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# Cost and health care benefits of an antimicrobial management programme

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- **OBJECTIVE** — To assess the cost and health care benefits of a multidisciplinary antimicrobial management team (AMT) comprising a consultant microbiologist and a clinical pharmacist operating within the medical and care of the elderly directorates of an NHS trust.
- **METHODS** — AMT input was assessed over a three-month period. Performance indicators were; AMT input with respect to modification of antimicrobial prescriptions, patient outcome and cost (calculated by extrapolation). A net saving to the trust was calculated from the assumption that the patients' doctors would have made all the antimicrobial changes made by the AMT by day 3.5.
- **RESULTS** — Assuming that the patients would have continued as per their doctor's prescription for a further 3.5 days after the review, savings in antimicrobial acquisition costs of 42 per cent and 24 per cent were estimated in the medical directorate and care of the elderly directorate respectively. The use of intravenous antimicrobials was also reduced by 48 per cent and 40 per cent respectively.
- **CONCLUSION** — The AMT was estimated to have reduced the cost of antimicrobial prescribing with no observed detrimental effect on patient care. The AMT reinforces good antimicrobial practice and helps educate staff.

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**U**se of antibiotics is directly linked to the development of antimicrobial resistance and to the incidence of hospital-acquired infection, both of which are detrimental to patient outcome and impose a substantial economic burden on health care expenditure.<sup>1-3</sup> Most antimicrobial use is in the community (80 per cent in the UK<sup>4</sup>). However, most infections with resistant bacteria such as methicillin-resistant *Staphylococcus aureus* (MRSA) or multi-resistant *Pseudomonas aeruginosa* and *Acinetobacter* spp, which are associated with increased morbidity, mortality and health care costs, occur in hospitals.<sup>5,6</sup>

Antimicrobial use may be controlled by a number of strategies, including educational programmes, which need continual reinforcement, antimicrobial formulary restriction, therapeutic substitution and de-escalation and switching from parenteral to oral therapy. Selective microbiology laboratory reporting of the antimicrobial susceptibility of the infecting organism facilitates appropriate and targeted antimicrobial prescribing. Computerised prescribing systems can link the prescription to the pathology results and patient-specific information, allowing for more sophisticated patient-directed antimicrobial prescribing. Antimicrobial use may be further controlled by a multidisciplinary antimicrobial management team (AMT) comprising an infectious disease doctor and/or a clinical microbiologist and a clinical pharmacist, as a minimum requirement. An infection control practitioner and/or a hospital epidemiologist may also be included. The primary responsibility of the AMT is to assist doctors in the use of antimicrobials for optimal patient care.<sup>7</sup>

AMTs have been shown to improve patient care and outcome, reduce prevalence of antimicrobial-resistant organisms and control costs.<sup>8-10</sup> An EU conference in 1998 recommended that every hospital should establish an antimicrobial management team.<sup>11</sup> In the UK, antimicrobial control measures have relied upon antimicrobial formulary restriction and antimicrobial policies with supporting educational programmes.<sup>12</sup> However, the Government has recognised antimicrobial drug resistance as a significant public health issue and has also identified hospital pharmacists as an underused resource.<sup>13</sup> Subsequently, the Department of Health set aside £12 million for improving

antimicrobial prescribing through increased hospital pharmacist activity.<sup>14</sup>

This observational study prospectively assessed the cost and health care benefits of the AMT operating within the medical and care of the elderly directorates at Southampton University Hospitals NHS Trust (SUHT). The SUHT AMT comprises a consultant microbiologist and a directorate-based clinical pharmacist, who have provided weekly consultations since September 2000. These teams were introduced to support other hospital antimicrobial control measures already in operation, including education and an antimicrobial formulary. The consultant microbiologist provides expert antimicrobial advice, liaising between the microbiology laboratory, the attending team and patients. The pharmacist ensures that the advice adheres to the hospital formulary and provides the knowledge of appropriate antimicrobial prescribing in relation to patient data such as liver and renal function. The AMT provides a valuable educational opportunity for trainees in microbiology and pharmacy and provides feedback and teaching opportunities for ward-based medical and nursing staff.

Ward-based pharmacists identify patients who are prescribed intravenous or second line oral antibiotics and a list of those patients is faxed to the consultant microbiologist responsible for the directorate within two hours of the ward round. The microbiologist collates the relevant pathology data for each of the patients listed. The antimicrobial requirement of each patient is then assessed on the ward round. Most changes in prescription are made directly by the microbiologist, as agreed with the directorate from inception of the AMT rounds. Any changes made are documented in the patient's notes. If the clinical case is complicated and further discussion is required then a doctor from the patient's own team is contacted.

The care of the elderly AMT covers 90 beds and deals with elderly patients who often have non-specific symptoms and signs of infection and who are exceedingly vulnerable to *Clostridium difficile* infection or antibiotic-associated diarrhoea. The medical AMT covers 208 beds and deals with a large and diverse inpatient population. Both the patient population and the attending doctors have rapid turn-around times.

## Panel 1: Classification of input from the AMT

- A** = Define management plan (choice of antimicrobial, route and course length)  
**B** = Agree with current antimicrobials prescribed by attending doctors or surgeons  
**B<sup>M</sup>** = Continue current antimicrobials or management plan as suggested by microbiology  
**C** = Stop all antimicrobials (immediately or within 48 hours of ward round)  
**D** = Narrow the focus of antimicrobial therapy  
**E** = Change or broaden antimicrobial therapy  
**F** = Change dose of antimicrobials  
**G** = Intravenous to oral switch

## Methods

Impact of the AMT was assessed over a three-month period from January 2003 using the performance indicators outlined below:

- AMT input with respect to modification of antimicrobial prescription.
- Patient outcome (mortality at 28 days and length of stay).
- Cost. The costing analysis was worked out by extrapolation since it is unknown whether or not the antibiotic changes made by the AMT would have been made by the patients' own doctors. A net saving to the trust was calculated from the assumption that the patients' doctors would have made all the antimicrobial changes as made by the AMT by day 3.5.

The input from the AMT was classified as described in Panel 1.

Inputs B and B<sup>M</sup> are monitoring activities rather than interventional activities. Inputs A and C–G are interventional activities. Individual patient reviews may be allocated more than one AMT input if one of the inputs was the definition of a management plan.

This study was an observational description of current practice and therefore ethical

## Table 2: Total daily cost of all antimicrobials prescribed for reviewed patients pre- and post-AMT ward round\*

Directorate	Total daily cost (£) of antimicrobials pre-ward round	Total daily cost (£) of antimicrobials post-ward round	Saving (per cent)
Care of the elderly	567	430	24
Medicine	3,323	1,934	42

\*Figures are averaged for the three-month study period

approval was not required.

## Results

Table 1 shows the breakdown of AMT input over a period of three months at the beginning of 2003.

During the study period 69 care of the elderly patients and 263 medicine patients were seen, with approximately five minutes allocated for each patient review.

A management plan (A) was made in 19 (25 per cent) of the care of the elderly AMT inputs and 77 (25 per cent) of the medical AMT inputs. A management plan is defined as recommending either the choice of antimicrobial, the preferred route, the duration of therapy or the criteria for changing the antimicrobial from an intravenous to an oral formulation.

Having established a management plan, 24 (31 per cent) of the AMT inputs in care of the elderly and 79 (26 per cent) of the AMT inputs in medicine represented monitoring activities (B and B<sup>M</sup>), ie, ensuring that the plan was appropriate. Monitoring is defined as agreement with the current antimicrobials prescribed by the attending doctors or continuation of the current antimicrobials or management plan as suggested by microbiology.

One or more antimicrobials were stopped (C and D) in 19 (25 per cent) of the care of the elderly AMT inputs and 73 (24 per cent) of the medicine AMT inputs. In these cases either all of the antimicrobials were stopped or the focus of the antimicrobial therapy was narrowed.

A change in antimicrobial or a change in the dose of the prescribed antimicrobials (E and F) was recommended in eight (10 per cent) of the care of the elderly AMT inputs and 21 (7 per cent) of the medicine AMT

inputs.

An intravenous to oral switch (G) was made in seven (9 per cent) of the care of the elderly AMT inputs and 77 (25 per cent) of the medicine AMT inputs.

Overall, a management plan was made in 25 per cent of both the care of the elderly and the medicine AMT inputs. The rate for monitoring activities, stopping antimicrobials and changing antimicrobials or their dose was similar for both care of the elderly and medicine patients. The main difference between the care of the elderly and medicine AMT inputs was in the intravenous to oral switch category. Only 9 per cent of the care of the elderly AMT inputs represented an intravenous to oral switch, and this is accounted for by the fact that many of the care of the elderly patients were awaiting an assessment of their swallowing ability and therefore the oral route of administration was not available.

**Patient outcome** No differences were observed in mortality at 28 days or in length of stay when comparing the patient group in whom all antimicrobials were stopped by the AMT with the patient group in whom antimicrobials were continued as per the doctor's own prescription. This second group was reviewed by the AMT but their therapy was assessed as appropriate and therefore their antimicrobials were continued. The patients in the two groups were broadly comparable in terms of age, sex and underlying disease states.

**Follow up of AMT ward rounds** All of the patients who were assessed by the AMT ward round over the third month were reassessed at 48 hours and again at seven days, to determine whether the advice given on the ward round had been adhered to by the patients' own doctors. Monitoring involved reviewing the patients' notes and the drug charts.

In the care of the elderly directorate, 22 patients were reviewed by the AMT during month three. Follow up showed that all antimicrobial prescription changes suggested by the AMT had been accepted by the patients' doctors.

In the medical directorate, 125 patients

## Table 1: Antimicrobial management team input over three months

Directorate	No of ward rounds	No of patients seen	Average time/patient (mins)	Total no of AMT inputs
Care of the elderly	11	69	6	77
Medicine	10	263	5	306

were reviewed by the AMT during month three. Follow up showed that three patients who had antimicrobials stopped by the AMT were restarted on antimicrobials by the patients' own team. In two of these three patients, antimicrobials were stopped again on the following AMT ward round. In the third patient, the same antimicrobials were restarted on the basis of a new fever and signs of infection. In another case a recommendation of switching from intravenous to oral antimicrobials was not adhered to because the patient remained unable to swallow safely. In one patient a recommendation of a five-day treatment course was not adhered to and the antimicrobials were continued until the following week when they were stopped by the AMT. Finally, in one patient the antimicrobial management plan advised by the AMT was not adhered to because of a new diagnosis. Therefore, in the medical directorate, the advice given by the AMT was not adhered to in six out of 125 (4.8 per cent) patient episodes. The advice was not adhered to in three of these six cases due to new clinical circumstances which arose after the AMT ward round.

## Financial evaluation

### Costing of prescribed antimicrobials

The cost (price paid by the trust) of each prescribed daily dose of antimicrobial was calculated for each patient. The total daily cost of all antimicrobials prescribed before and after AMT intervention was calculated, and is shown in Table 2 (p180).

**AMT costing** The cost of each ward round was determined by calculating the microbiologist's time spent reviewing the patients' results, the pharmacists' time collating the patient antimicrobial information and both the pharmacist's and microbiologist's time spent on the ward round. The cost of the weekly AMT ward round was calculated to be approximately £45 and £163 for the care of the elderly and medicine directorates, respectively.

**Overall cost saving** From the antimicrobial cost saving made per ward round per day and the cost of the weekly AMT, a cost saving was calculated. Actual cost savings could only be

**Table 4: Total daily number of intravenous and oral antimicrobials (Abs) prescribed pre- and post- antimicrobial management team ward round\***

Directorate	Pre-round IV Abs	Pre-round oral Abs	Post-round IV Abs	Post-round oral Abs	% reduction in IV Abs
Care of the elderly	72	55	43	47	40
Medicine	267	175	138	197	48

\*Figures are averaged for the three-month study period

predicted since it is not known if and when the attending team would have made similar prescription changes to the AMT.

AMT ward rounds have been performed across all of the wards for a number of years and so there was no specific control group. It was not therefore possible to define the absolute cost savings.

Antibiotic prescription changes made on AMT ward rounds are cost effective where they pre-empt decisions by the attending team to change the prescription. Higher savings are achieved when a change is made by the AMT that would otherwise not have been made until several days later by the attending team. They are not cost effective if the changes were to be made by the attending team on the same day as the AMT round. However, in the medical directorate, assuming no change was made by the attending team in between the weekly rounds, a cost saving of £42,000 would be achieved for the 263 patients assessed (Table 3).

**Reduction in the use of intravenous antimicrobials** The use of intravenous antibiotics was reduced on the care of the elderly and medical wards by 40 per cent and 48 per cent, respectively, following the AMT ward round. This was done by either stopping antibiotics or by switching to a suitable oral agent (Table 4).

## Discussion

At SUHT, AMTs have been in operation since 2000, reviewing patients on selected antimicrobial therapy. Patients with serious

infections who are on appropriate antimicrobial treatment are also identified and reviewed as part of the round. Patients on inappropriate treatment may not be reviewed, if this therapy is initiated [or?] changed by the attending team in between AMT ward rounds.

Over the three-month study period, AMTs achieved a 42 per cent direct reduction in antimicrobial acquisition costs for the patients assessed in the medical directorate and a 24 per cent reduction for assessed patients in the care of the elderly directorate. These percentages are based on the assumption that the patients' antimicrobials would have continued as per their doctors' prescription for a further 3.5 days.

The medical and care of the elderly AMT ward rounds reduced the number of antimicrobials prescribed intravenously by 48 per cent and 40 per cent respectively. Converting the route of administration of antimicrobials from intravenous to oral results in direct cost savings in terms of nursing time and furthermore reduces the risk to the patient of complications as a result of the presence of an intravenous cannula. The presence of an intravascular line is associated with an eight-fold increase in the risk of health care-associated infection,<sup>2</sup> including MRSA bacteraemia.<sup>15</sup> Switching to an effective oral therapy can also allow earlier discharge, improve patient comfort and mobility and can significantly reduce the cost of treatment.<sup>16</sup> Patients who develop a health care associated infection have been shown to remain in hospital 2.5 times longer than uninfected patients and incur costs 2.8 times higher than uninfected patients.<sup>2</sup>

*Clostridium difficile* is the leading cause of antibiotic-associated diarrhoea<sup>17</sup> and its incidence reflects antibiotic usage. Data from the care of the elderly directorate demonstrates a reduction in the number of new cases of *C difficile* in parallel with a reduction in the use of cephalosporins.<sup>18</sup>

There was no detrimental effect identified, on either patient mortality or length of stay as a result of stopping the antimicrobials when compared with the group in whom

**Table 3: Annual antimicrobial acquisition cost savings**

Directorate	AMT cost per week	Antimicrobial cost saving per ward round per day	Estimated cost saving, assuming similar prescription changes would have been made by attending team after:		
			One day	3.5 days	7 days
Care of the elderly	£45	£12.5	-£1,700	-£80	£2,200
Medicine	£163	£139	-£1,200	£17,000	£42,000

antimicrobials were continued as per the doctor's own prescription. It may have been expected that stopping antimicrobials would shorten the length of stay in hospital, however many other factors are involved and this study was not powerful enough to demonstrate any significant effect. The impact of the AMT on antibiotic resistance was not assessed.

The doctors at SUHT respect and value the AMT and the clinical pharmacists and clinicians found the ward rounds to be a good forum for discussion and education. The AMT reinforces good antimicrobial prescribing practice and educates the junior staff in the appropriate use and delivery of antimicrobials.

## Limitations

Limitations of this study include:

- It was not possible to assess the initial impact of introducing the AMT in this study, since they had been in operation for 2.5 years.
- The costing analysis was worked out by extrapolation and the net saving to the trust was calculated from the assumption that the patients' own doctors would have made all the antimicrobial changes as made by the AMT by day 3.5. In our experience this is a reasonable estimate of the rate of change of antimicrobials if not prompted by the AMT.
- The cost saving in terms of prevention of hospital-acquired infection and prevention of antibiotic resistance is unquantifiable on the basis of this prospective non-comparative study.
- The assessment of the AMTs was a short period (three months).

This project was labour intensive because of the lack of informa-

tion systems allowing data retrieval. Computerised prescribing and computerised ward round feedback would facilitate future evaluations of the performance of the AMTs.

## Conclusion

This observational study has shown that antimicrobial management teams consisting of a consultant microbiologist and a senior directorate-based clinical pharmacist are interventional, educational and improve antimicrobial prescribing, as shown through current episode specific feedback. The AMT was estimated to have reduced the cost of antimicrobial prescribing and had no observed detrimental effect on patient care. A close working relationship between the clinical pharmacists and the microbiologist is essential to promote effective antimicrobial prescribing.

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