

Guidelines for antibiotic usage in hospitals

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In this issue of the Journal van de Beek *et al.*¹ describe a prospective audit of compliance with national guidelines for the empirical therapy of adult patients with bacterial meningitis in The Netherlands. The consensus-based guidelines were developed by a multidisciplinary group of experts in bacterial meningitis. Patients were assigned to one of four categories: age 16–60 years, no risk factors; age >60 years, no risk factors; age >16 years with risk factors; age >16 years, recent neurosurgery. An antibiotic regimen was recommended for patients in each of the categories. The guidelines were disseminated in booklet form and the audit was begun 1 year after they were issued.

Overall, only 87 patients (33%) received treatment that was in accordance with the guidelines; the rates of compliance for patients in the four groups ranged from 16% to 49%. Reassuringly, although adoption of the guidelines was poor, 95% of patients were treated with antibiotics to which their pathogens were susceptible. In the case of the 87 patients whose treatment was in accordance with the guidelines, 98% of pathogens were susceptible.

Why did so few clinicians in The Netherlands adopt national guidelines for the treatment of adult patients with bacterial meningitis? Unfortunately, van de Beek *et al.*¹ have provided only a few clues to the explanation and have themselves offered only speculation. Could it have been the method used to develop the guidelines? We are given very little information about the development process. Indeed, all we are told is that the guidelines were consensus-based. However, it is not clear whether or not they were also evidence-based and, therefore, scientifically valid. Consequently, individual practitioners may have simply disagreed with the recommendations. For example, 50 (39%) of the 127 patients in the largest group (those 16–60 years of age with no risk factors), who were assigned to be given a penicillin as empirical therapy, actually received a regimen containing a third-generation cephalosporin. This may have been because their clinicians were concerned that they were infected with penicillin-resistant strains of either *Streptococcus pneumoniae* (even though the incidence of resistance to this antibiotic among pneumococci is only 1.8% in The Netherlands) or other less common bacterial pathogens. The observation that two of the

62 pathogens isolated from patients in this group whose clinicians were compliant with the guidelines were resistant to the recommended regimen, compared with none of the pathogens recovered from patients whose clinicians did not comply with the guidelines, might be seen as justification of these concerns. For this reason, as well as an innate mistrust of national guidelines, a large number of practitioners may have elected to follow their own locally developed antibiotic guidelines.

Alternatively, the explanation may lie in the way the guidelines were disseminated. In the present study, they were distributed in booklet form—a poor means of ensuring that information is read by clinicians without the introduction of one or more other effective measures. Finally, the majority of practitioners may not have adopted the guidelines because of the failure to introduce any interventions to promote their implementation. Any one, or more likely all, of these explanations may have resulted in two out of three clinicians in The Netherlands ignoring national guidelines for the empirical therapy of patients with bacterial meningitis. This study should represent a salutary lesson to those who may be devising clinical guidelines for antibiotic usage (or, indeed, for any other purpose) that if the intended users of the guidelines fail to implement them, their efforts will have been wasted. In the light of the results of this study, and evidence that they are far from unique, as well as a greater trend toward producing guidelines for antibiotic usage, both nationally and locally, in response to increasing concerns about antibiotic resistance, it is timely to review the principles underlying the guideline process.

Clinical guidelines are becoming increasingly popular as a means of influencing clinicians' practice. This is particularly true of guidelines for antibiotic usage. In a survey of consultant microbiologists and hospital pharmacists conducted by a working party of the British Society for Antimicrobial Chemotherapy in 1990, 62% of respondents indicated that antibiotic guidelines were available in their hospitals.² More recently, a 1998 survey of hospitals in the USA participating in Project ICARE (Intensive Care Antimicrobial Resistance Epidemiology) showed that 70% of these institutions had introduced clinical guidelines for antibiotic usage.³

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Clinical guidelines have been defined as ‘systematically developed statements to assist practitioner and patient decisions about appropriate health care for specific clinical circumstances’.⁴ They have several aims: to reduce variations in the methods and standards of care; to improve the appropriateness of care; to improve the quality of care; to reduce the costs of care; to improve the cost-effectiveness of care; in the case of antibiotic guidelines, to control, or even reduce, the levels of resistant organisms; to serve as educational tools; and to promote evidence-based decision making. At the very least, they can be regarded as a useful synthesis of current evidence or the consensus of a group of responsible and informed practitioners.

Despite the obvious theoretical benefits arising from the introduction of guidelines, guidelines themselves and the guideline process are fraught with numerous problems and limitations:

- No guideline can be sufficiently specific that it can apply to all clinical situations.
- There is a lack of robust scientific evidence to support many of the recommendations that comprise guidelines.
- Guidelines rarely address co-morbid conditions and concurrent therapy.
- Guidelines fail to take account of patient preferences.
- Until recently there has been little guidance on the methodology of guideline development.
- There is no agreement on the optimal methods of implementing guidelines.
- The costs of developing and implementing guidelines can be considerable.
- Some clinicians perceive that guidelines lead to a loss of autonomy and choice, thereby threatening their clinical freedom.
- Some surveys have raised concerns about the quality of many of the clinical guidelines developed by speciality societies on the grounds that they do not fulfil the basic principles of guideline development;^{5,6} the implementation of inappropriate recommendations may lead to inappropriate practices that might compromise patient care.
- There is uncertainty as to whether or not clinical guidelines affect changes in clinical practice and, hence, whether or not the current investment in guideline development is warranted. Some surveys have shown that guidelines have had a limited impact in terms of changing clinical behaviour.^{7–14} Conversely, others have demonstrated that guidelines both lead to improvements in clinical practice and achieve health gains when developed, disseminated and implemented appropriately and when introduced in the context of rigorous evaluation,^{15,16} although the magnitude of improvements in performance have varied widely from study to study.^{7,15}

Stages of the guideline process

The success of a guideline depends on many factors but, most importantly, the rigour and the commitment used in developing, disseminating, implementing and evaluating it.

Development

A detailed description of the methodology by which guidelines are created is outside the remit of this article. Readers, and particularly those contemplating the development of guidelines, are therefore strongly urged to consult the documents produced by guideline development groups such as SIGN¹⁷ and AGREE,¹⁸ as well as reviews by Thomson *et al.*¹⁹ and Kish.²⁰ However, the principal features of guideline development can be summarized as follows:

- The group preparing the guidelines must be multi-disciplinary and there must be a sufficient number of members (6–10) with expertise and experience in the subject of the guidelines in order to allow it to be adequately explored²⁰ and to ensure that the guidelines are credible. The group should comprise at least one individual with the skills necessary to conduct literature and systematic reviews.
- The group should determine whether or not evidence-based guidelines on the same topic already exist. If so, they can be adopted as they are or adapted to suit local circumstances.
- The guidelines must be based on a systematic review of the scientific evidence. In order to minimize the risk of bias, the literature should be identified according to an explicit search strategy, selected according to defined inclusion criteria and assessed against consistent methodological standards.²¹ The method by which the literature is obtained, along with the search terms and the period of the search, should be specified.
- As scientifically robust evidence is not always available, it is likely that most guidelines will be a hybrid of varying degrees of evidence and expert opinion. To ensure transparency of the recommendations that comprise the guidelines the recommendations should be graded according to the strength of the evidence supporting them. The grading system should be validated, with the grading based on an objective assessment of the study design and quality and of the consistency, clinical relevance and external validity of the evidence.²¹
- The guidelines should not be excessively long, i.e. no more than 20–25 pages.²⁰
- The guideline development group should identify evidence that is lacking and areas for further research.
- The development group should identify sample outcome measures that would form the basis for auditing both the process and outcome of the guidelines.
- The guidelines should be reviewed by respected peers who are not members of the guideline panel, but who are experts in the relevant field.²⁰
- Guidelines are not static. They should be reviewed at periodic intervals that should be specified (e.g. 2-yearly),²⁰ and updated to take account of advances in medical knowledge, changes in clinical practice and local circumstances, and the outcome of guideline evaluations. Any modifications to the guideline must be the result of the same rigour and commitment as the original recommendations.

Dissemination

One reason why guidelines are ineffective is that target clinicians are often not aware of their existence. Dissemination then is the process of bringing guidelines to the attention of their intended users with the aim of increasing awareness and influencing knowledge, attitudes and behaviour.²²

Dissemination can be achieved in a variety of ways: publication in journals; newsletters; local reports or documents; junior doctors' handbooks; configuration into a brief and portable format that is readily accessible to clinicians; posters on wards and in relevant departments; patient literature; group educational programmes; and personal visits. The optimal method has not been determined. Publication in medical journals, especially general medical journals, has, to date, been the most commonly used strategy, but is regarded as a poor means of disseminating guidelines with a low likelihood of implementation.²³ Direct mailing to relevant practitioners is seen as a more effective measure, but is still of limited efficacy, levels of awareness rarely increasing to >40%.^{7,24} The impact of this intervention can be enhanced by making the guidelines visually attractive and/or by staging their delivery in manageable 'chunks' of information.^{25,26} In general, however, the ability of passive methods such as written communications to achieve even a temporary change in behaviour is questionable. Grimshaw & Russell²³ claimed that the more overtly educational the dissemination strategy the greater the likelihood that guidelines will be adopted and the more lasting their impact, provided that dissemination is linked to an effective implementation strategy.

Implementation

Simply developing and disseminating guidelines, regardless of how well they are done, is of limited value in terms of affecting improvements in health care, unless the guidelines are implemented. Implementation is the process of ensuring that guidelines are introduced into clinical practice. Regrettably, the resources dedicated to developing guidelines have not been matched by those to promote compliance with them and, consequently, there is strong evidence that guidelines are often not adopted.^{7-9,11,12,14} Surveys have shown that compliance can vary from 20% to >90%,^{7,9,11,12,14} depending on the nature of the guideline, the specific clinical problem it is designed to address, the patient group being targeted, the mode of implementation and the definition of adherence.^{7,9,11,12,14,27} The most experienced practitioners may be the least likely to comply with guidelines.²⁷ Several groups of investigators have attempted to determine why rates of compliance with guidelines are so low. Cabana *et al.*²⁸ have identified the following barriers to implementation:

- Failure of dissemination strategies to effectively bring the guidelines to the attention of intended users.
- Lack of familiarity with guideline recommendations.
- Lack of agreement with one or more recommendations that comprise the guidelines or the concept of guidelines in general.
- Lack of self-efficacy (due to a lack of confidence in one's ability to perform a behaviour or a lack of preparation).
- Lack of outcome expectancy (i.e. the expectation that a given behaviour will lead to a particular consequence). If a clinician does not believe that implementation of a recommendation will lead to an improved outcome, it is unlikely that the recommendation will be adopted.
- Inability to overcome the inertia of previous views and practice or lack of motivation to change.
- External barriers, including guideline-related barriers (the perception that guidelines are inconvenient or difficult to use), patient-related barriers (an inability to reconcile patient preferences with guideline recommendations) and environment-related barriers (compliance with guidelines may require changes that are outside of clinicians' control, e.g. the need for new or additional resources or facilities such as personnel, equipment, drugs, etc.).

Others have suggested the following additional explanations for practitioners' failure to adhere to guidelines:

- Guidelines may not be written for practising clinicians, but merely represent a summary of the current state of knowledge;²² in other words, they lack scientific validity.²⁹⁻³¹
- Lack of representation of important stakeholders in the groups that develop guidelines;^{5,21,32,33} clinicians may disagree with or distrust guidelines written by national 'experts'.
- Clinicians may choose to ignore guidelines for non-clinical reasons such as financial incentives or fear of litigation.
- Guidelines may lack applicability to individual patients.^{15,34}
- Failure of local opinion leaders to endorse the guidelines.^{29,31,35}
- Inefficiencies of the healthcare system.^{34,36}

Guidelines should facilitate changes in practice, but if the changes are to be sustained, measures designed to promote implementation of guidelines must also change clinicians' knowledge, attitudes and beliefs.^{31,37} Active educational interventions, such as seminars that are devoted exclusively to the guidelines and where potential users are given the opportunity to discuss them (following direct mailings of the guidelines as a means of dissemination), are more likely to be effective than didactic lectures or simply including the guidelines as part of an educational programme.³⁸ However, education alone is insufficient to ensure compliance

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with clinical guidelines.³⁹ Other interventions that have been shown in at least some studies to promote adoption of guidelines and to lead to improvements in practice behaviour and clinical outcome include the following:

- Endorsement by local and national professional organizations.¹⁵
- Incorporation into routine practice by local 'opinion leaders'.^{19,33,40,41}
- Dissemination of guidelines by department heads.⁴²
- Audit of compliance with guidelines, with feedback of results to clinicians.^{8,19,23}
- Peer review.²³
- Printed patient-specific reminders at the time of consultations to prompt clinicians to use guidelines, e.g. by attaching the guidelines to clinical notes or by including them on desktop computers.^{39,43-47}
- General reminders of guidelines.^{18,22}
- Making guidelines available to practitioners when they are making clinical decisions. This process has been facilitated by computer-assisted decision support programmes such as that developed by Pestotnik *et al.*,⁴⁸ although the effects of these systems on patient outcomes have not yet been adequately assessed.⁴⁹
- Promoting 'ownership' of guidelines by involving potential users in their development; alternatively, local adaptation of national guidelines may be sufficient to convey a sense of ownership.
- Incorporation of guidelines into service contracts between purchasers and providers.
- 'Academic detailing', i.e. pre-arranged face-to-face discussions between a detailer (a trained educator such as a pharmacist) and a practitioner in the latter's office with the aim of persuading the practitioner to change behaviour through information and evidence.⁴¹ To date, this has been the most effective and most lasting method of promoting compliance⁵⁰⁻⁵³ and has the advantage of allowing those clinicians who most need to change their practices to be targeted. On the other hand, it is expensive and labour-intensive and concerns have been raised about whether or not it is effective outside the research setting.³³

Any one or a combination of measures improves compliance with guidelines to varying degrees. However, because most studies of the efficacies of interventions have involved multiple strategies, it has not been possible to discern from these studies the relative contribution of each measure. For this reason, and because many of the studies suffered from flaws in design and/or execution and because there have been very few comparative studies, efforts to identify the most effective intervention(s) have been frustrated. In general, multiple measures have proved more effective than single interventions, and a combination of strategies is therefore most likely to have the maximum impact on guideline implementation.

Evaluation

Evaluation is the assessment of the efficacy of the guidelines with the aim of ensuring that they have produced the intended changes in both practice and outcome. Audit is the most effective means of doing so, but it is essential to evaluate all of the components of the guideline process, not simply outcome, as they are inextricably linked. In other words, improvements in clinical outcome will not be achieved unless guidelines are received, read and adopted.

National versus local guidelines

Guidelines can be developed nationally or locally. Those developed locally (or internally) by the clinicians who will use them are less likely to be scientifically valid than those developed nationally by Royal Colleges and working parties of speciality societies^{54,55} because local groups lack the clinical, managerial and technical skills, as well as the time and financial resources, needed for the task.²³ Moreover, expertise at the local level is unlikely to be sufficiently broad and personal opinions may influence conclusions.⁵⁶ Locally produced guidelines must be no less robust than those produced nationally if patients are to receive optimal care. On the other hand, clinicians may disagree with or distrust guidelines written by remote national 'experts'. It has been claimed that '...medical practices are locally driven, and national guidelines simply do not reflect or determine the systems of care and patterns of practice in the individual hospitals. Experience has demonstrated that national guidelines are seldom studied thoroughly by physicians, and if they are read, they are rarely incorporated into everyday practice';⁵⁷ this view has also been expressed by others.^{7,15,32,58-60} Guidelines are more likely to be adopted if users have participated in their development.²³ Consequently, fewer resources are needed for effective dissemination and to promote implementation, compared with national guidelines for which greater emphasis must be placed on these phases of the process. A reasonable compromise would be to adapt national evidence-based guidelines (where such guidelines exist) for local use, a strategy that may be adequate to ensure clinicians' compliance.

References

1. van de Beek, D., de Gans, J., Spanjaard, L., Vermeulen, M. & Dankert, J. (2002). Antibiotic guidelines and antibiotic use in adult bacterial meningitis in The Netherlands. *Journal of Antimicrobial Chemotherapy* **49**, 661-6.
2. Working Party of the British Society for Antimicrobial Chemotherapy. (1994). Hospital antibiotic control measures in the UK. *Journal of Antimicrobial Chemotherapy* **34**, 21-42.
3. Lawton, R. M., Fridkin, S. K., Gaynes, R. P., McGowan, J. E. & the Intensive Care Antimicrobial Resistance Epidemiology (ICARE) Hospitals. (2000). Practices to improve antimicrobial use at 47 US hospitals: the status of the 1997 SHEA/IDSA position paper recommendations. *Infection Control and Hospital Epidemiology* **21**, 256-9.

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4. Institute of Medicine Committee to Advise the Public Health Service on Clinical Practice Guidelines. (1990). In *Clinical Practice Guidelines: Directions of a New Program* (Field, M. F. & Lohr, K. N., Eds), National Academy Press, Washington, DC.
5. Grilli, R., Magrini, N., Penna, A., Mura, G. & Liberati, A. (2000). Practice guidelines developed by specialty societies: the need for a critical appraisal. *Lancet* **355**, 103–6.
6. Mansfield, C. D. (1995). Attitudes and behaviours towards clinical guidelines: the clinicians' perspective. *Quality in Health Care* **4**, 250–5.
7. Lomas, J., Anderson, G. M., Domnick-Pierre, K., Vayda, E., Enkin, M. W. & Hannah, W. J. (1989). Do practice guidelines guide practice? The effect of a consensus statement on the practice of physicians. *New England Journal of Medicine* **321**, 1306–11.
8. Woolf, S. H. (1993). Practice guidelines: a new reality in medicine. III. Impact on patient care. *Archives of Internal Medicine* **153**, 2646–55.
9. Grilli, R. & Lomas, J. (1994). Evaluating the message: the relationship between adherence rate and the subject of a practice guideline. *Medical Care* **32**, 202–13.
10. Pearson, S., Goldman, L., Garcia, T., Cook, E. & Lee, T. (1994). Physician response to a prediction rule for triage of emergency department patients with chest pain. *Journal of General Internal Medicine* **9**, 241–7.
11. Davis, D. A., Thomson, M. A., Oxman, A. D. & Haynes, R. B. (1995). Changing physician performance. *Journal of the American Medical Association* **274**, 700–5.
12. Oxman, A. D., Thompson, M. A., Davis, D. A. & Haynes, R. B. (1995). No magic bullets: a systematic review of 102 trials of interventions to improve professional practice. *Canadian Medical Association Journal* **153**, 1423–31.
13. Hayward, R. S. (1997). Clinical practice guidelines on trial. *Canadian Medical Association Journal* **156**, 1725–7.
14. Worrall, G., Chaulk, P. & Freake, D. (1997). The effects of clinical practice guidelines on patient outcomes in primary care: a systematic review. *Canadian Medical Association Journal* **156**, 1705–12.
15. Grimshaw, J. M. & Russell, I. T. (1993). Effect of clinical guidelines on medical practice: a systematic review of rigorous evaluations. *Lancet* **342**, 1317–22.
16. Halm, E. A., Atlas, S. J., Borowsky, L. H., Benzer, T. I. & Singer, D. E. (1999). Change in physician knowledge and attitudes after implementation of a pneumonia practice guideline. *Journal of General Internal Medicine* **14**, 688–94.
17. Scottish Intercollegiate Guidelines Network. (2001). *SIGN 50: A Guideline Developers' Handbook*. SIGN, Edinburgh.
18. Appraisal of Guidelines Research and Evaluation in Europe (AGREE) Collaboration. (2000). Guideline development in Europe: an international comparison. *International Journal of Technology Assessment in Health Care* **16**, 1039–49.
19. Thomson, R., Lavender, M. & Madhok, R. (1995). How to ensure that guidelines are effective. *British Medical Journal* **311**, 237–42.
20. Kish, M. A. (2001). Guide to development of practice guidelines. *Clinical Infectious Diseases* **32**, 851–4.
21. Miller, J. & Petrie, J. (2000). Development of practice guidelines. *Lancet* **355**, 82–3.
22. Lomas, J. (1991). Words without action? The production, dissemination, and impact of consensus recommendations. *Annual Review of Public Health* **12**, 41–65.
23. Grimshaw, J. M. & Russell, I. T. (1994). Achieving health gain through clinical guidelines. II: Ensuring guidelines change medical practice. *Quality in Health Care* **3**, 45–52.
24. Jacoby, I. & Clark, S. M. (1986). Direct mailing as a means of disseminating NIH consensus statements. *Journal of the American Medical Association* **255**, 1328–30.
25. Avorn, J. & Soumerai, S. B. (1983). Improving drug-therapy decisions through educational outreach. A randomized controlled trial of academically based 'detailing'. *New England Journal of Medicine* **308**, 1457–63.
26. Evans, C. E., Haynes, R. B., Birkett, N. J., Gilbert, J. R., Taylor, D. W., Sackett, D. L. *et al.* (1986). Does a mailed continuing education program improve physician performance? Results of a randomized trial in antihypertensive care. *Journal of the American Medical Association* **255**, 501–4.
27. Halm, E. A., Atlas, S. J., Borowsky, L. H., Benzer, T. I., Metlay, J. P., Chang, Y. *et al.* (2000). Understanding physician adherence with a pneumonia practice guideline. *Archives of Internal Medicine* **160**, 98–104.
28. Cabana, M. D., Rand, C. S., Powe, N. R., Wu, A. W., Wilson, M. H., Abboud, P.-A. C. *et al.* (1999). Why don't physicians follow clinical practice guidelines? A framework for improvement. *Journal of the American Medical Association* **282**, 1458–65.
29. Hayward, R. S., Wilson, M. C., Tunis, S. R., Guyatt, G. H., Moore, K. A. & Bass, E. B. (1996). Practice guidelines: what are internists looking for? *Journal of General Internal Medicine* **11**, 176–8.
30. Cook, D. J., Greengold, N. L., Ellrodt, A. G. & Weingarten, S. R. (1997). The relation between systematic reviews and practice guidelines. *Annals of Internal Medicine* **127**, 210–6.
31. Hayward, R. S., Guyatt, G. H., Moore, K. A., McKibbon, A. & Carter, A. O. (1997). Canadian physicians' attitudes and preferences regarding practice guidelines. *Canadian Medical Association Journal* **156**, 1715–27.
32. Kosecoff, J., Kanouse, D. E., Rogers, W. H., McCloskey, L., Winslow, C. M. & Brook, R. H. (1987). Effects of the National Institutes of Health consensus development program on physician practice. *Journal of the American Medical Association* **258**, 2708–13.
33. Greco, P. J. & Eisenberg, J. M. (1993). Changing physicians' practices. *New England Journal of Medicine* **329**, 1271–4.
34. Weingarten, S. (1997). Practice guidelines and prediction rules should be subject to careful clinical testing. *Journal of the American Medical Association* **277**, 1977–8.
35. Lee, T. H. & Cooper, H. L. (1997). Translating good advice into better practice. *Journal of the American Medical Association* **278**, 2108–9.
36. Ellrodt, A. G., Conner, L., Riedinger, M. & Weingarten, S. R. (1995). Measuring and improving physician adherence with clinical practice guidelines: a controlled interventional trial. *Annals of Internal Medicine* **122**, 277–82.
37. Tunis, S. R., Hayward, R. S., Wilson, M. C., Rubin, H. R., Bass, E. B., Johnston, M. *et al.* (1994). Internists' attitudes about clinical practice guidelines. *Annals of Internal Medicine* **120**, 956–63.

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- 38.** Onion, C. W. & Bartzokas, C. A. (1998). Changing attitudes to infection management in primary care: a control trial of active versus passive guideline implementation strategies. *Family Practice* **15**, 99–104.
- 39.** Headrick, L. A., Speroff, T., Pelecanos, H. I. & Cebul, R. D. (1992). Efforts to improve compliance with the National Cholesterol Education Program guidelines: results of a randomized controlled trial. *Archives of Internal Medicine* **152**, 2490–6.
- 40.** Lomas, J., Enkin, M., Anderson, G. M., Hannah, W. J., Vayda, E. & Singer, J. (1991). Opinion leaders vs audit and feedback to implement practice guidelines: delivery after previous cesarean section. *Journal of the American Medical Association* **265**, 2202–7.
- 41.** Soumerai, S. B. & Avorn, J. (1990). Principles of educational outreach ('academic detailing') to improve clinical decision making. *Journal of the American Medical Association* **263**, 549–56.
- 42.** Everitt, D. E., Soumerai, S. B., Avorn, J., Klapholz, H. & Wessels, M. (1990). Changing surgical antimicrobial prophylaxis practices through education targeted at senior department leaders. *Infection Control and Hospital Epidemiology* **11**, 578–83.
- 43.** Cohen, D. I., Littenberg, B., Wetzell, C. & Neuhauser, D. B. (1982). Improving physician compliance with preventive medicine guidelines. *Medical Care* **20**, 1040–5.
- 44.** Brownbridge, G., Evans, A., Fitter, M. & Platts, M. (1986). An interactive computerised protocol for the management of hypertension: effects on general practitioners' clinical behaviour. *Journal of the Royal College of General Practitioners* **36**, 198–202.
- 45.** Packer, G. J., Goring, C. C., Gayner, A. D. & Craxford, A. D. (1991). Audit of ankle injuries in an accident and emergency department. *British Medical Journal* **302**, 885–7.
- 46.** Cowan, J. A., Heckerling, P. S. & Parker, J. B. (1992). Effect of a fact sheet reminder on performance of the periodic health examination: a randomized controlled trial. *American Journal of Preventive Medicine* **8**, 104–9.
- 47.** Lilford, R. J., Kelly, M., Baines, A., Cameron, S., Cave, M., Guthrie, K. *et al.* (1992). Effect of using protocols on medical care: randomised trial of three methods of taking an antenatal history. *British Medical Journal* **305**, 1181–4.
- 48.** Pestotnik, S. L., Classen, D. C., Evans, R. S. & Burke, J. P. (1996). Implementing antibiotic practice guidelines through computer-assisted decision support: clinical and financial outcomes. *Annals of Internal Medicine* **124**, 884–90.
- 49.** Hunt, D. L., Haynes, B., Hanna, S. E. & Smith, K. (1998). Effects of computer-based clinical decision support systems on physician performance and patient outcomes. *Journal of the American Medical Association* **280**, 1339–46.
- 50.** Avorn, J. & Soumerai, S. B. (1983). A new approach to reducing suboptimal drug use. *Journal of the American Medical Association* **250**, 1752–3.
- 51.** Schaffner, W., Ray, W. A., Federspiel, C. F. & Miller, W. O. (1983). Improving antibiotic prescribing in office practice: a controlled trial of three educational methods. *Journal of the American Medical Association* **250**, 1728–32.
- 52.** Ray, W. A., Schaffner, W. & Federspiel, C. F. (1985). Persistence of improvement in antibiotic prescribing in office practice. *Journal of the American Medical Association* **253**, 1774–6.
- 53.** Ray, W. A., Blazer, D. G., II, Schaffner, W., Federspiel, C. F. & Fink, R. (1986). Reducing long-term diazepam prescribing in office practice: a controlled trial of educational visits. *Journal of the American Medical Association* **256**, 2536–9.
- 54.** Brook, R. H. (1989). Practice guidelines and practicing medicine. Are they compatible? *Journal of the American Medical Association* **262**, 3027–30.
- 55.** Grimshaw, J. M. & Russell, I. T. (1993). Achieving health gain through clinical guidelines. I: Developing scientifically valid guidelines. *Quality in Health Care* **2**, 243–8.
- 56.** Varonen, H. & Makela, M. (1997). Practice guidelines in Finland: availability and quality. *Quality in Health Care* **6**, 75–9.
- 57.** Goldmann, D. A., Weinstein, R. A., Wenzel, R. P., Tablan, O. C., Duma, R. J., Gaynes, R. P. *et al.* (1996). Strategies to prevent and control the emergence and spread of antimicrobial-resistant microorganisms in hospitals. A challenge to hospital leadership. *Journal of the American Medical Association* **275**, 234–40.
- 58.** Haines, A. & Feder, G. (1992). Guidance on guidelines. *British Medical Journal* **305**, 785–6.
- 59.** McGowan, J. E., Jr. (1994). Do intensive hospital antibiotic control programs prevent the spread of antibiotic resistance? *Infection Control and Hospital Epidemiology* **15**, 478–83.
- 60.** Jarvis, W. (1996). Preventing the emergence of multidrug-resistant microorganisms through antimicrobial use controls: the complexity of the problem. *Infection Control and Hospital Epidemiology* **17**, 490–5.