Isolation policies in the hospital management of MRSA

Systematic review of isolation policies in the hospital management of methicillin-resistant *Staphylococcus aureus*: a review of the literature with epidemiological and economic modelling

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Executive summary

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Executive summary

Background

The incidence of patient infection and colonisation with methicillin-resistant *Staphylococcus aureus* (MRSA) continues to rise in UK hospitals and poses a considerable socio-economic burden. Management of this problem includes screening to detect asymptomatic carriers and the use of various isolation measures to control its spread. There has been much debate about the rationale and cost-effectiveness of these measures. MRSA guidelines have been published but there was an urgent need for a systematic review to examine the evidence base for these recommendations.

Objectives

1. To review the evidence for the effectiveness of different isolation policies and screening practices in reducing the incidence of MRSA colonisation and infection in hospital inpatients.
2. To develop transmission models to study the effectiveness and cost-effectiveness of isolation policies in controlling MRSA.

Methods

- The search strategy covered the main subject areas addressed in the review: MRSA; screening; patient isolation; and outbreak control.
- Studies with economic data or analysis were included.

Data sources

- Searches of electronic databases MEDLINE (1966–2000), EMBASE (1980–2000), CINAHL (1982–2000), The Cochrane Library (2000) and SIGLE (1980–2000).
- Manual searches of the principal hospital infection journals to validate electronic database searches.
- No language restrictions were imposed.

Study selection

- Abstracts were appraised by two or three reviewers working together and selected if they mentioned endemic or epidemic MRSA and an attempt at control in a hospital setting.
- Two investigators reviewed the full papers independently and extracted data where studies were prospective, employed planned comparisons using retrospective data or used isolation wards or nurse cohorting (designated nurses for the care of MRSA-affected patients).

Data extraction

The study period was divided into phases, where appropriate, and the following data were extracted:

- details of all populations under investigation
- details of patient isolation, screening and other infection control measures (e.g. eradication of carriage, antibiotic restriction, hand-hygiene, feedback, ward closures)
- information on outcomes (e.g. infection, colonisation, bacteraemia, death)
- details of potential confounders or effect modifiers including length of stay, antibiotic use, strain change, pre-existing trends, numbers colonised on admission, seasonal effects, staffing levels and aspects of study design that might introduce biases.

Authors were written to when isolation or screening policies, or their timing, were unclear.

Studies were excluded if isolation policies or timing of interventions remained unclear, or if the only outcomes reported were colonisations and screening policy was unclear or changed substantially.

Data synthesis

- Data were summarised in table form. Formal meta-analysis was considered inappropriate owing to heterogeneity in study design and patient populations.
- The strength of evidence in each study was evaluated by examining the study design, quality of data, size of effect and presence of plausible alternative explanations due to confounders and biases.

Modelling methods

- Stochastic and deterministic compartmental models were used to investigate the long-term transmission dynamics of MRSA.

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- Hospital and community populations were considered, but all transmission was assumed to occur in hospitals.
- Models studied the impact of a fixed-capacity isolation ward.
- Local cost data were coupled to models to produce economic evaluations.
- Models were also used to address issues of statistical validity in publication and analysis bias.

Results: systematic review

- There were 4382 abstracts from which 254 full-article appraisals were made. Forty-six were included in the final review.

Study designs

- one prospective cohort cross-over study
- two prospective cohort studies with historical controls
- nine prospective interrupted time series (ITS) (three had prospective data collection but unplanned interventions)
- six prospective observational one-phase studies
- five hybrid retrospective/prospective ITS
- one retrospective cohort study with systematic data collection and the comparison decided on in advance of examining the data
- two retrospective studies with the comparison decided on before examination of the data
- eighteen retrospective ITS
- two retrospective observational studies.

Study interventions

- Eighteen studies described the use of **isolation wards**. Study durations ranged from 3 months to 15 years, and involved between 11 and 5345 MRSA cases.
- Nine studies described the use of **nurse cohorting (NC)**. Study durations ranged from 3.5 months to 4 years, and involved between 5 and 1074 MRSA cases.
- Nineteen studies described **other isolation policies**. Study durations ranged from 1 month to 9 years, and involved between 9 and 1771 cases.
- In nearly all the studies isolation was combined with at least one other simultaneous intervention.

Study settings

- Twenty-five studies were set in one or more entire hospitals, 20 were set in individual hospital units and one used survey data from multiple hospitals.

Quality of studies

- There were few formally planned prospective studies with predefined pre- and postintervention periods.
- Systematic assessment and adjustment for potential confounders was lacking.
- Regression to the mean effects and confounders were plausible threats to the validity of many studies. The predominance of unplanned retrospective reports suggests that reporting bias may be important.
- Statistical analysis was absent or inappropriate in all but two studies.
- There was no robust economic evaluation.

Results

- No conclusions could be drawn about the effect of isolation in one-third of studies. In studies with multiple simultaneous interventions it was not possible to assess the relative contribution of individual measures.
- Most others provided evidence consistent with reduction of MRSA. In half of these, the evidence was considered weak because of poor design, major confounders and/or risk of systematic biases.
- Two studies presented evidence consistent with immediate isolation reducing transmission.
- Stronger evidence was presented in the larger and longer time series, with large changes in MRSA numbers, detailed information on interventions and relative absence of plausible alternative explanations.
- There were six such studies:
  (a) Three presented conflicting evidence of the effectiveness of **isolation wards** (with other measures) in reducing MRSA infection hospital wide: one reduced infection, one did not and one resulted in control for many years until a change in strain and/or an increase in the number of patients colonised on admission overwhelmed the institution.
  (b) One presented evidence that **single-room isolation** with screening, eradication and an extensive hand-hygiene programme reduced MRSA infection and colonisation hospital wide.
  (c) One provided evidence that **NC** in single rooms with screening and eradication reduced infection hospital wide. One paediatric intensive care unit study provided evidence that **single-room isolation** and patient cohorting in bays (with screening, feedback of infection rates and hand-hygiene education) reduced infection.
- It was not possible to draw any conclusions about the cost-effectiveness of the interventions because of the poor quality of the economic evaluative work presented. The costs ►

included were not comprehensive – many items were omitted – and they were not consistent as the items included in the studies varied widely.

Results: modelling

- Equilibrium endemic prevalences of MRSA in hospitals with fixed-capacity isolation facilities were shown to be dependent on the detection rate of MRSA patients, the number of isolation beds available and the transmissibility of the organism.
- Improving either the detection rate or isolation capacity was shown to decrease endemic levels provided that the other was not the limiting factor.
- The final endemic level often depended on when the isolation ward opened, with ultimate eradication often possible only when the isolation ward was opened early.
- In many scenarios, long-term control failure occurred owing to saturation of isolation facilities as the numbers colonised on admission rose. However, even when such control failure occurred, the isolation ward delayed the rate at which prevalence increased and reduced the ultimate endemic level. Saturation of isolation facilities can be prevented by ensuring sufficient capacity.
- A paucity of reliable information on key parameter values hampered economic evaluations. However, under a wide range of plausible parameter values estimated independently, substantial savings could be achieved over 10 years compared with a policy of no isolation, provided that the burden of unused isolation ward capacity and staff time was not too great. Assumptions were made about the unused capacity on the isolation wards that had implications for the estimates of opportunity costs. Our assumptions possibly overestimated the opportunity costs. The opportunity costs in practice may have been less and would depend crucially upon what the alternative uses would have been and what would have been the cost of maintaining unused capacity. We lacked data to estimate these costs.

Conclusions

Implications for healthcare

- There was evidence that intensive concerted interventions that include isolation can substantially reduce MRSA, even in settings with a high level of endemic MRSA. Little evidence was found to suggest that current isolation measures recommended in the UK are ineffective, and these should continue to be applied until further research establishes otherwise.

Research recommendations

- Future research should concentrate on prospective planned comparisons, with predefined pre- and postintervention periods and systematic assessment and adjustment for potential confounders as necessary. Randomised controlled trials with cluster randomisation by hospital or specialist unit are one possibility. Consideration should also be given to other valid designs, including those based on prospective interrupted time series as, although they represent weaker designs, they may often be more feasible.
- Priority research questions include an examination of the effect of adequately sized isolation wards in hospitals with endemic MRSA; the effects of single-room isolation with an extensive hand-hygiene programme, screening and eradication; and NC, with screening and eradication. Study designs that permit the identification of the effects of both individual interventions and the effects of combined interventions should be considered.
- Attention should be paid in intervention studies to estimating the resources used in the intervention in a comprehensive way. Cost vectors can then be applied that are designed as far as possible to reflect the opportunity costs associated with the use of these resources.
- We recommend that future outbreak reports and intervention studies be written up in a standardised manner with full recording of interventions, outcomes and confounders to ensure that specific threats to validity are addressed. We have produced guidelines to facilitate this.
- An audit system that enables infection control teams to collect and use data on potential effect modifiers, alongside current MRSA surveillance systems, needs to be designed, piloted and evaluated. Evaluation should focus on the role of the system in planning interventions and interpreting their outcomes.

Publication

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NHS R&D HTA Programme

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Initially, six HTA panels (pharmaceuticals, acute sector, primary and community care, diagnostics and imaging, population screening, methodology) helped to set the research priorities for the HTA Programme. However, during the past few years there have been a number of changes in and around NHS R&D, such as the establishment of the National Institute for Clinical Excellence (NICE) and the creation of three new research programmes: Service Delivery and Organisation (SDO); New and Emerging Applications of Technology (NEAT); and the Methodology Programme.

This has meant that the HTA panels can now focus more explicitly on health technologies ('health technologies' are broadly defined to include all interventions used to promote health, prevent and treat disease, and improve rehabilitation and long-term care) rather than settings of care. Therefore the panel structure was replaced in 2000 by three new panels: Pharmaceuticals; Therapeutic Procedures (including devices and operations); and Diagnostic Technologies and Screening.

The HTA Programme will continue to commission both primary and secondary research. The HTA Commissioning Board, supported by the National Coordinating Centre for Health Technology Assessment (NCCHTA), will consider and advise the Programme Director on the best research projects to pursue in order to address the research priorities identified by the three HTA panels.

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Reviews in *Health Technology Assessment* are termed 'systematic' when the account of the search, appraisal and synthesis methods (to minimise biases and random errors) would, in theory, permit the replication of the review by others.

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