Tackling MRSA — let's put more focus on spread

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Over the past decade or so, a marked increase in the number of deaths attributed to methicillin-resistant *Staphylococcus aureus* infection has been reported in hospitals in England and Wales, whereas deaths attributed to unspecified *S aureus* have remained relatively constant.[1] A number of reasons have been offered to account for increased incidences of MRSA, including lack of attention to hygiene by staff, visitors bringing in infections, and poor cleanliness.

Many of the measures that have been put in place to reduce the incidences of MRSA infection focus on preventing its introduction into a hospital or ward. Examples include improving arrangements for cleaning hospitals and sterilising indwelling devices such as catheters, and providing hand rub for friends and relatives to use when visiting patients.

Infection spread

Although such measures clearly have a place in tackling the rates of MRSA infection, greater emphasis should be placed on preventing the spread of infection. Practices such as requiring staff to wash their hands between patients clearly help with this, but more attention should be given to concepts such as "herd immunity".

Herd immunity, or more accurately "herd susceptibility" is the concept used to justify the mass immunisation of the population in order to eradicate diseases such as smallpox and measles from Western countries.

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In simple terms, it means that if enough of the population are immunised (ie, not susceptible to infection), then a disease will die out.

Herd immunity provides a measure of the susceptibility of individuals to infection. Mathematically, the force of infection (λ) can be expressed as:

$$\lambda = \frac{N}{SPE \times ADE} \qquad (1)$$

where N is the number of new infections, SPE is the number of susceptible persons exposed and ADE is the average duration of exposure. From equation (1) it is apparent that the number of new infections is directly proportional to both the number of susceptible persons exposed to the infection and the duration of exposure to the infection.

Neither of these parameters is easily defined for a given disease in a population of individuals. However, when considering a rectangular population distribution within which there is homogeneous mixing, the force of infection can be calculated from:

$$\lambda = \frac{1}{A} \qquad (2)$$

where A is the average age at which the infection is contracted.

The second facet of herd immunity is that it considers the progress of an infection based on the "basic reproduction number" (R_o) — that is, the number of susceptible, non-immune individuals that will be infected by a single infected individual (ie, secondary infection) and the fraction of the population that is susceptible to the disease (S). Therefore:

$$R_o \times S = 1 \qquad (3)$$

When R_o is less than 1, the infection will die out. However, when R_o is greater than 1, the infection will spread, becoming epidemic and pandemic as R_o increases.

In a susceptible population, in which each individual has an identical life expectancy (L), then:

$$S = \frac{A}{L} \qquad (4)$$

Therefore:

$$R_o = \frac{L}{A} \qquad (5)$$

Where the susceptible population has an exponential age distribution with an average life expectancy (L_e), this relationship becomes:

$$R_o = \frac{1 + Le}{A} \qquad (6)$$

Substituting for A from equation (2) gives:

$$R_o = 1 + (Le \times \lambda) \qquad (7)$$

Thus the number of secondary infections is directly proportional to the force of infection and R_o will always be greater than 1.

Impact on MRSA

How therefore do we reduce R_o, S and λ in respect of MRSA? Immunisation might be an option in the future, with a vaccine currently under development.[2] Patients set to undergo surgery for chronic conditions such as hip operations might be particular targets for vaccination schemes.

Among other options to be considered might be one to improve the design of hospitals to reduce the movement of personnel as they carry out their jobs. Reducing the patient population density and lowering the rate of bed occupancy are also likely to help. For large hospitals trying to reduce waiting lists and achieve other Government targets, the latter options must seem clearly unattractive.

Community care

There is a move, however, towards providing more care in localised community settings — such as admissions units and a "hospital at home" service — facilitated by, for example, changes to the information technology infrastructure.[3] Reasons for this policy include those associated with resources and transport.[4] An additional benefit of such an approach would potentially be to reduce the size of the "pool" of infection and therefore the spread of MRSA.

References

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2. Vaccine Research International Plc. Developing a vaccine against infection by staphylococcal bacteria. Available at www.vri.org.uk (accessed 4 October 2006).
3. Department of Health. Our health, our care, our say: a new direction for community services (Cm6737). The Stationery Office: London; 2006.
4. Graham R. Future emphasis is on localising services. Hospital Pharmacist 2005;12:26.

Targeting MRSA

Reducing MRSA infection rates by 50 per cent by 2008, from their 2003/04 baseline levels, is among the Healthcare Commissions' targets for NHS trusts. See p350 for details about the latest progress.