Measuring the effectiveness of catch-up MMR delivered by school nurses compared to signposting to general practice on improving MMR coverage.

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Abstract

Background: This study assesses whether increased coverage of the measles, mumps and rubella (MMR) vaccination differs between areas where school nurses deliver catch-up MMR doses to adolescents in school settings, compared to signposting to general practice.

Methods: A retrospective cohort study was conducted using Child Health Information Services records within the NHS England South (South Central) commissioning boundary. The sample population included children born 1 September 2000–31 August 2001, in school year 9 during the 2014/15 academic year.

Results: The primary outcome findings show an increase in coverage of at least one dose of MMR by 1.6% (n=334) in the cohort receiving catch-up MMR, compared to 0.2% (n=12) in the cohort signposted to general practice. Over time, the difference in increase between the two cohorts was 1.4%, analysed using the chi-squared comparison of proportions test, providing strong evidence ($p<0.0001$) that school nurse delivery of catch-up MMR is effective at increasing coverage. The findings also suggest that school nurse delivery of catch-up MMR may benefit black, Asian and minority ethnic children and those from more deprived backgrounds.

Conclusions: It is recommended that commissioners of school-aged immunisation services incorporate the delivery of catch-up MMR doses in their contracts with school nurses.

Introduction

In 2016 the number of measles cases (531) reported in England had risen more than five times compared to the 92 cases in 2015.[1] Analysis of these cases suggests that the burden of disease has shifted from children to older teenagers and young adults aged 15-35, with the majority unimmunised due to never receiving a dose of MMR vaccine (two doses are required for optimal immunity).[2,3] Measles contracted as a teenager or adult can be serious, requiring hospitalisation in some cases. Improving coverage of the MMR vaccination – the act of administering a MMR vaccine – benefits the population by increasing herd immunity and disrupting the transmission of measles, mumps and rubella.

Evidence shows that coverage of vaccinations for school-aged children is greater if delivered in a school setting compared to primary care.[4,5,6,7] In light of this, some school-aged immunisation services in England have been commissioned to deliver a targeted catch-up dose of MMR to those with an incomplete MMR vaccination record of less than two doses, sometimes in conjunction with the final routine dose of diphtheria, tetanus and polio (Td/IPV), which is given to adolescents aged 13-15 years old in school year 9 or 10 in England.[8]

Despite good evidence for increased coverage in school settings for routine human papillomavirus (HPV) and Td/IPV vaccinations[5,6,7], there is yet no robust evidence for the effectiveness of school nurses routinely delivering targeted catch-up MMR doses to adolescents compared to school nurses signposting to general practice, which is standard practice. A new retrospective cohort study is reported here, which aims to compare vaccination rates in school children over two intervals of time to assess the consequences of school nurses delivering an opportunistic dose of MMR to adolescents without a complete MMR vaccination record.

Outcomes of interest are the extent of differences in coverage of a) at least one dose, and b) two doses of MMR between Cohort 1 (school nurse delivered) and Cohort 2 (signpost to GP) at the end of the 2014/15 academic year on 31/08/2015, compared to baseline on 01/09/2014, and after a further follow-up year to the end of the 2015/16 academic year on 31/08/2016. Analyses of differences in coverage of at least one dose of MMR by ethnicity and deprivation have also been conducted. Those from minority ethnic backgrounds or with lower socioeconomic status are known to have poorer vaccination uptake. [9,10]

Methodology

Sample population

The target population for this study was all children born between 1 September 2000 and 31 August 2001 who were in school year 9 during the 2014/15 academic year in Bath and North East Somerset (B&NES), Berkshire, Buckinghamshire, Gloucestershire, Oxfordshire, Swindon or Wiltshire. In the 2014/15 and 2015/16 academic years (01/09/2014 to 31/08/2016), NHS England South (South Central) were already commissioning the delivery of catch-up MMR doses by school nurses as part of the school-aged immunisation services in Berkshire, Buckinghamshire and Oxfordshire. In Swindon, this service had been commissioned locally by Swindon Borough Council since at least 2012. Individuals from each of these four areas are collectively referred to as Cohort 1.

Contrastingly, in B&NES, Gloucestershire and Wiltshire, school-aged immunisation services during the same period were commissioned to signpost children that had not completed the schedule to general practice for catch-up MMR doses. Individuals from these three areas are collectively referred to as Cohort 2. In April 2017, however, all areas in Cohort 2 were brought in line with Cohort 1, with local school-aged immunisation services contractually required to offer catch-up MMR doses to eligible students receiving their Td/IPV or meningitis ACWY vaccinations.

Ethical approval

Ethical approval was granted by the Health and Applied Sciences Faculty Research Ethics Committee at the University of the West of England. The data request was for fully anonymised individual level records. The data were sent by providers via secure NHS.net email and upon receipt were encrypted through password protection of the data files.

Data collection

Approvals to request access to secondary data held by Child Health Information Services (CHIS) covering the research area were received from the Head of Public Health

Commissioning for NHS England South (South Central), the Screening & Immunisation Lead for B&NES, Gloucestershire, Swindon and Wiltshire, and the Screening & Immunisation Manager for Berkshire, Oxfordshire and Buckinghamshire.

The following information was requested at individual level from the analysts within each of the CHIS teams: gender; ethnicity; town of residence; county/unitary authority (at baseline); free school meal eligibility; postcode of school (at baseline); MMR status (0, 1, 2, >2 or unknown) at baseline and each follow-up; and deprivation score (at baseline), if available. MMR status was requested at three time points: 01/09/2014 (baseline); 31/08/2015 (first follow-up), and 31/08/2016 (second follow-up). The inclusion of a second follow-up allowed the longer-term benefits of signposting to general practice to manifest. Residential deprivation scores were not available; instead deprivation scores were based on school level postcode as a proxy, where available.

Analytical methods

Descriptive data for the different variables are presented by cohort in Table I. Comparison of the difference in increase in coverage of at least one dose of MMR and two doses of MMR between the two independent cohorts over time was conducted using the chi-squared comparison of proportions test.[11,12] The analyses were completed using Microsoft Excel 2013 and the MedCalc[13] comparison of proportions calculator. All numerators, denominators, proportions, confidence intervals, test statistics and *p*-values are reported. Proportions are reported to one decimal place.

Results

A total of 27,675 anonymised individual MMR records were received. Following data cleansing, 27,527 records were included in the study. Data from Berkshire were included as an exception as catch-up MMR was delivered to students in school year 8 upwards with incomplete/no history of MMR and not limited just to school year 9.[14] No data were received from Wiltshire.

The demographic data in Table I show that the number of male and female subjects is similar across each cohort. The ethnic mix is heavily weighted towards the White British and White – other categories, with a substantial number of unknown ethnicities (9,415/27,527; 34.2%).

The school level Indices of Multiple Deprivation (IMD) data are only available for B&NES, Buckinghamshire, Gloucestershire and Swindon as school name and/or postcode was provided (13,060/27,527; 47.4%). The median IMD score for these four areas is 8.7, falling just within the second national IMD quintile. There is a small majority in the number of IMD scores that are greater than or include 8.7 ($<8.7 = 6{,}488$; $\geq 8.7 = 6{,}572$), which suggests that almost half of the sub-sample attend schools in least deprived areas. The median IMD scores for each cohort are very similar (Cohort 1: 8.9; Cohort 2: 8.6), however Cohort 1 has 68.7% unknown deprivation compared to 1.3% in Cohort 2. This was particularly high because one of the providers covering two large regions in Cohort 1 (Berkshire and Oxfordshire) did not provide school affiliations with which to determine the deprivation score; records for which accounted for 42.5% of the total dataset.

Of the total number of students not vaccinated with at least one dose of MMR (N=3,038) at baseline (01/09/2014), the majority (n=2,359; 77.6%) do not have a school listed. Of the 152 school names provided, unvaccinated students were affiliated with 98 of these schools: 55 schools had ≤5 unvaccinated students; 15 schools had 6-10 students; 25 schools had 11-20 students; and 3 schools had 21 to 35 students. The lack of school affiliations meant it was not possible to explore potential reasons for any schools or clusters that have a noticeably different coverage of MMR.

Coverage of one dose and two doses of MMR

Coverage of at least one dose of MMR is higher in Cohort 2 at all three time points of interest. However, the absolute number of increased vaccinations and the comparative difference in increase across the three time points are both greater in Cohort 1. Table II shows that the increase in coverage of at least one dose of MMR is 1.6% (n=334) in Cohort 1 and 0.2% (n=12) in Cohort 2 from the start of the 2014/15 to the end of the 2015/16 academic years. The difference in the increase of coverage between the cohorts over this time is 1.4% ($p<0.0001$), providing strong evidence for the effectiveness of school nurse delivery on increasing coverage.

Coverage of two doses of MMR is noticeably lower in both cohorts compared to coverage of at least one dose; although it is still greater in Cohort 2 than Cohort 1. The findings for the secondary outcome closely mirror the primary. Across the two years of study, the increase in coverage of both doses is 1.5% (n=303) for Cohort 1 and 0.2% (n=11) for Cohort 2, resulting in a difference in increase in coverage between the two cohorts of 1.3%. This also provides strong evidence (*p*<0.0001) to suggest that exposure to catch-up MMR delivered by school nurses may have been more effective than signposting to the GP in children who were in school year 9 in the 2014/15 academic year.

Coverage by ethnicity

The results of the black, Asian and minority ethnic (BAME) analysis in Table III show that there is no evidence of a difference in increase in coverage of at least one dose by the end of the 2014/15 academic year (*p*=0.28). Coverage increases by 0.6% (n=13) in Cohort 1 and by 0.2% (n=1) in Cohort 2, resulting in a difference in increase in coverage between cohorts of 0.4%. However, by the end of the 2015/16 academic year there is good evidence of a difference (*p*=0.01), with coverage increasing in Cohort 1 by 1.8% (n=37) from baseline and staying the same for Cohort 2. This results in a difference in increase in coverage of 1.6%. These results could be partly explained by the different practice in delivery of catch-up MMR doses within Berkshire schools.[14] Further investigation would be required to confirm whether BAME ethnicity is a confounder of the primary outcome. For now, the current data suggest that catch-up MMR delivered by school nurses may have been slightly more effective than signposting to the GP in BAME children who were in school year 9 in the 2014/15 academic year.

In contrast, for the White ethnic subset from the start of the 2014/15 academic year to the end of the 2015/16 academic year, Table III shows that the increase in coverage of at least one dose is 1.2% (n=112) in Cohort 1 and 0.2% (n=10) in Cohort 2, with a difference in the increase in coverage between the cohorts over time of 1.0%. This shows strong evidence (*p*<0.0001) for the effectiveness of school nurse delivery of catch-up MMR doses. Despite this, the summary findings suggest that White ethnicity could also be a confounder, with a subtler influence on the primary outcome.

Coverage by deprivation

Each of the findings from baseline to the end of the 2014/15 and 2015/16 academic years show strong evidence of a difference ($p<0.0001$) for both high (IMD≥8.7) and low (IMD<8.7) deprivation groups (Table III). In the low deprivation group, the increase in coverage of at least one dose is 2.0% (n=65) in Cohort 1 compared to 0.2% (n=5) in Cohort 2, with a difference in coverage between the two cohorts of 1.8% over time. This is in comparison to the high deprivation group, with coverage of at least one dose increasing to 3.0% (n=96) in Cohort 1 and 0.2% (n=6) in Cohort 2, with a difference in coverage between the two cohorts of 2.8% over time. The findings further support that the delivery of catch-up MMR by school nurses may have resulted in a significant increase in coverage of at least one dose of MMR in the most and least deprived populations that were in year 9 during the 2014/15 academic year.

Discussion

Main finding of this study

The main findings show an increase in coverage in Cohort 1 of 1.6% of at least one dose, and 1.5% of two doses between the start of the 2014/15 academic year and the end of the 2015/16 academic year. When compared to the increase in coverage of Cohort 2 over time, strong evidence emerges for the effectiveness of school nurse delivery of catch-up MMR compared to sign-posting to the GP. Furthermore, the ethnicity and deprivation analyses provide encouraging findings that suggest the health inequalities experienced by BAME and more deprived groups in relation to MMR uptake could potentially be addressed by offering a targeted catch-up MMR programme delivered by school nurses. Coverage for individuals of BAME ethnicity or attending school in a more deprived area increased by 1.8% and 3.0%, respectively, in Cohort 1 over time. However, high rates of unknown deprivation and ethnicity in Cohort 1 may affect the robustness of this finding. Further research is needed to substantiate these findings.

What is already known on this topic

These findings are consistent with those of Lashkari & El Bashir[15] and Paranthaman & Bunce[16], with the percentage increase in the number of children vaccinated with two doses rising significantly when school nurses delivered catch-up MMR. This could be due to greater acceptability for the second dose on the part of parents who have already agreed for their child to have the first dose. Brown *et al.*[17] found that the primary predictor of first dose uptake during a 2008-9 catch-up campaign was receipt of an invitation. In contrast, the primary predictor for uptake of the second dose was the perceived social consequences and desirability of MMR vaccination. Parents of those children that have not previously been vaccinated may have concerns over the MMR safety controversy, or a lack of information provided by health professionals, which have been found to be common themes to negatively influence MMR decision making.[18,19]

Delivering vaccinations to adolescents in schools can offer a range of benefits. For example, the opportunity to work collaboratively with Child Health to identify children with incomplete vaccination records and offer them outstanding vaccines.[7] School-based delivery also provides an excellent health promotion opportunity to raise awareness of vaccines and vaccine-preventable diseases with adolescents.[20] Qualitative studies have found that adolescents and young people have a poor understanding of the severity of diseases such as measles, mumps and rubella, with some believing that these are diseases of the past or only the concern of developing countries.[20,21,22]

As a further benefit, Kale & Snape[6] refer to the cost-effectiveness of delivering routine universal vaccinations in schools to large numbers of adolescents who are all in one setting. In relation to a targeted catch-up MMR programme, Paranthaman & Bunce[16] estimate that the cost was £9.50 per dose delivered in 2011, which covered Child Health administrative costs for data extraction and uploads, the provider's running costs, MMR vaccine administration and storage. The tariff used in 2017/18 by NHS England South (South Central) of £14.50 per dose delivered[23] represents an additional cost to NHS commissioners of offering catch-up MMR doses missed in childhood; however, it can result in increased individual immunity and boost herd immunity.

What this study adds

This is the first study to compare the effectiveness of school nurses delivering catch-up MMR doses to a comparison group of eligible children signposted to the GP. The findings suggest that school nurse delivery of catch-up MMR doses to adolescents may be a more effective intervention to increase population coverage than signposting to the GP. The study also suggests that this approach could have a positive effect on closing the health inequalities gap in MMR vaccination of children from BAME and/or deprived backgrounds.[9,10]

A further strength lies in the study's commissioning perspective, with recommendations that can achieve a real population impact at relatively low cost. Notably, since April 2017, NHS England South (South Central) has commissioned catch-up MMR doses to be delivered by school nurses as part of school-aged immunisation services in all the areas covered by this study.

Limitations of this study

The completeness of the CHIS data, upon which this study is based, is unclear. It has not been possible to validate the dataset, or even a sample of it, as the data were provided in an anonymous format. Data cleansing found that some children were still recorded as attending a primary school. Other individuals had an unknown MMR status recorded at some or all of the time periods of the study that resulted, where necessary, in all three time points being categorised as unknown according to the national procedure outlined in PHE's '*Vaccination of individuals with uncertain or incomplete immunisation status*' pathway.[24] As the dataset was anonymised it was not possible to explore residential deprivation. Instead, deprivation at school level, where the name of the secondary school or its postcode had been provided, was determined but should be considered a proxy. Despite this, due to missing data it was not possible to determine the deprivation score for 68.7% of Cohort 1, with 43.5% unknown ethnicity as well. Finally, the demographic data fields available from CHIS were limited and did not allow for a wider assessment of potential confounders, such as school funding.

Conclusions

By comparing the increases in coverage between the cohorts receiving school nurse delivery of catch-up MMR and signposting to the GP from the start of the 2014/15 academic year to the end of the 2015/16 academic year, this study has shown strong evidence that school nurse delivery results in a greater increase in coverage: 1.6% (n=334) for at least one dose of MMR compared to 0.2% (n=12), and 1.5% (n=303) for both doses of MMR compared to 0.2% (n=11).

Furthermore, delivery of catch-up MMR doses by school nurses could play an important role in addressing health inequalities for individuals of BAME ethnicity or attending school in a more deprived area, with the results over the same time period showing a possible increase in coverage of at least one dose of MMR of 1.8% (n=37) compared to 0.2% (n=1), and 3.0% (n=96) compared to 0.2% (n=6), respectively.

Based on the encouraging evidence presented, it is recommended that NHS England Public Health Commissioning Teams consider commissioning school-aged immunisation services that incorporate the delivery of catch-up MMR doses by school nurses within their contracts.

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Authors contributions

FA, SG and IB contributed to the design of the programme of research. FA contributed to the ongoing data collection analysis and FA, SG and IB contributed to the interpretation of the research. FA conducted the analysis reported in the article and wrote the manuscript. All authors have read and commented on subsequent drafts of the article.

Conflict of interest

The authors have no conflict of interest to declare.

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Table I: Descriptive demographic data for the sample population included in the study, N=27,527

	Cohort 1	Cohort 2
Total records, n (%)	20,936 (76.1)	6,591 (23.9)
Gender		
Male, n (%)	10,415 (49.7)	3,331 (50.5)
Female, n (%)	10,521 (50.3)	3,260 (49.5)
Ethnicity		
Asian or Asian British, n (%)	1,375 (6.6)	120 (1.8)
Black or Black British, n (%)	179 (0.9)	48 (0.7)
Mixed back-ground, n (%)	431 (2.1)	190 (2.9)
Other ethnic group, n (%)	160 (0.8)	117 (1.8)
White British, n (%)	5,915 (28.3)	5,614 (85.2)
White - other, n (%)	3,772 (18.0)	191 (2.9)
Unknown, n (%)	9,104 (43.5)	311 (4.7)
IMD 2010 score		
Median score (range)	8.9 (1.9-40.4)	8.6 (3.0-47.7)
Unknown, n (%)	14,380 (68.7)	87 (1.3)
< Median score of total sample (8.7), n (%)	3,303 (15.8)	3,185 (48.3)
≥ Median score of total sample (8.7), n (%)	3,253 (15.5)	3,319 (50.4)
IMD 2010 quintiles		
1 (≤ 8.49; least deprived), n (%)	3,303 (15.8)	3,111 (47.2)
2 (8.5 - 13.79), n (%)	2,097 (10.0)	1,439 (21.8)
3 (13.8 - 21.35), n (%)	528 (2.5)	838 (12.7)
4 (21.36 - 34.17), n (%)	605 (2.9)	879 (13.3)
5 (≥ 34.18; most deprived), n (%)	23 (0.1)	237 (3.6)
MMR status at 01/09/2014, n (%)		
Unknown	5 (0.0)	228 (3.5)
0	2,425 (11.6)	380 (5.8)
1	1,867 (8.9)	427 (6.5)
2	16,490 (78.8)	5,526 (83.8)
>2	149 (0.7)	30 (0.5)
MMR status at 31/08/2015, n (%)		
Unknown	5 (0.0)	228 (3.5)
0	2,218 (10.6)	372 (5.6)
1	1,859 (8.9)	428 (6.5)
2	16,692 (79.7)	5,533 (83.9)
>2	162 (0.8)	30 (0.5)
MMR status at 31/08/2016, n (%)		
Unknown	5 (0.0)	228 (3.5)
0	2,091 (10.0)	369 (5.6)
1	1,898 (9.1)	427 (6.5)
2	16,775 (80.1)	5,537 (84.0)
>2	167 (0.8)	30 (0.5)

Table II: Results of the comparison of proportions analysis

Time	Increase in number vaccinated, n/N (%), by cohort	% difference between cohorts (CI)	*p*-value
Primary outcome *(vaccinated with at least one dose of MMR / not vaccinated)*			
$T_1 - T_2$	*Cohort 1* = 207/20,729 (1.0) *Cohort 2* = 9/6,582 (0.1)	0.9 (0.7 to 1.1)	<0.0001
$T_1 - T_3$	*Cohort 1* = 334/20,602 (1.6) *Cohort 2* = 12/6,579 (0.2)	1.4 (1.2 to 1.6)	<0.0001
Secondary outcome *(vaccinated with two doses of MMR / not vaccinated)*			
$T_1 - T_2$	*Cohort 1* = 215/20,721 (1.0) *Cohort 2* = 7/6,584 (0.1)	0.9 (0.7 to 1.1)	<0.0001
$T_1 - T_3$	*Cohort 1* = 303/20,633 (1.5) *Cohort 2* = 11/6,580 (0.2)	1.3 (1.1 to 1.5)	<0.0001

Table III: Results of the comparison of proportions test for the BAME and White ethnicity analysis

Time	Increase in number vaccinated, n/N (%), by cohort	% difference between cohorts (CI)	*p*-value
Ethnicity: BAME *(vaccinated with at least one dose of MMR / not vaccinated)*			
$T_1 – T_2$	*Cohort 1* = 13/2,132 (0.6) *Cohort 2* = 1/474 (0.2)	0.4 (-0.6 to 0.9)	0.28
$T_1 – T_3$	*Cohort 1* = 37/2,108 (1.8) *Cohort 2* = 1/474 (0.2)	1.6 (0.5 to 2.3)	0.01
Ethnicity: White *(vaccinated with at least one dose of MMR / not vaccinated)*			
$T_1 – T_2$	*Cohort 1* = 70/9,617 (0.7) *Cohort 2* = 7/5,798 (0.1)	0.6 (0.4 to 0.8)	<0.0001
$T_1 – T_3$	*Cohort 1* = 112/9,575 (1.2) *Cohort 2* = 10/5,795 (0.2)	1.0 (0.8 to 1.3)	<0.0001
Deprivation: IMD score <8.7 *(vaccinated with at least one dose of MMR / not vaccinated)*			
$T_1 – T_2$	*Cohort 1* = 46/3,257 (1.4) *Cohort 2* = 3/3,182 (0.1)	1.3 (0.9 to 1.8)	<0.0001
$T_1 – T_3$	*Cohort 1* = 65/3,238 (2.0) *Cohort 2* = 5/3,180 (0.2)	1.8 (1.3 to 2.4)	<0.0001
Deprivation: IMD score ≥8.7 *(vaccinated with at least one dose of MMR / not vaccinated)*			
$T_1 – T_2$	*Cohort 1* = 62/3,191 (1.9) *Cohort 2* = 5/3,314 (0.2)	1.7 (1.2 to 2.3)	<0.0001
$T_1 – T_3$	*Cohort 1* = 96/3,157 (3.0) *Cohort 2* = 6/3,313 (0.2)	2.8 (2.2 to 3.5)	<0.0001