information from GP colleagues (77%)	Strengths The researchers obtained a random sample of PN Limitations One nurse was interviewed from each general practice only, so these views may not reflect the other PN in the practice The study was conducted between 2005 – 2006, so may not reflect the most contemporary views of these PN All PN were female

				• PN cited the most significant factors to barriers on patients accessing immunisation services namely: parental apathy and ambivalence (47%), parental fear (59%) • After adjustment of the four main variables for region, Maori 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 a practice (P = 0.03), nurse perception of increased parental apathy (P = 0.005), or fear (P = 0.008) a barrier and PN comfort in their knowledge about immunisation (P = 0.0004) • After adjustment for the four main variables, more timely practice immunisation delivery was associated with: a lower ratio of nurse to children registered with the practice (P= 0.007), nurse perception of increased parental apathy as a barrier (P = 0.003) and comfort in knowledge about immunisation (P = 0.049)	

				• Factors 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 associated with more timely practice immunisation delivery: 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)	
Kennedy et al (2014) United Kingdom	51 health professionals (of which 7 were PN) 15 parents 8 teenage girls	To explore vaccination views amongst parents, teenage girls about 3 controversial vaccines: the MMR, HPV and the Influenza A (H1N1) vaccine	Qualitative interviews & focus group	Health professionals reported that they worked in a range of socio economic areas (urban and rural) and their involvement differed with the administration of different vaccines in the national programme • Two main themes were identified: 'vaccine risks' with PN adopting a cautious approach in advocating MMR and 'vaccine responsibilities with PN noting socio economic	Strengths This study provides new insight into views of health professionals, parents and teenage girls into 3 controversial vaccines Limitations The views of these groups cannot be extrapolated into the wider population The participants were self-selected and therefore, may have been more engaged in participating in this study

				differences as determinates of uptake	
Lamden and Gemmell (2008) United Kingdom	257 general practices targeting PN	To identify general practice factors associated with high MMR vaccine coverage	Survey	The response rate was 75.9% • The non-responding practices were not significantly different from the responders in terms of practice size (5414 versus 5738, P = 0.41) average number of GPs (2.7 versus 3.2, P = 0.06) and MMR uptake (87.2% versus 86.1%, P = 0.22) • There was no association between MMR uptake and the number of practice nurses (x^2 = 0.64, P = 0.93) • There was no association between MMR uptake and practice size (x^2 = 4.38, P = 0.22) or the number of GPs (x^2= 1.3, P= 0.73) • There was no difference in uptake between the 192 GMS practices and 65 PMS practices (86.3 versus 86.4%, t = 0.03, P = 0.97) or between single-handed versus group practices (85.2 versus 86.9%, t = 1.87, P = 0.062) • The MMR uptake was not correlated with practice deprivation score (r = 0.04, P = 0.45) or the percentage of the	Strengths The targeted sample group were PN in general practices The researchers excluded a general practice if they did not employ a PN There was statistical evidence to demonstrate that a designated MMR practice strategy was strongly associated with a higher MMR uptake Limitations It cannot be known if only PN answered the survey, as not all PN administered the MMR vaccine (n = 46%) and this may have influenced the results of the survey

				population who were white (r = 0.02, P = 0.78) • The MMR uptake was strongly correlated with the IMD domain of barriers to housing and services (r = - 0.230, P, <0.001) • Having a strategy with clear objectives for MMR was the only factor significantly associated with achieving an MMR uptake of over 90% (OR, 3.76, 1.26–12.04, P = 0.01)	
Leask et al (2008) Australia	95 GP 81 PN 30 early childhood nurses (ECN) 40 generalist community nurses (GCN) 76 hospital nurses (HN) 112 midwives	To describe differences in attitudes amongst different groups of health professionals between 2 regional areas (Hunter New England (HNE) and North Coast (NC) Area Health Services in New South Wales) To identify the immunisation knowledge, attitudes and practise among health professionals who provide immunisation with a focus on differences between professional groups	Survey	The response rates were: GP – 37%, PN– 60% , ECN– 67%, GCN - 58%, HN- 54% & Midwives- 41% • Nurses who received accreditation training reported significantly more confidence in answering parental questions about immunisation (P<0.001) , compared with nurses who did not receive such training • They were more likely to answer correctly that a family history of convulsions was not a contradiction to vaccination (P<0.001), but were not more likely to believe that immunisation was safe, effective or necessary (P = 0.16, P= 0.10 and P = 0.44) • PN agreed that childhood vaccines were safe (100%),	Strengths This survey elicited the differences in attitudes and immunisation knowledge amongst six professional groups Limitations There was a wide variation in responses amongst health professional groups (37% - 67%) Results did not always identify the designation of the health professional with a number of results referred to the six distinct groups of health professionals as 'Respondents' or 'Nurses' A total of 248 health professionals were required for both regional areas. This was not met. Therefore,

				effective (100%) and necessary (97%) • Respondents (PN and GP combined results) reported being more confident in answering questions about immunisation than hospital nurses and midwives combined (91%) [OR: 3.2, 95% CI 1.7-5.8]. • PN (91%) stated they would give more than two injections if needed, although 35% reported feeling uncomfortable doing so • 95% PN found newsletters a useful source of information on immunisation • The second highest rate of immunisation training in comparison to the other five health professionals occurred amongst PN (69%) with in service and/or updates cited as the most popular form of continuing education (58%)	these findings cannot be generalised to the wider population of these professional groups
MacDonald et al (2004) United Kingdom	282 GP 72 HV 88 PN 241 Parents	To identify contributing factors for low uptake of immunisation	Survey	The response rates were: GP – 73%, HV – 87% & PN – 60% • As 45% PN participated in childhood immunisation, only this sample was included in the final analysis • 45% PN had not received formal education about immunisation with only 8% used journals	Strengths A survey to ascertain the views of 3 different professional groups and parents concerning factors contributing to low uptake Limitations There were occasions where the responses of health visitors and

				where original research was reported as sources of their immunisation information • Parents who had their children immunised indicated that they were more likely to feel able to discuss their concerns with primary care staff, a difference that was statistically significant, (GPs P = 0.009; health visitors P = 0.003; practice nurses P = 0.024)	practice nurses were grouped together and therefore, it was not possible to discern which responses related to which group As no power calculation was undertaken, these results could not be generalised
Petousis-Harris et al (2005) New Zealand	150 Family PN	To understand the immunisation issues confronting PN	Mixed methods (Computer assisted telephone survey to obtain qualitative and quantitative data)	The response rate was 89% • PN identified parental fear as the greatest barrier to achieving immunisation uptake • Findings revealed lack of knowledge amongst PN. The mean number of correct answers to questions in the telephone survey regarding contraindications for MMR and pertussis vaccines indicated that those who had received training over 2 years prior to the survey, or had never attended a course, were significantly less likely to give correct responses (Bartlett's $x^2 = 7.1077, 1\ d.f., P = 0.0077$) • PN who had attended an update course rather than a	Strengths This was the first comprehensive survey of New Zealand PN on their views on barriers to immunisation, their knowledge and their reported responses to adverse events The authors justify the sample size of 150 relative to the number of PN in New Zealand Limitations The education level (e.g. Diploma/BSc/MSc) of PN was not identified, as this alone could have been a variable linked to higher immunisation coverage

				base course scored significantly better ($x^2 = 4.79, P = 0.029$) • PN who reached the highest coverage rate (>95%) had a significantly higher mean number of correct answers than those with the lowest coverage rate (<70%) (Bartlett's test P = 0.0034) • A higher level of confidence, more years in practice were not associated with better immunisation coverage rates when PN with immunisaiton coverage of <90% and >90% were compared. There was no statistical significance between the groups ($x^2 = 0.06, P = 0.813$) • All PN cited the Ministry of Health Immunisation Handbook as a source of further information on immunisation and 93% used their local immunisation coordinator district immunisation facilitator	
Petrovic et al (2001) United Kingdom	148 HV 239 PN 206 GP	To determine the knowledge, attitudes and practices among health professionals regarding the MMR vaccine	Survey	The response rates were: GP – 80%, HV – 95% & PN – 85% • 17% PN stated they gave advice on immunisation to parents • 75% PN reported that they would have liked more	Strengths The first published survey in the UK concerning the knowledge, attitudes and practices of 3 health professional groups concerning their views on the second dose of MMR

				information or training on the MMR vaccine • 54% PN stated they had reservations about the policy of giving the second dose of MMR GP were more likely than HV (odds ratio, 1.7 (confidence interval 1.1 to 2.8); or PN 1.7 ((1.1 to 2.7) to agree completely with the policy • 33% PN stated that an association between the MMR vaccine and Crohn's was very likely or possible, while 27% believed there to be an association with autism • There were differences amongst the three professional groups in their confidence to agree completely with the policy of giving the second dose of MMR (GP, odds ratio 5.2 (95% confidence interval 2.6 to 10.4); HV, 5.3 (2.4 to 11.9); PN 2.1 (1.1 to 4.0). • There were differences amongst the three professional groups when faced with a parent who was still unsure about the second dose of MMR. 72% (GP), 42% (PN) and 20% (HV) stating that they would recommend the second dose of the vaccine.	Limitations It is unclear whether this survey is generalisable to the wider population of these 3 professional groups, as no power calculation was identified for each professional group The authors make an assumption that the results can be generalised to North Wales due to the high response rates for the 3 professional groups without any clarification

				More respondents who stated that they agreed completely with the policy of giving the second dose stated that they would recommend it in such a situation than did those who gave another response to the policy (GP, odds ratio, 5.8 (95% confidence interval 2.6 to 13.1); HV, 5.1 (2.1 to 12.8); PN, 5.2 (2.6 to 10.2)	
Smith et al (2001) United Kingdom	238 GP 121 PN 53 HV	To determine whether health professionals' confidence in the MMR vaccine was affected To assess professional knowledge and attitudes towards the second dose of MMR	Survey	The response rates were: GP – 57%, HV – 75% & PN – 64% • Only 41% PN considered the second dose of MMR to be necessary • PN were less confident about the MMR vaccine with 11% PN suggesting separate vaccines instead of the MMR vaccine • 79% PN would encourage the first dose of MMR, while 61% would encourage the second dose of MMR	Strengths The response rate of PN was sufficiently high to provide a representative Indication of attitudes and knowledge in this professional group The survey was undertaken in July 1998 to assess the impact of adverse publication of 2 publications relating to the MMR vaccine, with the most recent publication being in February 1998 Limitations The authors did not always identify which of the 3 professional groups they were referring to in the results section, as they referred to: "health professionals, "respondents" or "sample"

Van Bekkum and Hilton (2013a) United Kingdom	9 PN 9 HV	To explore how primary care nurses' negotiate the challenges of communicating health information and research	Telephone semi-structured interviews	Three themes emerged • Communicating evidence to the critically minded patient • Confidence in communicating evidence • Maintaining the integrity of the patient practitioner relationship	Strengths A new area of research, as no studies to date had investigated how primary care nurses communicate health information and research Quotes attributed to PN are identifiable in the results section Limitations The use of a qualitative method limits the ability to generalise findings The sample size for each professional group was self-selected and therefore, the group of PN could be a highly engaged group of PN within their professional group Although, the year of publication was 2013, the data was collected in 2008/2009 and therefore, does not present a contemporary picture of the media and its influence on PN
Van Bekkum and Hilton (2013b) United Kingdom	9 PN 9 HV	To explore primary care nurses' experiences how mass media influences frontline healthcare	Telephone semi-structured interviews	Three themes emerged • Mass media influence on patients' • Mass media influence on nurses' • Developing media literacy skills	Strengths A new area of research, as no studies to date have investigated the role that the mass media plays in the patient practitioner encounter form the perspective of primary care nurses Quotes attributed to PN are identifiable in the results section. Limitations

					The use of a qualitative method limits the ability to generalise findings. The sample size of primary care nurses was self-selected and therefore, the sample of PN could be a highly engaged group within their professional group

Key: PN – practice nurses; HV – health visitors; GP – general practitioners; MMR – measles, mumps and rubella

Table S2. Summary of methodology; main findings of papers, including strengths and limitations

1st author, year & country	Participants	Aim/s relevant to practice nursing	Method	Results [Practice nurse results reported]	Strengths & Limitations
BMRB Social Research (2008) United Kingdom	272 GP 422 HV 573 PN	To provide information for improved support for health professionals To assess the information needs of GP, HV & PN	Survey	The response rates for the 3 groups were: GP – 31%, HV – 63% & PN – 63% • The majority of PN attended 1 – 2 immunisation sessions in the previous 2 years • PN used multiple sources of information to inform immunisation decision making with some raising concerns about the number of vaccines scheduled; complexity of the schedule and difficulty keeping up to date with the changes to the schedule	Strengths A contemporary survey about 3 health professional groups views about the childhood immunisation programme Limitations It is not always clear what professional group are being referred to in the results section and consequently, this does not identify the information and support needs for PN
Cotter et al (2003) Republic of Ireland	147 GP Focus groups consisting of 47 Parents 23 PHN 14 Midwives 12 PN	To determine factors influencing vaccination rates in the Southern Health Board region in the Republic of Ireland	Mixed methods (Survey & Focus groups)	PN identified a number of factors that prevented parents vaccinating their children, such as fear and side effects of vaccines, forgetting to vaccinate and not realising the importance of vaccination	Strengths This mixed methods study sought the views of both health professionals and parents on the determinants influencing vaccine uptake, with emphasis on the MMR vaccine. Limitations The characteristics of the PN, who participated in the two focus groups are unknown. They were self-selected and all employed as PN in 2 counties in the Republic of Ireland.

					It is not possible to determine whether these findings are generalisable, particularly the postal survey of GP. In addition, while the focus groups identify themes related to each focus group, this mixed methods study reveals the views and opinions of these parents and allied health professionals only. It cannot be determined if these views are held by other groups of health professionals and/or parents
Desmond et al (2011) New Zealand	115 PN	To determine nurse characteristics associated with childhood immunisation coverage and timelines in two different regions (Auckland and Midland)	Survey	The response rate was 93% • Immunisations were delivered by the majority of PN. Factors associated with higher practice immunisation coverage and less delay were a lower ratio of nurses to children; nurse comfort with their immunisation knowledge and their perception of parental fear as a barrier to immunisation • PN (97%) preferred source of information was the Ministry of Health Immunisation handbook. Other sources of information were seeking out information from other PN colleagues (87%) and seeking information from GP colleagues (77%)	Strengths The researchers obtained a random sample of PN Limitations One nurse was interviewed from each general practice only, so these views may not reflect the other PN in the practice The study was conducted between 2005 – 2006, so may not reflect the most contemporary views of these PN All PN were female

				• PN cited the most significant factors to barriers on patients accessing immunisation services namely: parental apathy and ambivalence (47%), parental fear (59%) • After adjustment of the four main variables for region, Maori 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 a practice (P = 0.03), nurse perception of increased parental apathy (P = 0.005), or fear (P = 0.008) a barrier and PN comfort in their knowledge about immunisation (P = 0.0004) • After adjustment for the four main variables, more timely practice immunisation delivery was associated with: a lower ratio of nurse to children registered with the practice (P= 0.007), nurse perception of increased parental apathy as a barrier (P = 0.003) and comfort in knowledge about immunisation (P = 0.049)	

				• Factors 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 associated with more timely practice immunisation delivery: 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)	
Kennedy et al (2014) United Kingdom	51 health professionals (of which 7 were PN) 15 parents 8 teenage girls	To explore vaccination views amongst parents, teenage girls about 3 controversial vaccines: the MMR, HPV and the Influenza A (H1N1) vaccine	Qualitative interviews & focus group	Health professionals reported that they worked in a range of socio economic areas (urban and rural) and their involvement differed with the administration of different vaccines in the national programme • Two main themes were identified: 'vaccine risks' with PN adopting a cautious approach in advocating MMR and 'vaccine responsibilities with PN noting socio economic	Strengths This study provides new insight into views of health professionals, parents and teenage girls into 3 controversial vaccines Limitations The views of these groups cannot be extrapolated into the wider population The participants were self-selected and therefore, may have been more engaged in participating in this study

				differences as determinates of uptake	
Lamden and Gemmell (2008) United Kingdom	257 general practices targeting PN	To identify general practice factors associated with high MMR vaccine coverage	Survey	The response rate was 75.9% • The non-responding practices were not significantly different from the responders in terms of practice size (5414 versus 5738, P = 0.41) average number of GPs (2.7 versus 3.2, P = 0.06) and MMR uptake (87.2% versus 86.1%, P = 0.22) • There was no association between MMR uptake and the number of practice nurses (x^2 = 0.64, P = 0.93) • There was no association between MMR uptake and practice size (x^2 = 4.38, P = 0.22) or the number of GPs (x^2= 1.3, P= 0.73) • There was no difference in uptake between the 192 GMS practices and 65 PMS practices (86.3 versus 86.4%, t = 0.03, P = 0.97) or between single-handed versus group practices (85.2 versus 86.9%, t = 1.87, P = 0.062) • The MMR uptake was not correlated with practice deprivation score (r = 0.04, P = 0.45) or the percentage of the	Strengths The targeted sample group were PN in general practices The researchers excluded a general practice if they did not employ a PN There was statistical evidence to demonstrate that a designated MMR practice strategy was strongly associated with a higher MMR uptake Limitations It cannot be known if only PN answered the survey, as not all PN administered the MMR vaccine (n = 46%) and this may have influenced the results of the survey

				population who were white (r = 0.02, P = 0.78) • The MMR uptake was strongly correlated with the IMD domain of barriers to housing and services (r = - 0.230, P, <0.001) • Having a strategy with clear objectives for MMR was the only factor significantly associated with achieving an MMR uptake of over 90% (OR, 3.76, 1.26–12.04, P = 0.01)	
Leask et al (2008) Australia	95 GP 81 PN 30 early childhood nurses (ECN) 40 generalist community nurses (GCN) 76 hospital nurses (HN) 112 midwives	To describe differences in attitudes amongst different groups of health professionals between 2 regional areas (Hunter New England (HNE) and North Coast (NC) Area Health Services in New South Wales) To identify the immunisation knowledge, attitudes and practise among health professionals who provide immunisation with a focus on differences between professional groups	Survey	The response rates were: GP – 37%, PN– 60% , ECN– 67%, GCN - 58%, HN- 54% & Midwives- 41% • Nurses who received accreditation training reported significantly more confidence in answering parental questions about immunisation (P<0.001) , compared with nurses who did not receive such training • They were more likely to answer correctly that a family history of convulsions was not a contradiction to vaccination (P<0.001), but were not more likely to believe that immunisation was safe, effective or necessary (P = 0.16, P= 0.10 and P = 0.44) • PN agreed that childhood vaccines were safe (100%),	Strengths This survey elicited the differences in attitudes and immunisation knowledge amongst six professional groups Limitations There was a wide variation in responses amongst health professional groups (37% - 67%) Results did not always identify the designation of the health professional with a number of results referred to the six distinct groups of health professionals as 'Respondents' or 'Nurses' A total of 248 health professionals were required for both regional areas. This was not met. Therefore,

				effective (100%) and necessary (97%) • Respondents (PN and GP combined results) reported being more confident in answering questions about immunisation than hospital nurses and midwives combined (91%) [OR: 3.2, 95% CI 1.7-5.8]. • PN (91%) stated they would give more than two injections if needed, although 35% reported feeling uncomfortable doing so • 95% PN found newsletters a useful source of information on immunisation • The second highest rate of immunisation training in comparison to the other five health professionals occurred amongst PN (69%) with in service and/or updates cited as the most popular form of continuing education (58%)	these findings cannot be generalised to the wider population of these professional groups
MacDonald et al (2004) United Kingdom	282 GP 72 HV 88 PN 241 Parents	To identify contributing factors for low uptake of immunisation	Survey	The response rates were: GP – 73%, HV – 87% & PN – 60% • As 45% PN participated in childhood immunisation, only this sample was included in the final analysis • 45% PN had not received formal education about immunisation with only 8% used journals	Strengths A survey to ascertain the views of 3 different professional groups and parents concerning factors contributing to low uptake Limitations There were occasions where the responses of health visitors and

				where original research was reported as sources of their immunisation information • Parents who had their children immunised indicated that they were more likely to feel able to discuss their concerns with primary care staff, a difference that was statistically significant, (GPs P = 0.009; health visitors P = 0.003; practice nurses P = 0.024)	practice nurses were grouped together and therefore, it was not possible to discern which responses related to which group As no power calculation was undertaken, these results could not be generalised
Petousis-Harris et al (2005) New Zealand	150 Family PN	To understand the immunisation issues confronting PN	Mixed methods (Computer assisted telephone survey to obtain qualitative and quantitative data)	The response rate was 89% • PN identified parental fear as the greatest barrier to achieving immunisation uptake • Findings revealed lack of knowledge amongst PN. The mean number of correct answers to questions in the telephone survey regarding contraindications for MMR and pertussis vaccines indicated that those who had received training over 2 years prior to the survey, or had never attended a course, were significantly less likely to give correct responses (Bartlett's $x^2 = 7.1077, 1\ d.f., P = 0.0077$) • PN who had attended an update course rather than a	Strengths This was the first comprehensive survey of New Zealand PN on their views on barriers to immunisation, their knowledge and their reported responses to adverse events The authors justify the sample size of 150 relative to the number of PN in New Zealand Limitations The education level (e.g. Diploma/BSc/MSc) of PN was not identified, as this alone could have been a variable linked to higher immunisation coverage

				base course scored significantly better ($x^2 = 4.79, P = 0.029$) • PN who reached the highest coverage rate (>95%) had a significantly higher mean number of correct answers than those with the lowest coverage rate (<70%) (Bartlett's test P = 0.0034) • A higher level of confidence, more years in practice were not associated with better immunisation coverage rates when PN with immunisaiton coverage of <90% and >90% were compared. There was no statistical significance between the groups ($x^2 = 0.06, P = 0.813$) • All PN cited the Ministry of Health Immunisation Handbook as a source of further information on immunisation and 93% used their local immunisation coordinator district immunisation facilitator	
Petrovic et al (2001) United Kingdom	148 HV 239 PN 206 GP	To determine the knowledge, attitudes and practices among health professionals regarding the MMR vaccine	Survey	The response rates were: GP – 80%, HV – 95% & PN – 85% • 17% PN stated they gave advice on immunisation to parents • 75% PN reported that they would have liked more	Strengths The first published survey in the UK concerning the knowledge, attitudes and practices of 3 health professional groups concerning their views on the second dose of MMR

				information or training on the MMR vaccine • 54% PN stated they had reservations about the policy of giving the second dose of MMR GP were more likely than HV (odds ratio, 1.7 (confidence interval 1.1 to 2.8); or PN 1.7 ((1.1 to 2.7) to agree completely with the policy • 33% PN stated that an association between the MMR vaccine and Crohn's was very likely or possible, while 27% believed there to be an association with autism • There were differences amongst the three professional groups in their confidence to agree completely with the policy of giving the second dose of MMR (GP, odds ratio 5.2 (95% confidence interval 2.6 to 10.4); HV, 5.3 (2.4 to 11.9); PN 2.1 (1.1 to 4.0). • There were differences amongst the three professional groups when faced with a parent who was still unsure about the second dose of MMR. 72% (GP), 42% (PN) and 20% (HV) stating that they would recommend the second dose of the vaccine.	Limitations It is unclear whether this survey is generalisable to the wider population of these 3 professional groups, as no power calculation was identified for each professional group The authors make an assumption that the results can be generalised to North Wales due to the high response rates for the 3 professional groups without any clarification

				More respondents who stated that they agreed completely with the policy of giving the second dose stated that they would recommend it in such a situation than did those who gave another response to the policy (GP, odds ratio, 5.8 (95% confidence interval 2.6 to 13.1); HV, 5.1 (2.1 to 12.8); PN, 5.2 (2.6 to 10.2)	
Smith et al (2001) United Kingdom	238 GP 121 PN 53 HV	To determine whether health professionals' confidence in the MMR vaccine was affected To assess professional knowledge and attitudes towards the second dose of MMR	Survey	The response rates were: GP – 57%, HV – 75% & PN – 64% • Only 41% PN considered the second dose of MMR to be necessary • PN were less confident about the MMR vaccine with 11% PN suggesting separate vaccines instead of the MMR vaccine • 79% PN would encourage the first dose of MMR, while 61% would encourage the second dose of MMR	Strengths The response rate of PN was sufficiently high to provide a representative Indication of attitudes and knowledge in this professional group The survey was undertaken in July 1998 to assess the impact of adverse publication of 2 publications relating to the MMR vaccine, with the most recent publication being in February 1998 Limitations The authors did not always identify which of the 3 professional groups they were referring to in the results section, as they referred to: "health professionals, "respondents" or "sample"

Van Bekkum and Hilton (2013a) United Kingdom	9 PN 9 HV	To explore how primary care nurses' negotiate the challenges of communicating health information and research	Telephone semi-structured interviews	Three themes emerged • Communicating evidence to the critically minded patient • Confidence in communicating evidence • Maintaining the integrity of the patient practitioner relationship	Strengths A new area of research, as no studies to date had investigated how primary care nurses communicate health information and research Quotes attributed to PN are identifiable in the results section Limitations The use of a qualitative method limits the ability to generalise findings The sample size for each professional group was self-selected and therefore, the group of PN could be a highly engaged group of PN within their professional group Although, the year of publication was 2013, the data was collected in 2008/2009 and therefore, does not present a contemporary picture of the media and its influence on PN
Van Bekkum and Hilton (2013b) United Kingdom	9 PN 9 HV	To explore primary care nurses' experiences how mass media influences frontline healthcare	Telephone semi-structured interviews	Three themes emerged • Mass media influence on patients' • Mass media influence on nurses' • Developing media literacy skills	Strengths A new area of research, as no studies to date have investigated the role that the mass media plays in the patient practitioner encounter form the perspective of primary care nurses Quotes attributed to PN are identifiable in the results section. Limitations

					The use of a qualitative method limits the ability to generalise findings. The sample size of primary care nurses was self-selected and therefore, the sample of PN could be a highly engaged group within their professional group

Key: PN – practice nurses; HV – health visitors; GP – general practitioners; MMR – measles, mumps and rubella