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NHS Scotland MRSA Screening Pathfinder Programme

Economic Analyses

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1 Executive Summary

In order to identify the most clinically effective and cost effective strategy for a national MRSA screening policy, an economic analysis comparing the three options for MRSA screening, as identified by the NHSScotland MRSA screening pathfinder programme, was undertaken. The options were: universal laboratory screening, universal clinical risk assessment and targeted laboratory testing of those identified at risk, and universal clinical risk assessment with targeted laboratory testing of this identified at risk as well as universal laboratory testing of selected specialities.

A ten-point framework for assessing an economic evaluation was adopted, and the reworked HTA economic model developed within the MRSA screening pathfinder programme used. The aim of economic model was to enable a like-with-like comparison of the alternative strategies within a defined set of parameters. The approach adopted examined both cost and consequence, in terms of infection reduction outcome of the intervention compared to existing current screening policy practice, with a view to producing a ranked list which could then be judged against the six dimensions of healthcare quality. This report represents the findings of those analyses, addresses limitations and includes the recommendation from the NHSScotland MRSA Screening Programme Board.

In terms of costing for both tertiary referral hospitals and large general hospitals, implementing universal laboratory based screening was estimated at twice the cost of universal clinical risk assessment with targeted laboratory testing of those identified at risk as well as universal laboratory testing of selected specialities, and four times the cost of universal clinical risk assessment alone. The results also indicated that all of the strategies were more clinically effective and more costly than the baseline (isolate and treat patients with infection only).

The clinical effectiveness of the three more effective strategies were similar. Universal screening indicated attaining the lowest number of infections each year in district general hospitals and tertiary hospitals; however, the difference between this and the other strategies using clinical risk assessment was not statistically significant

When the additional spend to achieve the limited increase in QALYs gained was calculated, the difference between the strategies became more apparent. The most desirable area for any programme of healthcare would be high incremental clinical effect on QALYs and a reduction in cost. The economic analysis indicated that for the universal laboratory screening, there would be an average cost effectiveness ratio of around £4,865 per QALY (£1,085,768/223.2) in a tertiary referral hospital and £7,730 (£330,084/42.7) in a large general hospital. The greatest clinical impact with lowest cost was clinical risk assessment.

In purely economic terms the strategies, in order of incremental cost per QALY, presented as follows (lowest first): clinical risk assessment of all admissions, clinical risk assessment plus two swab screening of high impact specialties, universal nasal swab screening. However, these strategies must be considered in terms of public and staff acceptability and the current economic climate. Within the context of current spend on partial rollout of universal nasal swab screening, the option which appears to offer the best clinical return for a similar level of financial investment is universal clinical risk assessment plus two swab screening of high impact specialties.

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5 Background

This report is part of the NHSScotland MRSA screening pathfinder project [1-5]. The Health Technology Assessment (HTA) report 'The clinical and cost effectiveness of screening for meticillin-resistant *Staphylococcus aureus* (MRSA)' was published in October 2007 [6]. This assessment examined alternative approaches to screening patients for MRSA on admission to acute hospitals. The results of the economic model indicated that:

- Screening for MRSA colonisation in all patients admitted using a laboratory test is the most effective strategy in reducing prevalence and preventing infection
- Using chromogenic agar for culture of MRSA from clinical swabs is the most cost effective method of laboratory testing

The report therefore recommended that a primary study to be set up in acute inpatient care to assess outcome, i.e. whether screening all patients for MRSA was effective in preventing MRSA infection, as predicted by the economic model. This would involve an outcome evaluation study and in order to be robust will require at least one year of data collection.

A Pathfinder Project was established in NHSScotland to test the proposed model, test the assumptions and predictions of the NHS QIS HTA model and to examine the feasibility and implications for health boards of the proposals. A report on the findings of the Pathfinder study was delivered to the Scottish Government Health Directorate on the 31st December 2009. There were a number of questions which were not addressed as part of the Pathfinder Project and identified as important in the context of decision making with respect to a national screening programme for MRSA. One of these questions was "what is the feasibility of using clinical risk assessment as a tool to identify patients who may be at risk of MRSA colonisation?"

The MRSA screening programme recently delivered the findings of a research study which aimed to evaluate the potential for use of Clinical Risk Assessment (CRA) for overnight admissions to Scottish Acute Hospitals. The findings indicated that whilst the CRA could successfully identify 80.7% of colonised patients, the total number of admissions identified as eligible for laboratory follow up screening using the CRA tool was 57% of total admissions. However it was noted that an initial risk assessment using three questions, and follow up laboratory testing of those who responded yes to any one of the three questions could identify 66% of all positive patients on admission but only required 9.7% of total admissions to undertake a laboratory test.

6 Introduction

The SGHD asked the MRSA screening programme board to provide them with a recommendation for policy direction regarding MRSA Screening based on; the evidence that has been gathered as part of the screening programme and new literature which has been published since the initiation of the screening programme [1]. The programme board considered that there were three options which remained feasible options for NHSScotland:

1. Universal screening using nasal swabs
2. Clinical risk assessment of all admissions (using three questions and direct chromogenic agar screening all patients who answer yes to at least one question; using nasal and perineal swabs)
3. Clinical risk assessment (using three questions and direct chromogenic agar screening for all patients who answer yes to at least one question) and all those treated in specialties undertaking procedures which would have a high impact in quality of life and expected outcome (using nasal and perineal swabs).

Before making a final recommendation, the programme board requested that HPS undertake a full economic analysis comparing the options which remain feasible in terms of MRSA screening. This included a process by which the comparison of more than one approach is undertaken whilst examining both cost and consequence of the intervention. This was undertaken with a view to producing a ranked list which could then be judged against the six dimensions of healthcare quality. This report represents the findings of those analyses and includes the recommendation and limitations identified by the Programme Board.

7 Methods

7.1 Question to be addressed

An economic analysis was requested to assist the programme board to make a policy recommendation to SGHD. The question to be addressed by these analyses was "What is the most clinical and cost effective strategy for MRSA screening?".

7.2 Definition of the screening strategies compared within this report to develop policy options

Three strategies were compared with a starting point of only minimum acceptable practice (Strategy 1). The analysis of which was used to develop a list of policy options which are presented in order of preference by the Programme board [7].

7.2.1 Strategy 1: Do nothing more that previous practice

This involves isolating and treating only patients who develop MRSA infection

In reality, all acute care areas in NHS Scotland were undertaking some form of screening prior to the Pathfinder study, but this approach allows a comparison with a zero spend option.

7.2.2 Strategy 2: Universal screening with nasal swabs

This represents the Pathfinder final report suggested strategy, namely nasal screening of all overnight admissions to Acute care excluding Paediatrics, Obstetrics and Psychiatry

7.2.3 Strategy 3: Clinical risk assessment of all admissions

All patients should be screened on admission or pre-admission using the CRA tool; those with one or more positive answers should proceed to nasal and perineal swab based screening, and prioritised for pre-emptive isolation/cohorting pending laboratory results.

The three questions are:

- Has the patient any past history of MRSA colonisation or infection at any time?
- Was the patient living anywhere other than a domestic household at the time of admission?
- Does the patient have a wound/ulcer or indwelling device which was present before transfer/admission to hospital?

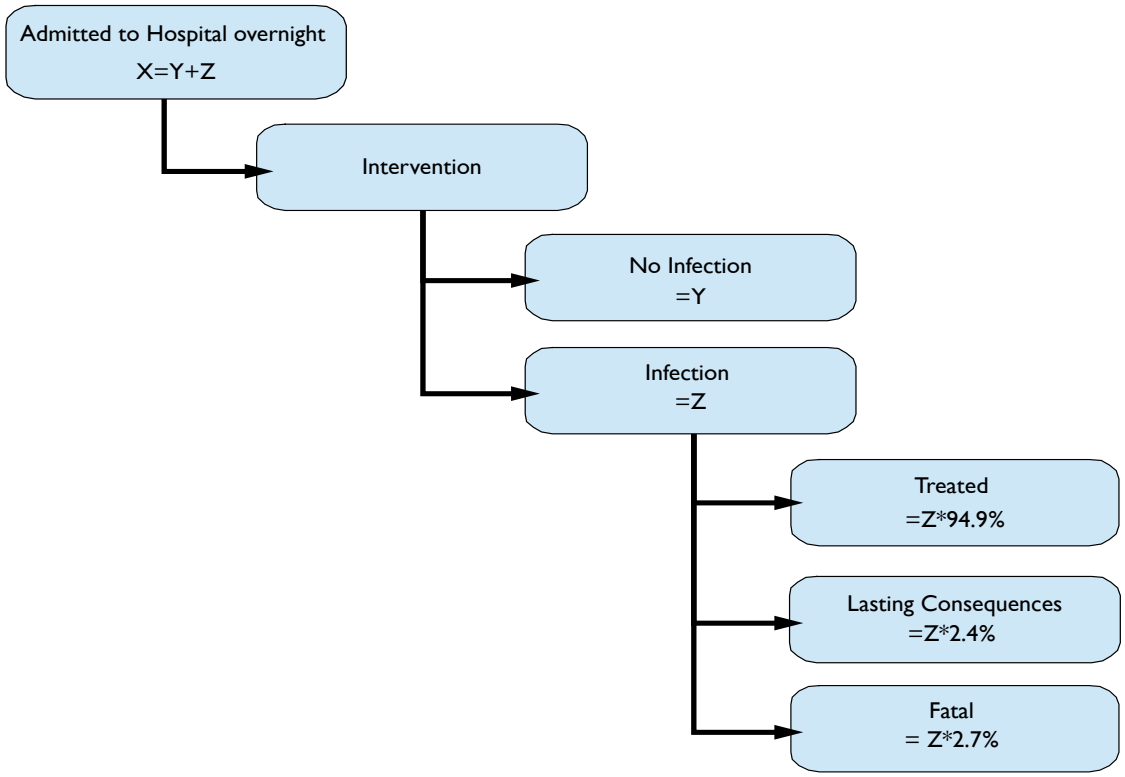
7.2.4 Strategy 4: Clinical risk assessment plus high impact specialties

CRA for all admissions as in Strategy 3, plus two swab (nasal plus perineal) screening for all admissions to high impact specialties; the latter are defined as those with particularly serious consequences of invasive MRSA infection, namely:

- Cardio
  - Cardiac surgery
  - Thoracic surgery
  - Vascular surgery
- Renal/Nephrology
- Orthopaedics
  - Orthopaedics elective
  - Orthopaedics trauma
- Anaesthesia/ICU

Based on the Pathfinder overall infection rates and published data, proportions for each infection type were estimated and were used to convert infections prevented to Quality Adjusted Life Years (QALYs). This allowed calculation of the cost per QALY gained for each strategy. The proportions are shown in Figure 7-1. Full details of the calculations used to calculate QALYs for MRSA infections is detailed within the MRSA Screening Programme Update report [1].

Figure 7-1: Decision tree for calculating QALYs



Within the MRSA Screening programme the initial Pathfinder Study objective was to implement universal MRSA Screening as described within the HTA, and to investigate the clinical effectiveness of MRSA screening as an intervention on outcomes within Pathfinder boards. The study collected data on clinical outcomes and on the assumed parameters used with the HTA model. Therefore robust observed data on prevalence of MRSA on admission and incidence of infection was available for universal nasal swab screening. For the "do no more than practice prior to the Pathfinder" screening option there were no data available on prevalence on admission or the incidence of infection. The CRA options have been developed and validated statistically, but have not been tested in practice within a hospital setting and therefore the clinical impact of these approaches is not directly known.

Due to the limited literature available at the time of the HTA [6] a stochastic or probabilistic model was developed, which allowed parameters to be assumed and altered in order to test the validity of the recommendation. This model was re-worked for the final Pathfinder report [2] and the assumed parameters replaced with observations from the Pathfinder study in order to compare alternative testing strategies (chromogenic agar and PCR) with the "do no more" option. The conclusion from this model was that universal chromogenic agar screening was the best option; however, the modelling of the "do no more" option also showed a degree of reduction in infection and colonisation.

Within the options which remain possible for MRSA screening only universal screening has been implemented within NHSScotland. The other options have been derived from the HTA and the admission and discharge research studies. In order to deliver a full economic analysis there was a requirement to be explicit about uncertainty and assumptions; to use data from many sources; to extrapolate to final end points; to predict outcomes that are unknown; and to understand relationship between the parameters of interest. Therefore, a modelling approach was undertaken.

7.3 Parameters used within the model to describe each strategy

A number of alterations were required to be made to the model due to the nature of the options and the fact that the options described were not previously tested within the HTA [6]. The HTA included a wide range of parameters within the model. The parameters which have been changed or added are described here for each strategy adopted with a reference to the source of each parameter.

Table 7-1: Strategy 1 Parameters altered to represent strategy 1 – Do no more than pre-national rollout

Parameter	Value	Source of information
Starting point true prevalence on admission	5.9%	Assumption based on Pathfinder [3]
Number of screens	0	From Original HTA [6]
Population screened	All eligible overnight admissions	From Original HTA [6]
Cost of isolation	£0	Opportunity cost removed from model

Table 7-2: Strategy 2 Parameters altered for model for universal nasal swab screening

Parameter	Value	Source of information
Starting point true prevalence on admission	5.9%	Assumption based on Pathfinder [3]
Number of screens	1	From Original HTA [6]
Population screened	All eligible overnight admissions	From Original HTA [6]
Cost Screening Chromogenic agar negative	£4.24	Updated version of HTA values [2]
Cost Screening Chromogenic agar positive	£7.24	Updated version of HTA values [2]
Cost swabbing	£3.05	Updated version of HTA values [2]
Sensitivity of test	0.66	From special studies Admission [8]
False positive rate	0.002	Nsira et al [9]; Stoakes et al [10]
Uptake of test	0.85	Pathfinder [2;3]
Cost of isolation	£0	Opportunity cost removed from model

Table 7-3: Strategy 3 Parameters altered for model for universal risk assessment by three questions and chromogenic agar screening using two swabs from all patients who answer yes to any question

Parameter	Value		Source of information
Starting point true prevalence on admission	5.9%		Assumption based on Pathfinder
Number of screens	2 if answer yes to any question		From Original HTA [6]
Population screened	Those who answered yes to any question		From Original HTA [6]
Cost for CRA	TRH	LGH	Calculated at one minute per question
	£1.13	£1.19	
Cost for swabbing	TRH	LGH	Calculated at 8 minutes [3]
	£4.88	£5.21	
Cost Screening Chromogenic agar negative	£6.94		Updated version of HTA values doubling costs of consumables and data processing [2]
Cost Screening Chromogenic agar positive	£12.06		Updated version of HTA values doubling costs of consumables and data processing [2]
Uptake of CRA	0.90		Assumed
Sensitivity of CRA	0.645		From special studies Admission [8]
False positive rate for CRA	0.079		From special studies Admission [8]
Sensitivity of test (nasal and perineal screen)	0.82		From special studies Admission [8]
False positive rate	0.002		Nsira et al [9] ; Stoakes et al [10]
Uptake of test	0.85		Assumption as no values available
Cost of isolation	£0		Opportunity cost removed from model

Table 7-4: Strategy 4 Parameters altered for model for universal risk assessment by three questions and chromogenic agar screening using two swabs for all patients who answer yes to any question and two swab screening for patient admitted to high impact of infection specialties

Parameter	Value		Source of information
Starting point true prevalence on admission	5.9%		Assumption based on Pathfinder [3]
Number of screens	2 if answer yes to any question or are treated in high impact specialties		From Original HTA [6]
Population screened	Those who answered yes to any question and those treated in high impact specialty		From Original HTA [6]
Cost for swabbing	TRH	LGH	Updated version of HTA values [2]
	£1.13	£1.19	
Cost for CRA	TRH	LGH	Updated version of HTA values [2]
	£4.88	£5.21	
Cost Screening Chromogenic agar negative	£6.94		Updated version of HTA values [2]
Cost Screening Chromogenic agar positive	£12.06		Updated version of HTA values [2]
Uptake of CRA	0.90		Assumed
Sensitivity of CRA	0.645		From special studies Admission [8]
False positive rate for CRA	0.097		From special studies Admission [8]
Sensitivity of test	0.82		From special studies Admission [8]
False positive rate	0.002		Nsira et al [9] ; Stoakes et al [10]
Uptake of test	0.85		Assumption as no values available
Cost of isolation	£0		Opportunity cost removed from model

7.4 Economic evaluation methodology

The methodology used within this report was based on a ten point framework for assessing economic evaluations [11].

Step 1: Each strategy was defined and parameters were either estimated or derived from the Pathfinder study in order to describe the strategy.

Step 2: The amended HTA model was used to produce an output which included infections prevented over a five year period and cost of the intervention over a five year period. The parameters described in Table 7-1 to Table 7-4 were used to re-populate the model which was used within the MRSA Screening Pathfinder final report volume 2 [2]. This model had been amended from the original HTA to include the observed performance of the hospital environment when universal screening was implemented. A full description of these changes is included within the report [2].

Step 3: Each strategy was run within the model to produce expected values over five years for cost, prevalence on admission and infections.

Step 4: Sensitivity analyses of the HTA model: there is considerable uncertainty around the values which have been used within the model to describe these parameters. It is important to recognise that observed parameters are only available for universal screening and, as outlined in the parameter tables, the data used within the other strategies come from a variety of sources. It is therefore imperative that the modelling should be subject to a sensitivity analyses to enable decision makers to be fully aware of the range of possible eventualities. A number of parameters were altered within the preferred model in order to assess the effect on the outcomes and costs. Only a single parameter was altered at a time to simplify interpretation.

Step 5: Economic Analyses: the expected infections derived from the model were converted to QALYs using the rationale presented within the MRSA Screening update report [1]. Each option was then ranked in order of increasing clinical effectiveness on the basis of securing maximum effect rather than considered cost. The ICERs (Incremental Cost Effectiveness Ratios) were then calculated as shown in Equation i. Cost per QALY gained can then be compared for alternative interventions, or can be compared against a threshold value of what is considered acceptable in terms of cost effectiveness.

Equation i: Incremental cost effectiveness ratio for Strategy 2

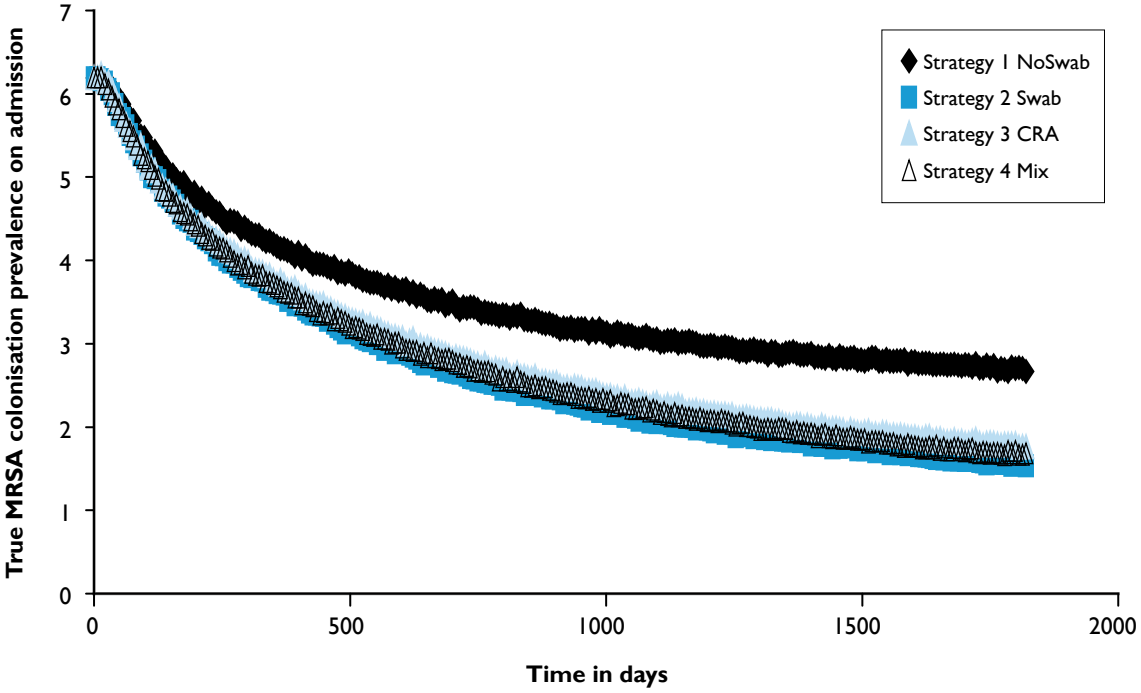
$$\text{ICER} = \frac{\text{Cost of P2 - Cost of P1}}{\text{Effect of P2 - Effect of P2}}$$

Step 6: A cost effectiveness plane was produced by plotting the incremental benefit on outcome (QALYs saved) against the incremental cost.

8 Model Results

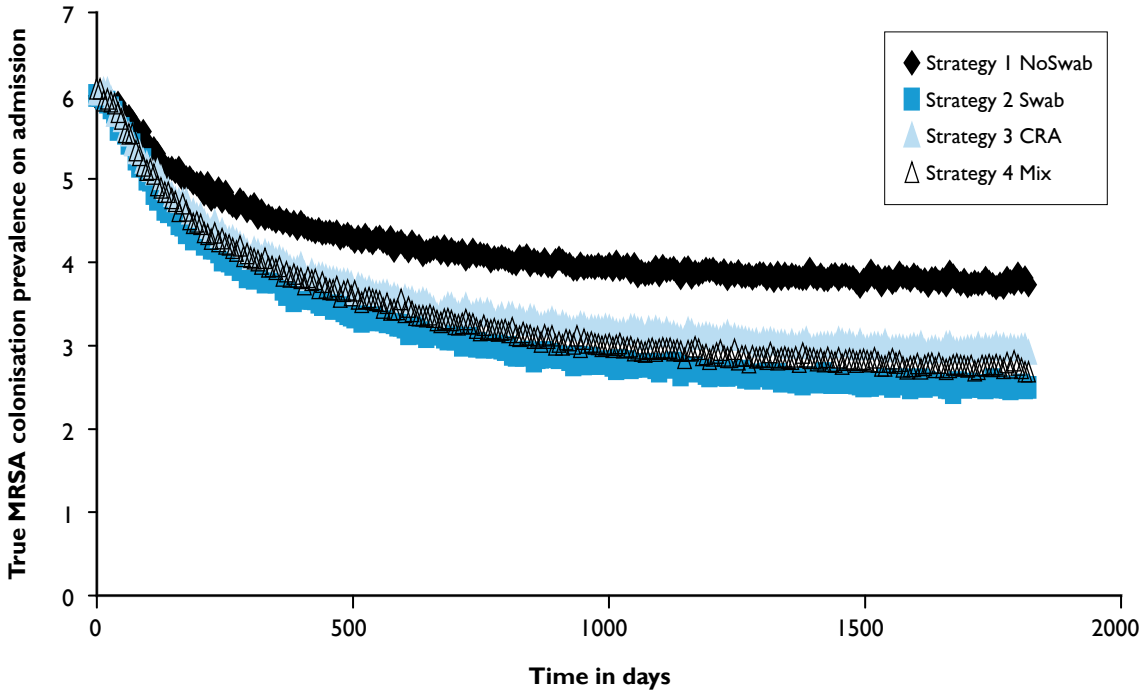
These model output are for a single theoretical hospital and do not aim to describe any particular NHS Scotland Hospital. No attempt has been made to produce a prediction for all Scotland effects. The aim of this model is to enable a like-with-like comparison of the four strategies within a defined set of parameters.

Figure 8-1: Mean true prevalence over time for four Screening strategies in a Tertiary Referral Hospital



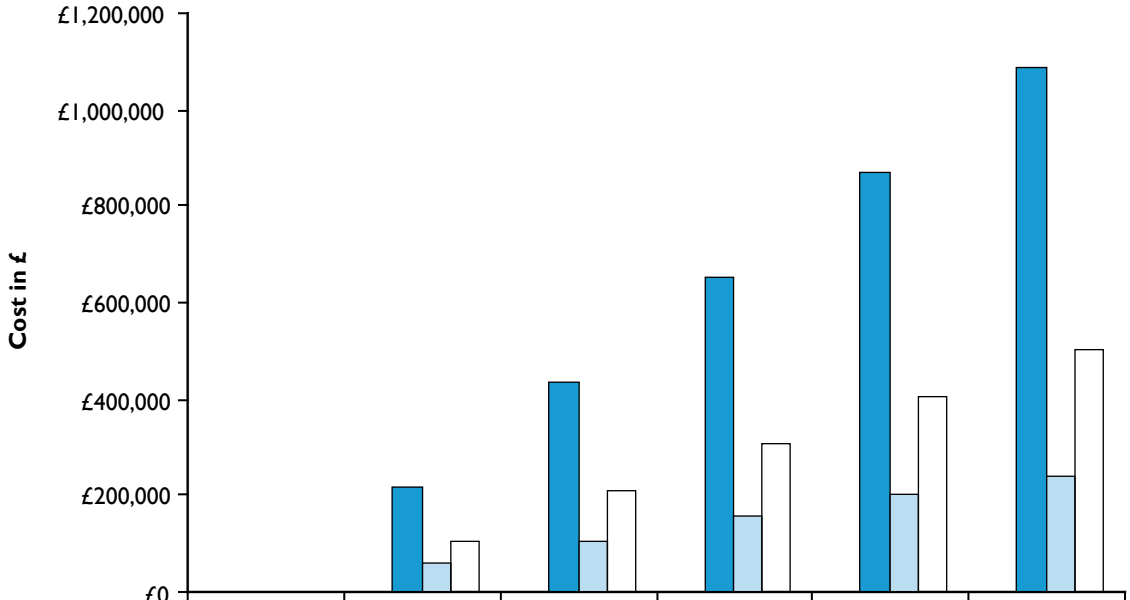
KEY:	
Strategy 1 No Swab	Do no more than pre-national rollout
Strategy 2 Swab	Universal nasal swab screening
Strategy 3 CRA	Universal risk assessment by three questions and chromogenic agar screening using two swabs from all patients who answer yes to any question
Strategy 4 Mix	Universal risk assessment by three questions and chromogenic agar screening using two swabs for all patients who answer yes to any question and two swab screening for patient admitted to high impact of infection specialties

Figure 8-2: Mean true prevalence over time for four Screening strategies in a Large General Hospital



In terms of costing for both tertiary referral hospitals and large general hospitals, implementing strategy two (nasal screen) is estimated at twice the cost of strategy four (CRA plus high impact specialties), and four times the cost of strategy three (CRA alone) (Figure 8-3 and Figure 8-4).

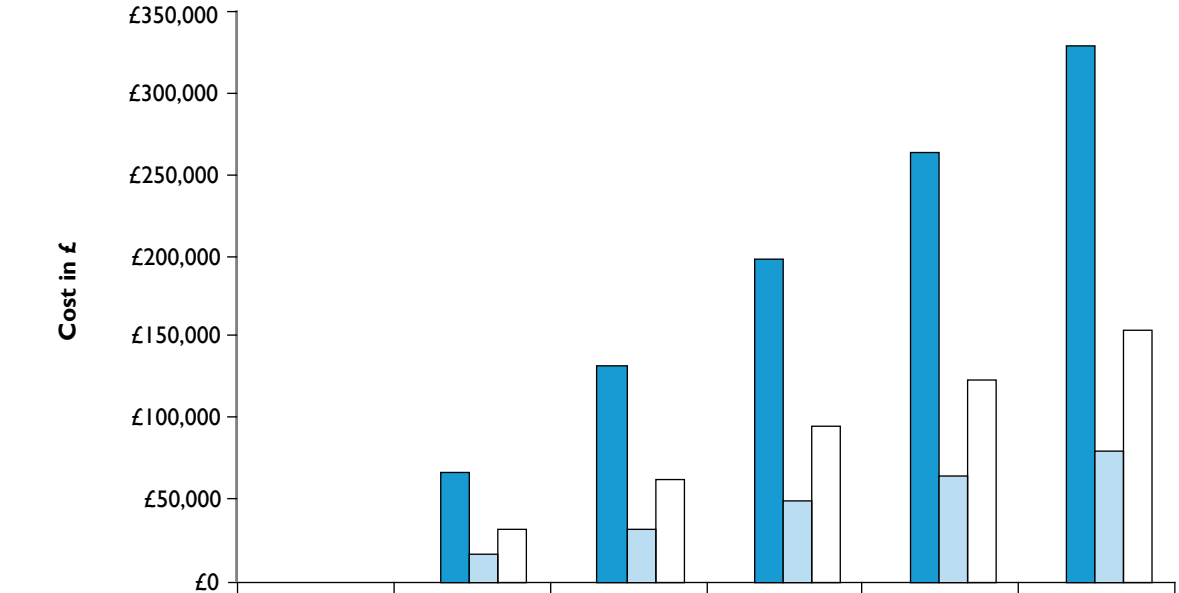
Figure 8-3: Cumulative cost of screening using four strategies in Tertiary Referral Hospital over five years



	0	1	2	3	4	5
Strategy 1 No Swab	£0	£0	£0	£0	£0	£0
Strategy 2 Swab	£278	£219,298	£437,208	£653,958	£870,028	£1,085,768
Strategy 3 CRA	£67	£57,201	£107,445	£154,341	£199,260	£242,957
Strategy 4 Mix	£132	£108,592	£210,752	£309,735	£406,791	£502,698

Year

Figure 8-4: Mean cumulative cost of screening using four strategies in Large General Hospital



	0	1	2	3	4	5
Strategy 1 No Swab	£0	£0	£0	£0	£0	£0
Strategy 2 Swab	£87	£67,378	£133,527	£199,205	£264,689	£330,084
Strategy 3 CRA	£24	£17,714	£33,874	£49,515	£64,872	£80,085
Strategy 4 Mix	£43	£33,031	£64,417	£95,187	£125,681	£156,030

Year

Within the tertiary referral hospital model there was a significant reduction in MRSA infections over the predicted five year span. It should be noted here that the resulting infection rate is considerably higher than was observed during the Pathfinder study. It must also be noted that this is a model and does not attempt to model any single actual hospital. The effect on the theoretical tertiary referral hospital with each strategy should therefore be compared in terms of proportional effect. Universal screening indicated attaining the lowest number of infections each year; however, the difference between strategies two, three and four was not statistically significant (Figure 8-5 and Table 8-1).

Figure 8-5: Annual MRSA infections for a Tertiary Referral Hospital (6-22)

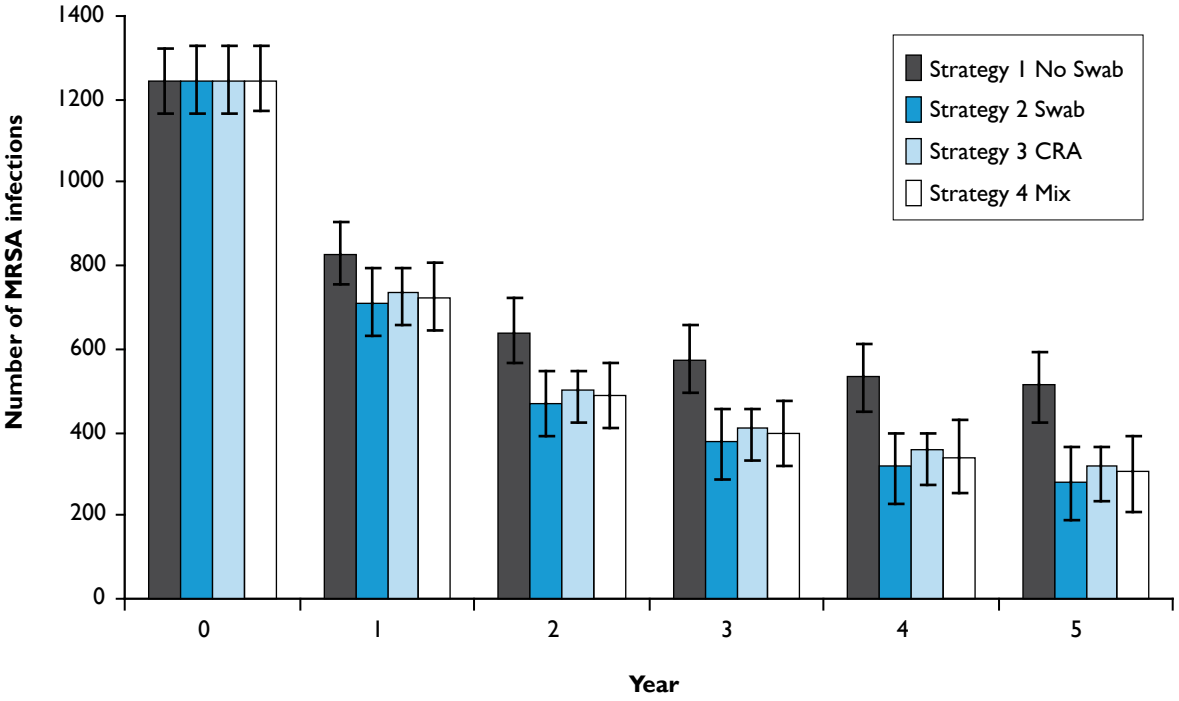


Table 8-1: Predicted MRSA infections in a Tertiary Referral Hospital

Year	Strategy 1 No Swab			Strategy 2 Swab			Strategy 3 CRA			Strategy 4 Mix		
		CI			CI			CI			CI	
		Lower	Upper		Lower	Upper		Lower	Upper		Lower	Upper
0	1245	1167	1324	1246	1163	1326	1246	1166	1326	1246	1169	1326
1	827	754	904	712	630	796	734	655	796	725	644	808
2	639	564	720	469	388	550	503	423	550	488	411	566
3	572	494	655	374	288	457	411	329	457	395	317	477
4	533	448	613	317	229	398	357	274	398	341	256	432
5	512	426	592	281	191	366	322	235	366	303	211	392
Total	**4328**			**3398**			**3572**			**3498**		

The model for the large general hospital and the indicated infection rate needs to be observed with the same caution as the tertiary referral hospitals described previously. In all strategies (including Strategy one) there was a significant reduction in infections within the five year span. As in the tertiary referral hospitals, the greatest decrease in infections was indicated by Strategy two (universal nasal swab screening), although this was only marginally better than strategies four and three, and not statistically significantly better (Figure 8-6 and Table 8-2).

Figure 8-6: Annual MRSA infections for a Large General Hospital

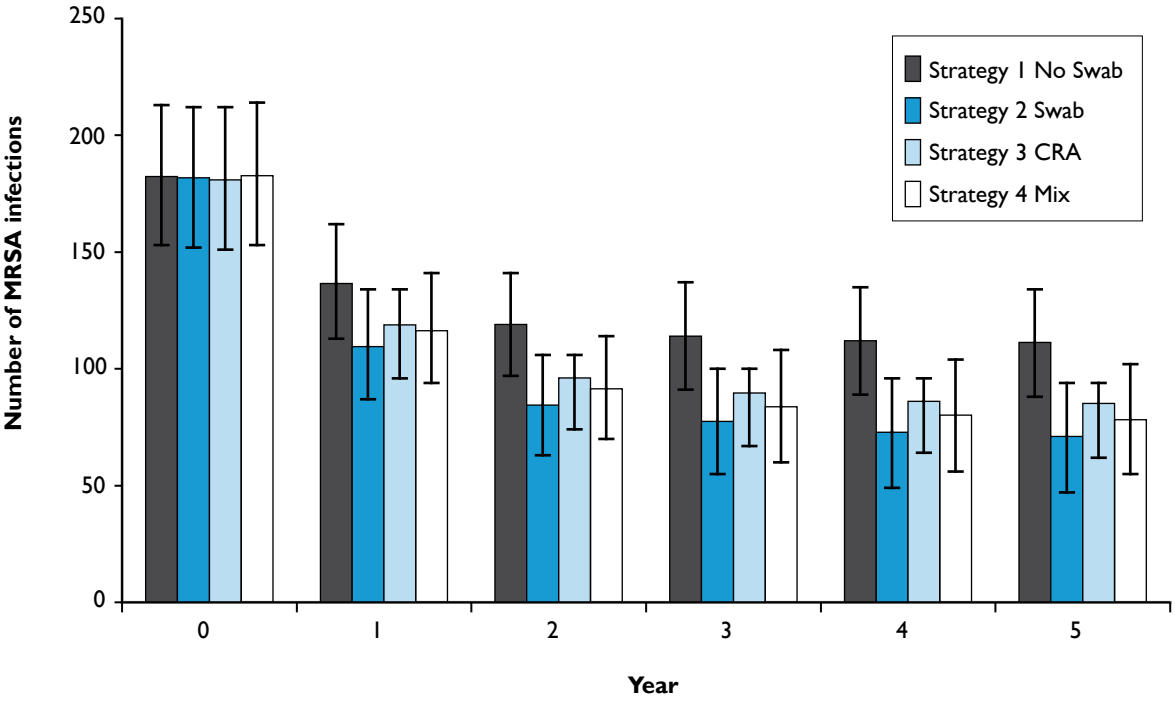


Table 8-2: Predicted MRSA infections in a Large General Hospital

Year	Strategy 1 No Swab			Strategy 2 Swab			Strategy 3 CRA			Strategy 4 Mix		
		CI			CI			CI			CI	
		Lower	Upper		Lower	Upper		Lower	Upper		Lower	Upper
0	182	153	213	182	152	212	181	151	212	183	153	214
1	137	113	162	110	87	134	119	96	134	116	94	141
2	119	97	141	84	63	106	96	74	106	91	70	114
3	114	91	137	78	55	100	90	67	100	84	60	108
4	112	89	135	73	49	96	86	64	96	80	56	104
5	111	88	134	71	47	94	85	62	94	78	55	102
Total	**775**			**597**			**657**			**632**		

9 Economic modelling results

Figure 9-2 shows a cost effectiveness plane display. It should be noted that all of the strategies are more clinically effective and more costly than Strategy one, which is considered to be the baseline. As previously indicated the clinical effectiveness of strategies two, three and four were similar. When the additional spend to achieve the limited increase in QALYs gained is calculated, the difference between the strategies becomes more apparent. The most desirable area for any programme of healthcare would be within in the bottom right quadrant (shown with the circle) i.e. high incremental clinical effect on QALYs and a reduction in cost.

All the strategies for MRSA screening result in increased benefit but incur an additional cost. The most desirable area would be more clinical benefit with less cost (Figure 9-1). Therefore only the top right quadrant has been displayed in Figure 9-2 and Figure 9-3.

Figure 9-1: Cost benefit graph.

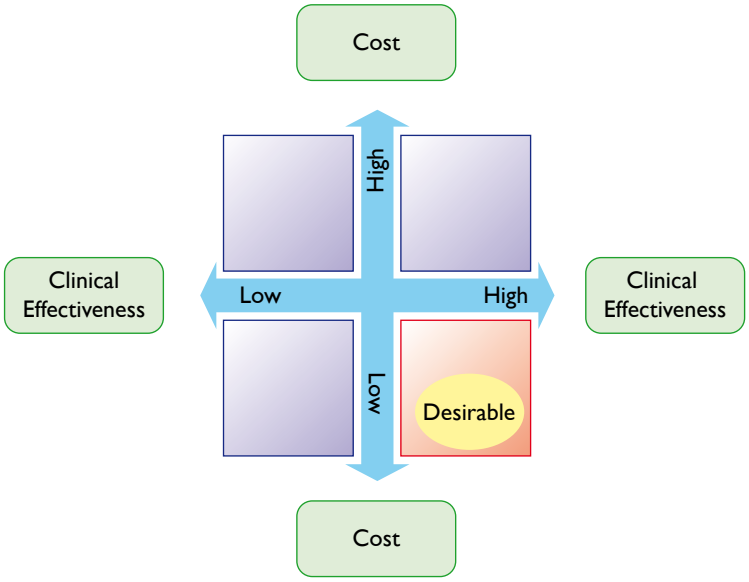


Table 9-1 shows the costs and benefits associated with each strategy. In cost utility analysis, QALYs are used as the measure of effectiveness allowing the benefit gained by each strategy to be expressed as a cost per QALY and also allowing one strategy to be compared with another. Columns 2, 3 and 4 indicate that for the most clinically effective strategy, strategy 2, there would be an average cost effectiveness ratio of around £4865 per QALY. (£1,085,768 / 223.2). However, the table also shows the incremental cost effectiveness ratio (ICER) for each strategy. The ICER shows the additional cost incurred for the additional unit of benefit gained (i.e. $\Delta C/\Delta E$). At the margin, strategy 2 costs £24,325 per additional QALY gained.

Table 9-1: Incremental cost effectiveness ratios for Tertiary Referral Hospital ranked in order of least to greatest clinical effect i.e. least infections and therefore most QALYs gained by implementing the strategy

	Cost	Infections	QALY Gain	Incremental cost	Incremental Effect	ICER
	[C]		[E]	[ΔC]	[ΔE]	[ΔC/ΔE]
Strategy 1 No Swab	£0	4328.3	0.0	£0	0.0	0
Strategy 3 CRA	£242,957	3571.9	181.5	£242,957	181.5	1,338
Strategy 4 Mix	£502,698	3498.3	199.2	£259,741	17.7	14,703
Strategy 2 Swab	£1,085,768	3398.5	223.2	£583,070	24.0	24,325

In interpreting the cost effectiveness plane, it is important to note that the axis shows the benefit and cost above the previously ranked option within the model, and not an absolute value for each strategy.

Figure 9-2 and Figure 9-3, illustrate the results presented in Table 9-1 and 9-2 respectively. Any strategy that lies along the line which connects the origin with strategy three and beyond will have similar cost effectiveness to strategy three. Strategies two and four are slightly more effective clinically, but more costly. The incremental cost effectiveness ratio is the slope of the line joining strategy 3 to and to 2. The steepness of the slope illustrates the increasing incremental cost.

Figure 9-2: Cost effectiveness plane showing the incremental cost and effect for each of the four strategies, using Strategy one as a baseline, and incremental costs presented in the following order: Strategy three, four, and two (Tertiary Referral Hospital).

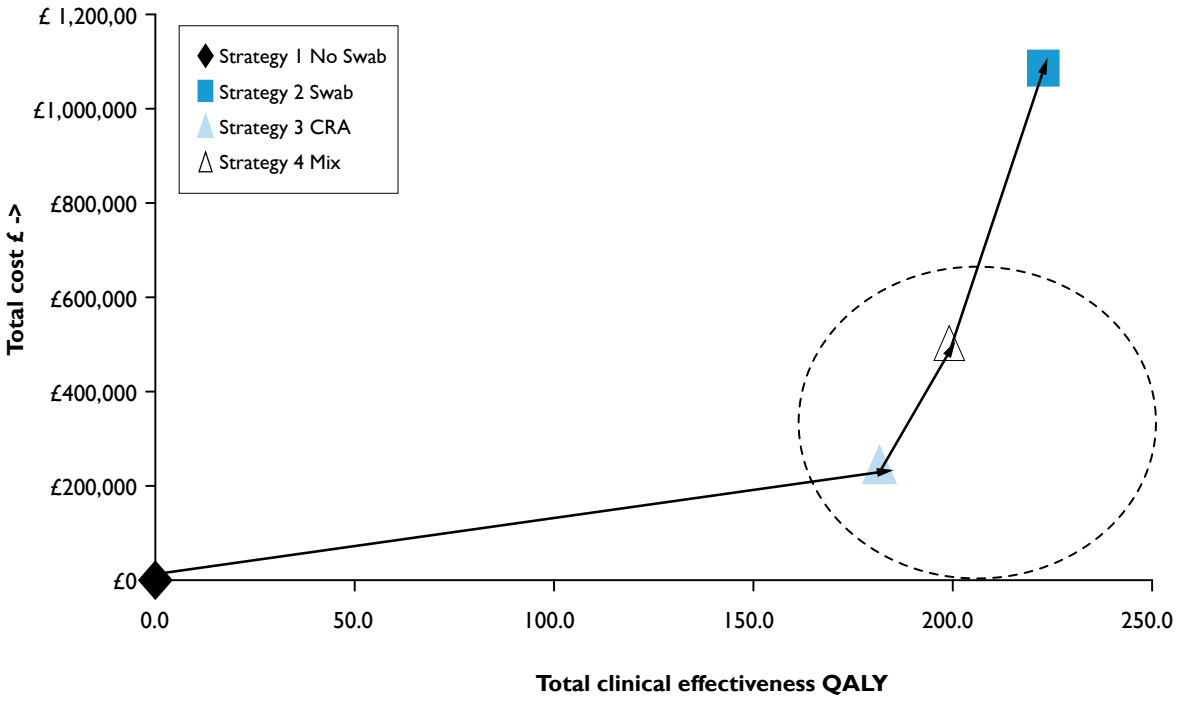
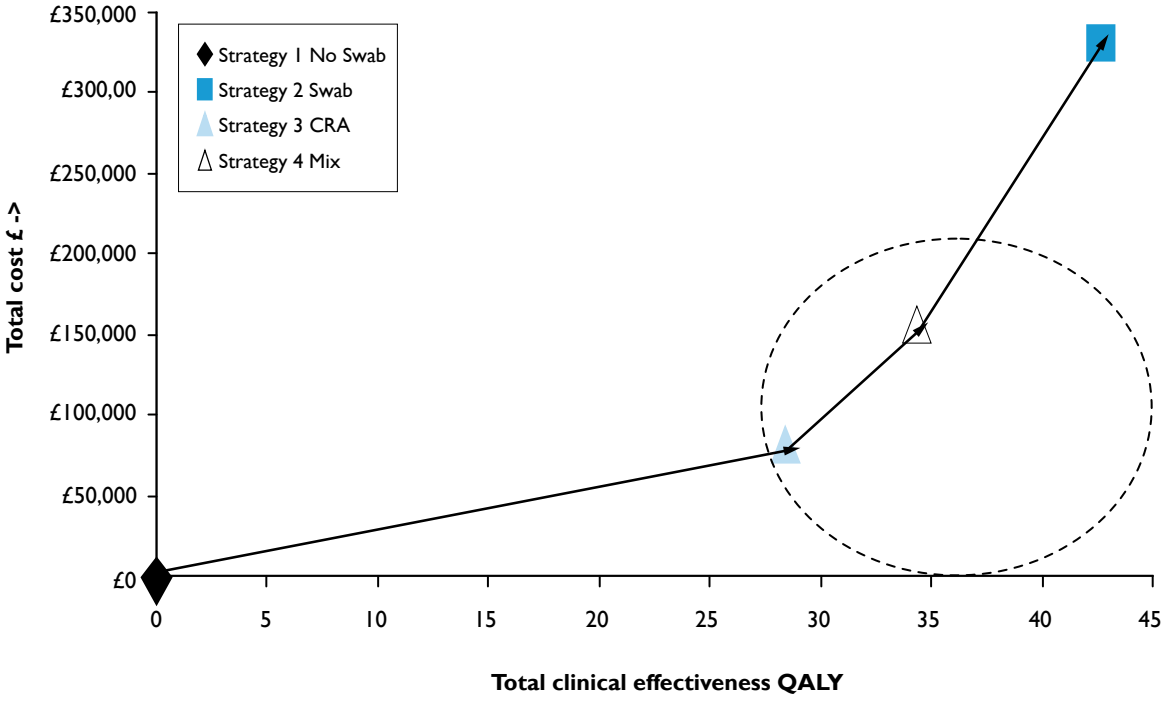


Table 9-2: Incremental cost effectiveness ratios for Large General Hospital ranked in order of least to greatest clinical effect i.e. least infections and therefore most QALYs gained by implementing the strategy.

	Cost	Infections	QALY Gain	Incremental cost	Incremental Effect	ICER
	[C]		[E]	[ΔC]	[ΔE]	[ΔC/ΔE]
Strategy 1 No Swab	£0	775.3	0.0	£0	0.0	0
Strategy 3 CRA	£80,085	656.8	28.5	£80,085	28.5	2,815
Strategy 4 Mix	£156,030	632.4	34.3	£75,945	5.9	12,945
Strategy 2 Swab	£330,084	597.5	42.7	£174,054	8.4	20,775

Figure 9-3: Cost effectiveness plane showing the incremental cost and effect for each of the four strategies, using Strategy one as a baseline, and incremental costs presented in the following order: Strategy three, four, and two (large general hospital)



10 Sensitivity Analysis of the model

Sensitivity analysis was undertaken on the base case of Strategy four (CRA plus high impact specialties). This strategy was selected as it was seen to be the "midpoint" option in terms of clinical effectiveness balanced against cost. The parameters which were thought to be most uncertain were tested with higher or lower values to assess the effect on the model

Table 10-1: Summary of results of sensitivity analyses in assumed Tertiary Referral Hospital for Strategy 4 CRA and high impact specialties

	Source	MRSA prevalence on admission after one year	MRSA prevalence on admission after five years	Costs of screening for 5 years	Total number of infections after five year
Base case – see Table 7-3	Model Cross reference table	3.7%	1.7%	£502,698	3498.3
Decrease true prevalence on admission to 3% [8]	Predicted true prevalence from model within three years (2% being 66% of true positive)	1.3%	0.1%	£456,767	1091.4
Decrease uptake of CRA to 80%	Test	3.7%	1.8%	£497,107	3580.5
Increase uptake of CRA to 95%	Test	3.7%	1.6%	£505,400	3462.8
Decrease pickup rate of two swabs to 71.4% [8]	Lower confidence limit for nasal plus throat swab	3.8%	1.8%	£497,907	3624.2
Increase sensitivity of CRA to 70% [8]	This is sensitivity of CRA based on whole data set (instead of test data set in baseline)	3.6%	1.6%	£506,861	3445.6

Within a tertiary referral hospital the only change to the parameters which had a significant impact on outcome was the lower starting MRSA colonisation prevalence. However the overall trend was the same with a very low final prevalence of 0.1%.

Figure 10-1: Sensitivity analyses for Strategy 4 - CRA and screening of all admissions to high impact specialties with two body site swabs in Tertiary Referral Hospitals

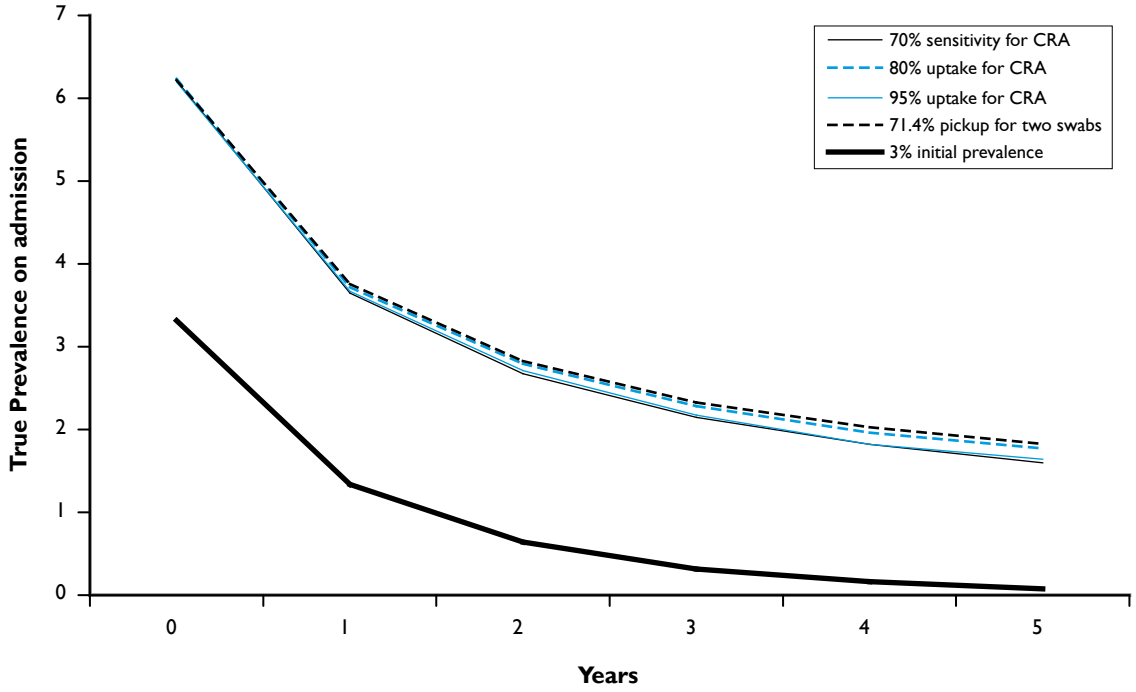
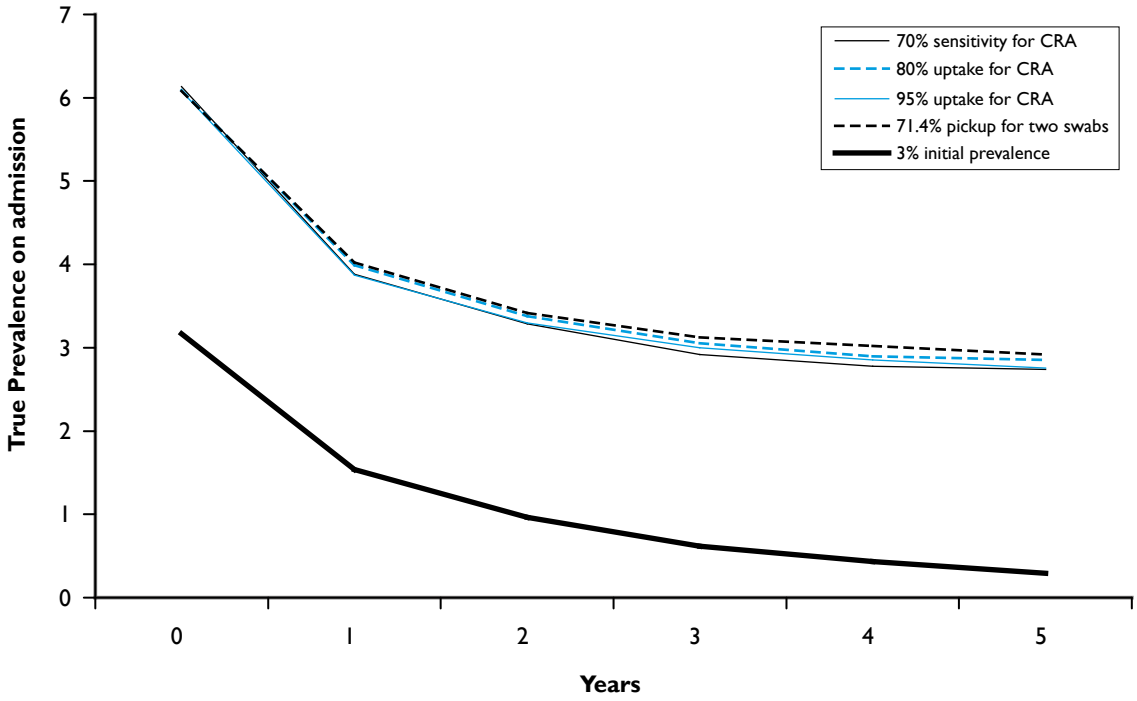


Table 10-2: Summary of results of sensitivity analyses in assumed Large General Hospital.To be undertaken on preferred option for Strategy 4 CRA and high impact specialties

	Source	MRSA prevalence on admission after one year	MRSA prevalence on admission after five years	Costs of screening for 5 years	Total number of infections after five year
Base case	Model Cross reference table	3.8%	2.7%	£156,030	632.4
Decrease true prevalence on admission to 3% [8]	Predicted true prevalence from model within three years (2% being 66% of true positive)	1.5%	0.3%	£139,270	199.3
Decrease uptake of CRA to 80%	Test	4.0%	2.9%	£154,160	643.5
Increase uptake of CRA to 95%	Test	3.9%	2.8%	£156,955	629.6
Decrease pickup rate of two swabs to 71.4% [8]	Lower confidence limit for nasal plus throat swab	4.0%	2.9%	£154,446	653.7
Increase sensitivity of CRA to 70% [8]	This is sensitivity of CRA based on whole data set (instead of test data set in baseline)	3.9%	2.7%	£157,542	627.6

Within a large general hospital the only change to the parameters which had a significant impact on outcome was the lower starting MRSA colonisation prevalence; the same as that of the tertiary hospital. However the overall trend was the same with a very low final prevalence of 0.3%.

Figure 10-2: Sensitivity analyses for Strategy 4 - CRA and screening of all admissions to high impact specialties with two body site swabs in Large General Hospitals



11 Assumptions/limitations

- "Best" point estimates were used from the Pathfinder project, or the Special Studies
- Prevalence in the model is "true" prevalence and nasal screening only detects 66% of true positives
- MRSA colonisation is directly related to infection incidence
- The strategy will be implemented for five years
- An average 0.24 QALYs were used per infection [1]
- High impact specialties are housed in wards that make up 16% of admissions
- Decrease in colonisation/infection is attributable to screening
- Proportions of infection type were constant regardless of intervention undertaken
- Implementation of other factors which may affect MRSA colonisation/infection are constant throughout the five years of the model

12 Discussion

The approach taken to the structure of the discussion section reflects a well established ten-point framework for assessing an economic evaluation [11]. The first two points in the framework (defining the study question and describing the alternative options) are covered within the previous sections of this report.

12.1 Evidence of effectiveness

No randomised trial data are available from implementation of any MRSA screening programmes. The Pathfinder study was an implementation study and, as such, only collected data on what happened when universal screening was implemented; it was not designed to test whether or not any additional clinical benefit was gained over a "do nothing more" approach. Given this limitation, the model did attempt to address a comparison against the 'do no more than identify and manage those patients with infection' approach; however, this latter approach would lead to a decrease in prevalence on admission over time, and therefore the benefit of screening must be compared against the decrease in infection which is projected without any additional intervention.

It must be noted that the evidence for universal screening has been collected in real time within NHSScotland over 18 months, and the effects have been studied for all patients (subject to exclusions) within six hospitals (a large teaching hospital, a tertiary referral orthopaedic unit, two large general hospitals and two small general hospitals); the parameters derived from the Pathfinder study are therefore deemed appropriate to use within the model. Given the cost and ethical issues around implementing a RCT on MRSA screening, these data are of as good a quality as could realistically be expected.

Previous work within the MRSA screening programme has been used to calculate QALYs gained by the implementation of universal screening [1]. Within the model the outputs showed that strategy two – universal screening with nasal swabs – produced the greatest gain in infections prevented in both tertiary referral hospitals and large general hospitals.

The second most clinically effective strategy was a combination of CRA using three questions and swabbing those identified at risk, as well as targeted nasal plus perineal swab screening for four specialties where MRSA infection would have a particularly high impact on outcome. The third ranked intervention in absolute terms of infections prevented was Strategy three. However, the number of infections prevented by any of the intervention strategies was similar.

12.2 Were all the relevant costs and consequences for each alternative identified?

It is not possible to measure all of the costs and consequences for each alternative under comparison; however a full identification of the important and relevant costs is available within the Final Pathfinder report Volume 2 [2]. Costs for undertaking the CRA three question approach were estimated based on a small 'proof of principle' study undertaken within the Western Isles, and costs for swabbing two body sites and laboratory processing costs were based on the updated costs used in the re-worked model.

Two outcomes are under consideration; reducing the primary outcome of MRSA colonisation rates will result a reduction in the secondary outcome of MRSA infection rates (within the Pathfinder study, those patients found to be colonised were 15 times more likely to develop infection that those who were not colonised). Each of the comparative strategies showed a similar reduction in colonisation prevalence on admission. There was some variation in infections predicted; however this difference was not statistically significant.

Only acute care costs were taken into account; repeated visits to GPs and other primary care costs were not included with the analyses. Loss of productivity to the workforce and social costs (e.g. costs of care for family members) were not included.

Impact of the clinical outcome of infection was measured in terms of categorising likelihood and seriousness of infections predicted, which was then converted into QALYs. There are other wider measures which should also be considered within any recommendation, for example the increased perceived safety of healthcare (universal swab screening was deemed highly acceptable and viewed in a positive light by both staff and patients [5]).

12.3 Costs and consequences measurement

Costs were based on values used within the HTA [6] for staff time and consumable costs; inflation had been added to the HTA costs during the final Pathfinder Report Volume 2 [2]. Clinical consequences were based on observations made within the pathfinder study based on trained data collection teams within the health boards in addition to published estimates.

12.4 Was discounting necessary and was it used?

Discounting was included within estimation of QALYs per infection in relation to perceived benefits of future health. No further discounting was undertaken within the model or within the cost effectiveness analyses.

12.5 Incremental costs and outcomes

Table 9-2 shows the incremental cost effectiveness ratio of each strategy within a large general hospital. The overall impact is very similar and Strategy three is once again the most financially attractive choice. While the incremental clinical effectiveness between strategy three and four appears limited, the QALY techniques applied make the assessment for strategy four likely to be very conservative, and the cost consequence of including this is likely to be marginal as it is existing practice in many hospitals already. Strategy four requires considerably more cost investment to achieve this marginal increase in clinical outcome. The choice between strategy three and four must be additionally based on acceptability and the six dimensions of healthcare quality.

12.6 Sensitivity analysis performed

Sensitivity analysis was undertaken on the critical elements of which affect the outcomes of cost, MRSA infection and MRSA colonisation prevalence. Within the model a number of runs of the preferred option of Strategy 4 were tested (Table 10-1 and 10-2).

Sensitivity was undertaken on the following variables:

- Prevalence on admission

  MRSA prevalence in non-Pathfinder hospitals on admission is currently unknown. Within the Pathfinder hospitals, universal screening by nasal swab has been undertaken for one year, followed by a study which screened patients at multiple body sites. Within the Pathfinder study prevalence of colonisation on admission decreased from 5% to 3.5%. The special studies found that nasal swabbing alone identified only 66% of true positives; the baseline figure used was 6%, which was based on the overall Pathfinder prevalence during the year of 3.9%, and assuming that this was 66% of the true positives.

  Sensitivity analyses were undertaken using an initial prevalence of 3%. The effect of this was to reduce overall colonisation to a very low level over five years (0.1% in tertiary referral hospitals and 0.3% in large teaching hospitals). The number of infections was reduced by one third but the cost was only altered by one tenth. This was the only sensitivity analysis that materially affected the overall outcomes of the model.

- Compliance

  Compliance was increased to 95% and decreased to 80% for the clinical risk assessment. There was an increase in the number of infections with decreasing compliance, but the cost and prevalence rates did not change markedly. This is reassuring, as it indicates a "feasible" challenge for boards to implement.

- Detection rate for nasal and perineal swabs

  The parameter of detection rate was changed in order to test the effect of undertaking throat screening instead of perineal screening in cases where perineal screening was deemed too difficult or unacceptable for the patient. This showed a small resultant increase infections and colonisation, but these also demonstrated that the fallback option of screening with throat rather than perineal swabs in addition to nasal would not alter the overall findings of the economic analyses.

12.7 Are the results adequate to inform decision making?

There has been much debate around whether a threshold value for cost per QALY should be used in order to make a decision. In their paper on NICE [12] Culyer et al argue that the decision should be for *policy makers* to decide. This decision making will necessarily be in the context of alternative public spend. They argue that the role of economic evaluation is to provide guidance on the optimal incremental cost effectiveness ratio that is "consistent with the aim of maximising population health".

The economic analysis presented within this paper aims to inform the programme board and ultimately SGHD using the best information available for determining the shape of future national rollout of MRSA Screening. The resulting recommendations have been made based on the patient safety, acceptability of the approach, efficacy in detecting true MRSA carriage, and the costs.

13 Conclusion

In pure economic terms, the strategies present, in order of incremental cost per QALY, as follows (lowest first):

1. Clinical risk assessment of all admissions (Strategy 3)
2. Clinical risk assessment plus two swab screening of high impact specialties (Strategy 4)
3. Universal nasal swab screening (Strategy 2)
4. Do nothing more that previous practice (Strategy 1)

This would lead to an economic conclusion of investing in clinical risk assessment of all admissions. However, these strategies must be considered in terms of clinical effectiveness, public and staff acceptability, and the current economic climate.

The CRA model has only been tested in the pathfinder boards and validated statistically and thus to ensure clinical effectiveness in those patients most at risk of serious consequences of MRSA infection, it is worth considering continue to laboratory screen in selected at risk groups until the CRA model is validated for all NHSScotland. Evaluation of the CRA should form part of the national programme for MRSA screening. Therefore within the context of current spend on partial rollout of universal nasal swab screening and the resources allocated for this therein, the option which appears to offer the best clinical return for a similar level of financial investment is clinical risk assessment plus two swab screening of high impact specialties (Strategy four).

13.1 Are the conclusions justified?

These results and the policy recommendation SBAR submitted separately represent the culmination of three years of data collection, research, interview and analyses. The model has been used to allow a 'level playing field' comparison of each of the four strategies, and that model has been populated with a combination of the best published research available at time of writing in addition to directly observed parameters from a large number of NHSScotland patients with the last two years.

13.2 Are the results generalisable?

These model output are for a single theoretical hospitals and do not aim to describe any particular NHS Scotland Hospital. No attempt has been made to produce a prediction for all-Scotland effects. The aim of this model is to enable a like with like comparison of the four strategies within a defined set of parameters in tertiary referral hospitals and large general hospitals.

14 References

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10a. Abstract : [Maximum 200 words]

This report presents economic analyses of options for MRSA Screening within NHS Scotland. The options examined were universal screening with a single nasal swab, clinical risk assessment for all admissions, clinical risk assessment (with nasal and perineal swabs) for all admissions and screening for all admissions in four specialties (with nasal and perineal swabs). The incremental cost effectiveness was calculated compared with a baseline of only isolate or treat patients who present with infections. In purely economic terms the strategies, in order of incremental cost per QALY, presented as follows (lowest first): clinical risk assessment of all admissions, clinical risk assessment plus two swab screening of high impact specialties, universal nasal swab screening. However, these strategies must be considered in terms of public and staff acceptability and the current economic climate. Within the context of current spend on partial rollout of universal nasal swab screening, the option which appears to offer the best clinical return for a similar level of financial investment is universal clinical risk assessment plus two swab screening of high impact specialties.

Authorisation *(complete as applicable)*

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