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Cost effectiveness of a web-based decision aid for parents deciding about MMR vaccination:

a three-arm cluster randomised controlled trial in primary care

Abstract

Background

Levels of measles in England and Wales are at their highest for 18 years, and strategies targeting the different groups of parents who do not vaccinate their children continue to be needed. Decision aids for decisions regarding childhood immunisation appear to be effective in achieving an increase in vaccine uptake but their cost effectiveness is unknown.

Aim

To assess the cost effectiveness of a web-based decision aid to increase uptake of the MMR vaccine.

Design and setting

Economic evaluation conducted alongside a cluster randomised controlled trial using urban GP practices in the north of England.

Method

Fifty GP practices in the north of England were randomised to one of three trial arms: decision aid, leaflet, usual practice. A total of 220 first-time parents (child aged 3–12 months) were recruited. Parents self-reported their contacts with the NHS and other previous/expected resource utilisation; associated costs were calculated. Vaccine-uptake data were collected from GP practices. A cost-effectiveness analysis was undertaken and provided the incremental cost per first-vaccine uptake. Multiple imputation was used to account for missing data and findings were adjusted for baseline differences in parents' levels of decisional conflict regarding MMR vaccination.

Results

Of the 220 first-time parents recruited to the study, 179 completed the baseline and post-intervention questionnaires. MMR uptake was highest for those receiving the decision aid (42 out of 42, 100%) versus usual practice (61 out of 62, 98%) and leaflet arm (69 out of 75, 92%), and was associated with lower cost (–£9.20 versus usual practice and –£7.17 versus leaflet).

Conclusion

The decision aid has a high chance of being cost effective, regardless of the value placed on obtaining additional vaccinations. It also appears to offer an efficient means of decision support for parents.

Keywords

cost effectiveness; decision aids; immunisation; MMR; vaccination.

INTRODUCTION

In England and Wales, the decline in the uptake of the combined measles, mumps, and rubella (MMR) vaccine following Wakefield *et al*'s now discredited study¹ continues to reverse.² However, at 92% (first dose by 24 months) and 88% (first and second dose by 5 years), it remains below the 95% target required for population immunity.³ Levels of measles are at their highest for 18 years.⁴ Outbreaks in the UK and elsewhere are partially attributable to vaccine refusal and delay by parents;^{5,6} as such, strategies targeting parents who do not vaccinate their children on time continue to be needed.^{6,7}

A critical factor shaping parental attitudes to vaccination is their interactions with primary care health professionals; the goal of the vaccination encounter is to promote a quality (informed) decision and, ultimately, vaccination.⁸ Information provided by health professionals about MMR vaccination (for example, *MMR: The Facts*)⁹ emphasises the risks of not having the vaccine, with the aim of increasing uptake. Decision aids come in a variety of formats such as leaflets, DVDs, or web-based tools. They provide written and graphical information relevant to healthcare decisions. Importantly they provide detailed information on both the probable risks and benefits of having, and not having, the MMR

vaccination. Decision aids also prompt people to actively evaluate this information in accordance with their values in order to make a decision.¹⁰

The concern about using decision aids in the context of vaccination is that encouraging people to deliberate about their MMR beliefs may affect their motivation to vaccinate.^{11–13} However, increasing evidence,^{14,15} including the findings from the recently published Detailed Evaluation of a Childhood Immunisation Decision Aid (DECIDA) study,¹⁶ suggests that decision aids for childhood vaccination decisions may actually achieve both informed decision making and increased vaccine uptake.

If decision aids are to be effective in increasing vaccine uptake or other positive health behaviours, it is important to determine whether they represent an efficient use of resources before committing to their routine use. There is relatively little existing literature on the cost effectiveness of decision aids; in addition, their cost effectiveness in comparison with usual care has not been investigated for childhood immunisation decisions. Most of the studies undertaken have investigated the cost of decision aids in contexts other than vaccination;^{17–25} only one study has considered cost effectiveness²⁶ and that concerned modes of delivery in pregnancy. A systematic review of the impact of decision aids on costs savings²⁷ has

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Submitted: 10 March 2014; **Editor's response:**

23 April 2014; **final acceptance:**

18 May 2014.

©British Journal of General Practice

This is the full-length article (published online 28 Jul 2014) of an abridged version published in print. Cite this article as: **Br J Gen Pract 2014;**

DOI: 10.3399/bjgp14X680977

How this fits in

Measles in children who are unvaccinated against it can cause serious health problems, such as meningitis and brain damage, or even death. Levels of measles in England and Wales have not declined in the past 18 years and strategies targeting parents who don't vaccinate their children are, therefore, required. Decision aids to help with decisions about childhood immunisation have been shown to be effective for vaccine uptake, but it has not yet been determined whether such aids are cost effective. This study revealed that a web-based decision aid appears to be a cost-effective use of NHS resources. The challenge now is to identify ways of implementing this tool into routine practice that are burdensome to neither health professionals nor parents.

recently emphasised insufficient evidence to conclude whether they do, in fact, lead to such savings.

The DECIDA study was the first randomised controlled trial (RCT) to evaluate the effectiveness of a decision aid for a childhood immunisation (MMR) decision. This article presents the economic evaluation for that study. Details of the trial design and the effectiveness findings are reported elsewhere.¹⁶

METHOD

Study design

The DECIDA study randomised GP practices in the north of England in a three-arm cluster RCT design.¹⁶ A total of 220 first-time parents whose first child was offered the first MMR vaccine dose (aged 3–12 months) received either:

- MMR decision aid plus usual practice. Parents were sent a web link (www.leedsmmr.co.uk) for the MMR decision aids and log-in instructions by post; they also received usual practice;
- MMR leaflet plus usual practice. Parents were sent NHS Health Scotland's leaflet, *MMR: Your Questions Answered*²⁸ by post, and also received usual practice; or
- Usual practice only (control). Parents received the usual service provided by their GP practice.

Parents were contacted at recruitment by telephone to collect demographic data, then sent a postal baseline questionnaire. A second (post-intervention) questionnaire

was sent 2 weeks after randomisation/intervention and included questions for the economic analysis that is presented here.

Recruitment and follow-up occurred from May 2009 until the end of September 2010. As the first dose of MMR is due at 12–13 months, it was assumed that all expenditures occurred within 12 months of initial contact, making discounting for future events unnecessary. The timeframe that provides the base year for the analysis is 2008–2009.

Trial outcomes

Decisional conflict. This was the primary outcome and was measured at both time points. It assessed a parent's perception that their decision was:

- informed;
- in accordance with their values; and
- could be acted on.

Scores ranged from 1 to 5; values of <2 were associated with implementing informed decisions, whereas higher scores were interpreted as delaying decisions or feeling unsure about their implementation.²⁹

Data on first-dose MMR uptake. These were collected from GP practices 9 months after recruitment. These data are routinely collected by GP practices and were transferred to the research team using a secure postal delivery service.

Resource utilisation. Data were collected in the post-intervention questionnaire. Parents reported the intended and actual number of contacts that were 'mainly related to MMR' they had had with health professionals since joining the study. They also reported their MMR-related personal expenditures on private health care, any purchases of information about MMR, travel costs, and loss of income due to any time they had taken off work to attend appointments. Resource utilisation for each item was compared across the three arms using analyses of variance. Intended and actual contacts were combined as an indicative total volume of resource use; this is motivated by the short time lapse between randomisation and completion of the questionnaire (2 weeks).

Analysis of cost data

Costs were assessed using both an NHS perspective and a societal perspective (that is, NHS plus parents' costs),

including those related to delivering the two interventions (MMR decision aids and MMR leaflet) as part of routine practice. Interventions were sent to parents with their routine MMR vaccination invitation letter. Details of the unit costs used to value NHS resource utilisation for the MMR leaflet, decision aid, and usual practice,^{30,31} are presented in Table 1.

Parents were also asked how easy it is to travel to their GP (very easy, fairly easy, fairly difficult, very difficult). A mean cost was calculated for each stated level of ease in access and used if parents indicated a level of ease of access but did not indicate a monetary cost for that travel. To account for missing values, multiple imputations by chained equations^{32,33} were used to impute missing baseline demographic data (costs, baseline decision conflict).

Cost-effectiveness analysis

The analysis computes incremental costs and vaccine uptake across the three arms. As there were different numbers of patients with low (<2) and high (≥2) baseline decisional conflict in each arm, patients within each arm were randomly selected to achieve the same mix of parents with 'high decisional conflict' and 'low decisional conflict'. To account for potential sampling bias, this random selection was repeated 10 000 times to build up distributions for mean incremental costs and vaccine uptake. Whether an option is cost effective or not depends on whether it provides the greatest expected net benefit; that is, the balance of vaccine uptake and costs. The more value is placed on increasing uptake,

the more likely it is that the treatments that provide greater uptake will be cost effective. Cost-effectiveness acceptability curves were used to express the likelihood that each of the three arms was the most cost-effective option as the value that might be attached to vaccinating one additional child was varied.

RESULTS

Descriptive statistics

MMR vaccination-uptake data were available from GP practices for 203 children (93%). Of these 203, 48 were in the decision-aid arm, 85 in the leaflet arm, and 70 in the control arm; vaccination uptake was 100%, 91%, and 99% respectively [χ^2 [1, $n = 203$] = 8.69; P [using Fisher's exact test] = 0.017]. Post-hoc tests revealed statistically significant differences in uptake between the leaflet arm and both the control ($P = 0.04$) and decision-aid arms ($P = 0.05$). The sample contained a marginally higher number of parents with high decisional conflict at baseline within the decision-aid arm (85%) than the leaflet (82%) and usual-practice (67%) arms.

Imputation of costs was required for 24 parents (12%) who did not complete the NHS or societal resource-use questions in the post-intervention questionnaire; a further 10 patients (5%) required imputation of a baseline decisional conflict score due to incomplete data.

Resource utilisation

Table 2 presents NHS resource-utilisation data for the 179 parents who provided these. Contacts typically involved meeting with health visitors (at a GP practice or at home)

Table 1. Data sources and unit costs used to cost MMR-related NHS resource use

Contact	Setting	Unit cost (£) ^a	Source
MMR leaflet	n/a	0.20	DECIDA trial
Decision aid	n/a	0.00	
GP	Telephone	20.00	Curtis (2010) ³⁰
	GP practice	32.00	Curtis (2010) ³⁰
	Walk-in centre	32.37	Curtis (2010) ³⁰
Practice nurse	Telephone	3.10	Curtis (2010) ³⁰
	GP practice	10.00	Curtis (2010) ³⁰
Health visitor	Home visit	35.67	Curtis (2010) ³⁰
	GP practice	24.67	Curtis (2010) ³⁰
NHS Direct	Telephone	25.00	House of Common Hansard (2008) ³¹

^a Base year = 2008–2009. DECIDA = Detailed Evaluation of a Childhood Immunisation Decision Aid. MMR = measles, mumps, rubella vaccine.

Table 2. Parent-reported MMR-related actual and intended contacts with the NHS since joining the study, by trial arm ($n = 179$)

Contact	Setting	Mean actual and intended contacts ^a			P-value
		Decision aid, ^b Mean (SD)	Leaflet, ^c Mean (SD)	Usual practice, ^d Mean (SD)	
GP	Telephone	0.05 (0.22)	0.03 (0.16)	0.13 (0.38)	0.08
	GP practice	0.17 (0.44)	0.25 (0.47)	0.39 (0.75)	0.15
	Walk-in centre	0.02 (0.15)	0.00 (0.00)	0.00 (0.00)	0.20
Practice nurse	Telephone	0.05 (0.22)	0.04 (0.26)	0.07 (0.25)	0.84
	GP practice	0.31 (0.52)	0.31 (0.64)	0.31 (0.56)	0.99
Health visitor	Home visit	0.24 (0.96)	0.31 (1.38)	0.15 (0.44)	0.66
	GP practice	0.31 (0.60)	0.41 (1.43)	0.44 (0.64)	0.82
NHS direct	Telephone	0.02 (0.15)	0.01 (0.12)	0.02 (0.13)	0.92

^aActual and intended contacts have been combined. ^b $n = 42$. ^c $n = 75$. ^d $n = 62$. MMR = measles, mumps, rubella vaccine. SD = standard deviation.

or practice nurses (at GP practice). Parents in the usual-practice arm (control) reported four times as many telephone contacts with the GP as the parents in the leaflet arm (0.13 versus 0.03), and more than twice as many as parents in the decision-aid arm (0.13 versus 0.05). The only marginally significant difference in resource utilisation was for

actual/intended contacts with GP over the phone ($P = 0.08$).

Relatively few parents reported any private expenses besides travel costs (Table 3). Parents in the leaflet arm reported spending money on purchasing magazines on MMR vaccination ($n = 3$), spending money on parenting books ($n = 1$), having

Table 3. Parent-reported MMR-related costs to private expenses, by trial arm

Expenses type	Frequency	Average cost of item, £ (SD)	Decision Aid		Leaflet		Usual Practice	
			Frequency	Mean (SD)	Frequency	Mean (SD)	Frequency	Mean (SD)
Travel expenses								
Public transport	13	2.89 (1.44)	3	3.87 (1.90)	7	2.71 (1.47)	3	2.33 (0.58)
Private transport	28	4.34 (9.27)	7	2.71 (2.38)	9	2.91 (1.78)	12	6.35 (14.06)
Other expenses	1	1 (n/a)	–	–	–	–	1	1 (n/a)
Total transport expenses (including ease of appointment)	177	8.21 (8.32)	42	9.36 (12.57)	75	7.10 (3.26)	62	8.52 (8.95)
Purchase of information about MMR vaccination								
<i>Mother & Baby</i> magazine	1	£2.80 (n/a)	–	–	–	–	1	–
<i>Parenting</i> magazine	4	£2.55 (n/a)	–	–	3	2.57 (0.12)	1	2.5 (n/a)
Newspaper	1	£0.20 (n/a)	1	0.2 (n/a)	–	–	–	–
Parenting book	1	£14.99 (n/a)	–	–	1	14.99 (n/a)	–	–
Private clinic appointment	1	£300 (n/a)	–	–	1	300 (n/a)	–	–
Homeopath	1	£40 (n/a)	–	–	1	40 (n/a)	–	–
Productivity costs								
Loss of income	6	35.42 (21.24)	3	39.17 (27.88)	1	15 (n/a)	2	40 (14.14)

MMR = measles, mumps, rubella vaccine. SD = standard deviation.

Table 4. NHS and societal costs for the three trial arms and cost-effectiveness results

	NHS costs			Societal costs		
	Decision aid	Leaflet	Usual practice	Decision aid	Leaflet	Usual practice
Costs (SD)	35.06 (6.40)	42.23 (7.68)	44.26 (5.25)	42.23 (8.07)	50.99 (9.32)	48.85 (6.29)
MMR uptake, proportion (SD)	1.00 (0.00)	0.90 (0.03)	0.98 (0.02)	1.00 (0.00)	0.90 (0.03)	0.98 (0.02)
Incremental costs versus decision aid, £	-	-7.17	-9.20	-	-8.75	-6.62
Incremental uptake, versus decision aid, (proportion)	-	0.10	0.02	-	0.10	0.02

MMR = measles, mumps, rubella vaccine. SD = standard deviation.

an appointment at a private clinic ($n = 1$), and seeing a homeopath ($n = 1$) (Table 3). Six parents across the three trial arms reported a loss of income from taking time off work to visit their GP or nurse, with the average loss of income being £35.42 (Table 3).

Costs, cost effectiveness and uptake

Table 4 provides estimates of NHS and societal costs for the three trial arms, alongside data regarding the vaccination uptake for each group. Decision aids show a higher MMR uptake with a gain of £7.17 for the NHS when compared with the leaflet, and a gain of £9.20 when compared with usual practice (Table 4). Uptake in the leaflet arm is lower than for the usual-practice arm (0.90 versus 0.98, Table 4), and typically incurs higher estimated societal costs.

Figure 1 shows a cost-effectiveness acceptability curve. Where no value is placed on additional vaccinations (that is, choosing only on the basis of costs), the decision aid

has around a 72% chance of being cost effective, based on the NHS perspective. In comparison, the leaflet has only a 22% chance of being cost effective and the usual-practice arm has an 8% chance of being cost effective. If the horizontal axis in Figure 1 is considered and a higher value is placed on vaccination uptake, the chance of the decision aid being cost effective to the NHS rises. This reaches approximately an 88% chance of being cost effective when vaccinating an additional child is valued at £100. As long as the value placed on vaccinating an additional child is not negative, the decision aid appears to be the most cost-effective option.

DISCUSSION

Summary

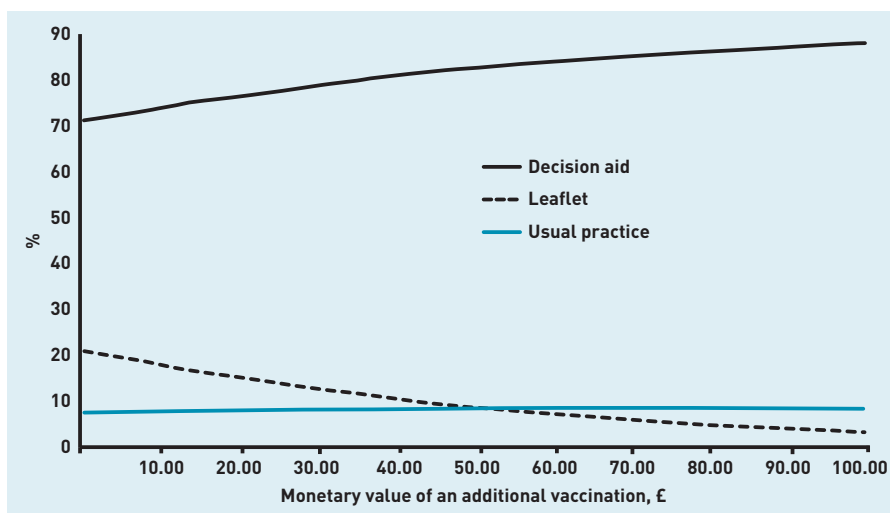
This study is the first to consider the cost effectiveness of decision aids for parents facing questions of whether or not to give their child the MMR vaccine, based on data from the first cluster RCT in this area. The trial¹⁶ concluded that, of the two interventions, only the decision aid achieved both informed decision making and MMR uptake.

The additional analyses presented in this study indicate both that the decision aid appears to cost less than a leaflet similar to those used in the NHS and is highly likely to be cost effective. The findings also appear robust when the costs to parents are also taken into consideration.

In contrast, this study suggests that the MMR leaflet may actually decrease vaccination uptake as uptake in that arm was lower than for the usual-practice arm. In addition, the MMR leaflet typically incurred higher estimated societal costs than the decision aid.

There appears to be a strong case for the decision aid tested in this study.

Figure 1. Cost-effectiveness acceptability curve.



Funding

The study was funded by the Research for Patient Benefit Programme of the National Institute for Health Research (NIHR) (reference number: PB-PG-0107-12048). This article presents independent research commissioned by the NIHR. The views expressed are those of the authors and not necessarily those of the NHS, NIHR, or the Department of Health. The trial was registered as a UK Clinical Research Network portfolio study (reference number: 4811) and International Standard Randomised Controlled Trial Number 72521372.

Ethical approval

The study obtained ethical approval from the York Ethics Committee (reference number: 08/H1311/23).

Provenance

Freely submitted; externally peer reviewed.

Competing interests

The authors have declared no competing interests.

Acknowledgements

We thank Julie Leask and Lyndal Trevena for giving us permission to adapt and evaluate their MMR decision aid, and their support in doing so. We also thank: the GP practices; our parent participants; and Judy Taylor, project secretary, and the Primary Care Research Network for their contributions to this trial. The DECIDA research team comprised Cath Jackson, Swati Shourie, Francine Cheater, Hilary Bekker, Richard Edlin, Sandy Tubeuf, Wendy Harrison, Elaine McAleese, Martin Schweiger, Beryl Bleasby, and Lisa Hammond.

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Strengths and limitations

Limitations of this study include the fact that its findings are based on a relatively small sample size and, in part, on parental expectations of future contacts with the NHS, as opposed to contemporaneous or retrospective recording of these contacts. In addition, the findings have been adjusted for missing data (a common issue in economic evaluation³⁴) but, as a result, bias due to partial data cannot be ruled out entirely. The analysis appears to provide broadly similar findings under alternative assumptions (that is, complete case analysis, analysis without correction for numbers of high and low decisional conflict parents); these additional analyses are available on request from the authors.

All possible sources of uncertainty have not been explored in this analysis and further analysis is possible. In particular, costs have not been apportioned for constructing the decision aid (as opposed to using it) into a scenario analysis. However, the high numbers of parents who could potentially use the decision aid in routine care would render this per-child cost small and unlikely to influence the overall results.

The strength of this study is to be based on data from the first cluster randomised trial evaluating the effectiveness of a decision aid versus a leaflet versus usual practice for a childhood immunisation decision. In addition, it contributes to determine the cost and cost effectiveness of decision aids, which is a research question under-studied in the literature. To the authors' knowledge, this study is the second to undertake a cost-effectiveness analysis of decision aids.

Comparison with existing literature

As outlined in the introduction, the existing literature on the cost effectiveness of decision aids is small, with only one study considering this issue in a different setting.²⁶ The current study adds to the body of evidence in favour of decision aids as a cost-saving option;^{17,19,24,25} it finds that a decision aid appears to minimise costs and is cost effective in the area of vaccination uptake.

Implications for practice

Where any public-health activity provides value to the NHS as a whole per participant

(based on both its costs and benefits), efficiency suggests that the NHS should attach a positive monetary value to increasing vaccination uptake. The cost effectiveness of MMR immunisation is documented and immunisation guidance from the National Institute for Health and Care Excellence³⁵ concluded that efforts to increase MMR vaccination uptake appear cost effective. In the case of immunisation against MMR there is a clear rationale for interventions like decision aids that will help to increase vaccination uptake.

In addition to the protective-health effects of immunisation, it is also an intervention expected to save the NHS money. Carabin *et al*³⁶ estimated that a measles case would cost on average £295 for the society including complicated hospitalised and non-hospitalised cases. (The average treatment cost per case of measles in the UK was the GBP equivalent of US\$307 in 2002 and then inflated to 2011–2012 using the NHS Hospital Community Health services inflator). International studies^{37–39} have also shown that measles cases are problematic as well as expensive for society; there is the potential for serious complications (for example, meningitis and brain damage) and death in children who are unvaccinated. The recent measles outbreaks in England and Wales^{40–42} confirms that the value attached to increasing the uptake of the MMR vaccination appears so high that even small improvements towards achieving herd immunity have the potential for large health gains.

This MMR decision aid is web-based, which allows it to be easily incorporated into different formats such as standard letters, emails, or even text messages. If the NHS moves towards more mobile technologies, such as emails or text messages, instead of standard invitation letters, this web-based MMR decision aid could easily be incorporated into that written communication. It could then be forwarded by parents to other parents or family members. As the decision aid appears to be beneficial with respect to vaccination uptake, further investigation of how it might be incorporated into routine use is recommended.

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