This suggests that the public may be prepared to choose to have less spent on one service to have the benefits of another.

Out results have given a general impression of the public's views. The survey raised awareness in the health authority of the need to open a dialogue with residents. Purchasers will wish to find ways in which they can identify and react to public opinions. As well as providing a means of doing this, surveys can contribute to public awareness and knowledge.

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Vaccine coverage: recent trends and future prospects

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Abstract

Objective—To assess the feasibility of achieving the target of 95% coverage for the childhood immunisation schedule by 1995 and to determine the influence of sociodemographic factors and information systems on recent trends.

Design—Analyses of trends in quarterly vaccination data for diphtheria, pertussis, and measles in health districts between February 1988 and February 1991.

Setting—District health authorities in England and Wales, and health and social services boards in Northern Ireland.

Subjects—Cohorts of children whose youngest member had reached the target age of 18 months for receiving the third doses of diphtheria and pertussis vaccines and 2 years for receiving measles vaccine.

Results—Predicted coverage levels for mid-1995 were in excess of 95% for diphtheria, pertussis, and measles vaccines. In the 118 districts that continuously reported between February 1988 and February 1991 the increase in coverage was 6% for diphtheria and 13% for pertussis and measles vaccines. 1991 coverage depended primarily on 1988 coverage. The additional effects of deprivation, change in computer system, and child population size achieved at most only marginal statistical significance.

Conclusions—The government's target of 95% coverage by 1995 is realistic, although projections should be viewed with caution. Several national vaccination initiatives are likely to have contributed to the recent steady increase in coverage. Updating and validation exercises are likely to improve recorded coverage.

Introduction

Substantial improvements in coverage of childhood vaccinations have been reported over the past 10 years. Statistics from the Department of Health (unpublished) show that between 1979 and 1989-90 coverage in England rose from 80% to 89% for diphtheria, tetanus, and polio; from 51% to 84% for measles; and from 35% to 78% for pertussis. This achievement has been brought about by a combination of organisational change, health education, and professional commitment to the programme.¹ What further improvements in vaccine coverage might we expect? The government's

recent proposals for a national health strategy include a target of 95% coverage for the childhood immunisation schedule by 1995.² This will be achieved only if continuing improvements can be shown in all districts, including those with characteristics beyond the control of the health service such as high population mobility and unemployment.³ None of this will be possible without accurate, timely information. The efficiency of child health computer systems is therefore of paramount importance.

The most recent Department of Health statistics relate to children who reached their second birthday between April 1989 and March 1990. However, more up to date information on vaccine coverage is available from the COVER (cover of vaccination evaluated rapidly) scheme,⁴ which was established by the Public

FIG 1—Vaccine coverage, February 1988 to February 1991. Percentage coverage of third dose diphtheria and pertussis, single antigen measles, and measles, mumps, and rubella (MMR) vaccines (all reporting districts). (Source: COVER (cover of vaccination evaluated rapidly) scheme)

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FIG 2—Districts achieving 90% coverage for third dose diphtheria, England, Wales, and Northern Ireland

Health Laboratory Service Communicable Disease Surveillance Centre in 1987. Over 95% of districts in England, Wales, and Northern Ireland currently contribute to the COVER scheme, and the data are now routinely used by the department in assessing national performance. The aim of this study was to assess the feasibility of achieving the 95% target by analysing recent trends in COVER data and the influence of sociodemographic factors and information systems on these trends.

Subjects and methods

Quarterly vaccination data for diphtheria, pertussis, and measles were requested from health districts in England and Wales (from February 1987) and Northern Ireland (from August 1989). Cohorts of children studied were those whose youngest member had reached the target age for receiving the three sentinel vaccines: 18 months for diphtheria (third dose) and pertussis (third dose) and 2 years for measles. For districts using the NHS child health system, data were available as routine output from the computer.⁵ In the other districts ad hoc programmes were written to provide the data.

Analyses of trends were carried out for the period February 1988 to February 1991. During this time the number of districts providing data increased from 122 to 193, of which 118 reported every quarter. Two types of analyses were performed by using different data sets: (1) projections of vaccine coverage to 1995 were derived from analyses of trends in all reporting districts; (2) associations between sociodemographic variables, information systems, and 1991 vaccine coverage were sought by using the subset of 118 districts that reported to every quarterly evaluation between 1988 and 1991.

PROJECTIONS OF VACCINE COVERAGE

For some districts it was not possible to obtain accurate figures for total measles coverage for evaluation immediately after the introduction of measles, mumps, and rubella vaccine. These records were therefore excluded. The total number of quarterly district evaluations analysed was 2096 for diphtheria and pertussis and 1601 for measles. Trends were modelled by logistic quadratic regression⁶ of the number of children vaccinated in each reporting district against time. By using these regression equations projections were obtained for mid-1995 along with 95% prediction limits.

TABLE I—Vaccine coverage in 118 districts: February 1988 and February 1991. Figures are percentages

	Coverage		
	1988	1991	Increase
Diphtheria	84.4	90.8	6.4
Pertussis	71.6	84.7	13.1
Measles	76.0	88.8	12.8

VARIABLES ASSOCIATED WITH 1991 COVERAGE

Districts were classified according to social deprivation, size of the 1991 child population, and whether or not they had changed their computer system since February 1988. Social deprivation was measured by the underprivileged area score,⁷ which for the 118 districts considered ranged from -26.64 (least deprived) to 54.66 (most deprived). For descriptive purposes districts with a score below 0 were classified as low deprivation and those with a score of 0 or greater as high deprivation. Districts were also classified as small or large according to whether the number of children in the cohort evaluated in February 1991 fell below or above the mean for all participating districts.

The relations between these variables and the 1991 coverage after allowing for different 1988 baselines were investigated by logistic regression⁶ of the numbers of children vaccinated in each of the 118 districts in February 1991. The following covariates were used: logit of percentage coverage in February 1988, underprivileged area score, change in computer system, and size of childhood population in February 1991. The analysis used the logits of coverage proportions rather than the proportions themselves. Consequently results are reported in terms of coverage odds (proportion vaccinated/proportion unvaccinated), and parameter estimates are expressed as odds ratios.

In both regression analyses the considerable extra-binomial variability attributable to variations between districts and birth cohorts was modelled by using the quasiliikelihood method of Williams.⁸

Results

There was a steady increase in coverage for all three sentinel antigens between February 1988 and February 1991 (fig 1). During this period the percentage of reporting districts that achieved 90% coverage rose from 29% (35/122) to 70% (135/193) for diphtheria (fig 2), from 0% (0/122) to 19% (36/193) for pertussis, and from 2% (3/122) to 63% (121/193) for measles.

In the 118 districts that reported in every quarter between February 1988 and February 1991 the increase in coverage was 6% for diphtheria and 13% for pertussis and measles (table I). The predicted levels of coverage in mid-1995, obtained by extrapolating the 1988-91 trends, were 99% for diphtheria and pertussis and 97% for measles. The lower limits of the 95% prediction intervals were 97% (diphtheria), 98% (pertussis), and 91% (measles).

VARIABLES ASSOCIATED WITH 1991 COVERAGE

Table II shows the coverage figures for 1988 and 1991 by dichotomised deprivation score, childhood population, and change in computer system. Coverage increased between the two evaluations for each antigen in all strata. The more deprived districts achieved lower coverage than the less deprived ones for both time periods, although the difference in percentage coverage was less in 1991 than 1988. Districts with small and large child populations performed similarly. Districts which changed their computer system between 1988 and 1991, though starting from lower

TABLE II—Vaccine coverage in 118 districts: February 1988 and February 1991. Figures are percentages

District characteristics		Diphtheria		Pertussis		Measles	
		1988	1991	1988	1991	1988	1991
Deprivation	High	78.4	88.4	66.9	82.4	71.3	86.3
	Low	87.2	92.1	74.1	86.0	78.7	90.3
Childhood population	Small	84.9	91.1	72.4	85.1	76.9	89.7
	Large	84.1	90.7	71.0	84.4	75.5	88.3
Change in computer system	Yes	81.4	90.7	70.0	84.9	73.3	88.8
	No	85.4	90.9	72.1	84.7	76.9	88.9

TABLE III—Regression analysis of 1991 vaccine coverage in 118 districts

Variable	Unit of measurement	1991 Coverage odds ratio (95% confidence interval)		
		Diphtheria	Pertussis	Measles
1988 Coverage	Twofold difference in odds	1.62 (1.43 to 1.84)	1.66 (1.48 to 1.85)	1.61 (1.38 to 1.87)
Deprivation score	10 Points on underprivileged area scale	0.97 (0.92 to 1.03)	0.98 (0.95 to 1.01)	0.94 (0.89 to 1.00)
Childhood population	100 Children	1.00 (0.98 to 1.02)	0.99 (0.98 to 1.01)	0.99 (0.97 to 1.01)
Change in computer system	Not applicable	1.14 (0.95 to 1.37)	1.07 (0.96 to 1.20)	1.10 (0.91 to 1.32)

coverage in 1988 than those which did not, achieved similar coverage in 1991.

As expected, 1991 coverage was strongly correlated with 1988 coverage, a twofold difference in coverage odds in 1988 corresponding to a 1.6-fold difference in 1991 (table III). Greater deprivation was found to correspond with lower coverage odds in 1991 (an increase of 10 points in the underprivileged area score corresponding to odds ratios 0.94 to 0.98), though this was significant at the 5% level only for measles. Changing the computer system corresponded to an appreciably, though not statistically significantly, higher coverage odds (odd ratios 1.07 to 1.14). Child population size had no effect.

Discussion

PROJECTIONS OF VACCINE COVERAGE

A number of national vaccination initiatives were launched during the study period, including the introduction of measles, mumps, and rubella vaccine; an accelerated immunisation schedule; publication of revised guidelines^{9 10}; and incentives under the new general practitioner contract. All of these are likely to have contributed to the observed improvements in coverage. The steady rate of increase shown in figure 1 suggests that it is not possible from this study to single out any one initiative that exerted a greater effect than others. It has been suggested that the contractual incentives may exert a perverse influence in areas where general practitioners perceive the likelihood of achieving targets to be slight.¹¹

Based on trends observed in this study, the predicted coverage levels for 1995 are in excess of 95%. This suggests that the government's 95% target is realistic, although projections of this nature should be viewed with extreme caution. In particular, the calculations make the improbable assumption that the particular functional form chosen to describe recent changes in coverage will also apply in future. It is also assumed that, in principle, every child may receive vaccine. In reality contraindications will apply to a few. Finally, it is assumed that no events such as adverse publicity will affect the vaccination programme.

VARIABLES ASSOCIATED WITH 1991 COVERAGE

The 118 districts selected for this analysis represented over half of all districts in the United Kingdom. The coverage rates for these 118 districts were within 2% of the national average, and every region in England and Wales was represented. The average deprivation score was -0.15, close to the national

average of zero. Thus the conclusions drawn from this sample are not likely to be subject to substantial bias.

Low vaccination coverage has been associated with adverse socioeconomic conditions.^{3 12} Nevertheless, good coverage can be achieved among disadvantaged populations.^{13 14} In this study, though deprived districts had lower overall cover, the biggest improvements occurred in some of the most deprived districts. Professional disorganisation and lack of commitment may be more important determinants than staffing levels and social factors.¹⁵

Vaccination records in low coverage districts are widely perceived as inaccurate.¹⁵ Districts in this study that had changed their computer system showed the greatest increases in coverage. It is likely that such a change within a district will focus attention on the quality of data being collected and entered. Updating and validation exercises are likely to improve recorded coverage.

Coverage levels achieved in 1991 depended primarily on 1988 levels. The additional effects of district deprivation, child population size, and change in computer system were found to operate in the directions expected: greater social deprivation as a hindrance; improved computer system as a help; size of child population without effect. However, none of these effects were statistically significant, with the sole exception of district deprivation on measles coverage. This exception may be attributable to measles vaccine being given later; measles, mumps, and rubella vaccine is given at 12-15 months compared with 8-10 months for completion of the diphtheria and pertussis courses.

The results of this study suggest that high levels of vaccine coverage are achievable in all districts. Provided the current impetus can be maintained, elimination of vaccine preventable infections in the United Kingdom now seems possible.

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