Antimicrobial streamlining is the practice of converting a broad-spectrum empirical regimen to therapy with either a single, narrow-spectrum parenteral agent or an oral agent as soon as possible. This practice results in many benefits for the patient and the hospital. When intravenous catheters can be removed early, the frequencies of catheter-associated bacteremias and phlebitis are reduced, thus making it possible to avoid incurring major costs. With the availability of newer oral agents with favorable pharmacokinetic, pharmacodynamic, and microbiological profiles, such as the fluoroquinolones, the macrolides/azalides, and the cephalosporins, the clinician has greater opportunity to employ streamlining tactics. The patient who is hospitalized with a lower respiratory tract infection (LRTI) often requires empirical antimicrobial therapy before the pathogen is identified. By day 3 of the hospital course, the pathogen is often known, the patient's condition may have stabilized, or both events may have occurred. At this point, streamlining is possible. At present, data suggest that rapid conversion from intravenous to oral antimicrobial therapy is safe and efficacious and should be considered for appropriate patients requiring hospitalization for LRTIs.

The term antimicrobial streamlining was coined in the mid-1980s to describe the practice of switching from a broad-spectrum antimicrobial regimen to a single agent with a narrower spectrum of activity [1]. Streamlining can involve the switch from a broad-spectrum parenteral agent or combination of agents either to a single, narrow-spectrum parenteral agent or to an oral agent; this approach is also called "transitional," "sequential," "step-down," or "switch" therapy [2]. Physicians have traditionally hesitated to make such changes in therapeutic agents because they generally believe that oral agents are less effective than their parenteral alternative in hospitalized patients with serious infections.

The recent development of potent, broad-spectrum oral antimicrobials (e.g., cephalosporins, macrolides/azalides, fluoroquinolones) has expanded the treatment options for streamlining. We discuss here the rationale and strategies for effective antimicrobial streamlining for patients with lower respiratory tract infections (LRTIs). The primary aims of streamlining are to balance efficacy, cost, and the patient's comfort.

Initial Management of LRTIs in Hospitalized Patients

The decision to hospitalize a patient with an LRTI requires careful consideration by the clinician. In the current climate of cost-containment, the decision to hospitalize is often foregone in favor of outpatient management of an initial episode of a community-acquired LRTI in an otherwise healthy adult.

Currently, the presence of one or more of the following risk factors has been associated with a more complicated course and is considered a criterion for hospital admission: (1) age of >65 years; (2) presence of a comorbidity (e.g., congestive heart failure, chronic obstructive lung disease, diabetes mellitus, or coronary artery disease); (3) pleuritic chest pain (e.g., pain on inspiration); (4) vital-sign abnormality (e.g., systolic blood pressure of <90 mm Hg, pulse rate of >140/min, or respiratory rate of >30/min); (5) alteration in mental status (e.g., lethargy, stupor, coma, or disorientation to person, place, or time); (6) arterial hypoxemia (e.g., oxygen tension <60 mm Hg on room air); (7) high-risk etiology (e.g., staphylococcal, gram-negative rod, aspiration, or postobstructive pneumonia); and (8) neoplastic disease or any acute coexistent medical condition requiring hospitalization (e.g., suspected acute myocardial infarction) [3, 4].

Hospitalized patients with serious LRTIs generally receive empirical, broad-spectrum, antimicrobial therapy at first because the responsible pathogen cannot be precisely identified, and a delay in treatment could increase morbidity and mortality [5]. Diagnostic criteria for LRTI that may prompt initiation of empirical therapy include sudden onset of fever, accompanied by a cough productive of purulent sputum, and signs of pulmonary consolidation, including dullness to percussion, egophony, and rales. These physical findings may be accompanied by radiographic evidence of an infection (e.g., infiltrates or consolidation) on a chest radiograph, although it should be noted that radiographic findings are not always diagnostic.

A final element of the diagnostic workup for an LRTI may also include a sputum gram stain. In community-acquired pneumonia, the problem is not isolating an organism from sputum or bronchial secretions; rather, it is determining which one of the isolated organisms, if any, is responsible for the infection. Since many healthy individuals are colonized with Haemophilus influenzae and Streptococcus pneumoniae, and since these bacteria may not grow unless the sputum is cultured promptly on the appropriate medium, the clinical relevance of the pres-
ence or absence of these bacteria from a sputum culture becomes difficult, if not impossible, to determine.

Although these data are difficult to interpret, it still remains helpful to perform a gram stain on a properly collected sputum specimen, since the stain may allow the quantification of the number of polymorphonuclear cells and the predominant organism [6–8]. Unfortunately, gram stains of sputum are often done poorly or not at all. Except for organisms that are not normal inhabitants of the oropharynx (e.g., *Pneumocystis carinii*), a definitive diagnosis of pneumonia cannot be made unless one isolates an organism from a body site (e.g., blood, pleural fluid, or lung tissue) that is normally totally devoid of microorganisms.

As a consequence of the unreliability of sputum cultures and the problems with gram stains, initial antibiotic therapy for community-acquired pneumonia is usually empirical, focusing on the usual suspected bacterial pathogens (e.g., *H. influenzae, Moraxella catarrhalis*, and *S. pneumoniae*) or the “atypical” intracellular organisms (e.g., *Chlamydia pneumoniae, Mycoplasma pneumoniae*, and *Legionella* species) or both. The selection of an effective empirical antimicrobial regimen depends upon many factors, including the severity of symptoms, clinical laboratory findings, radiographic evidence of infection, and the presence of comorbid conditions, such as HIV infection, neutropenia, diabetes mellitus, chronic steroid use, or chronic lung disease. The source of the infectious agent (community-acquired vs. nosocomial) is also important.

For most community-acquired LRTIs requiring hospitalization, the recommended empirical regimens consist of a second- or third-generation cephalosporin, such as cefuroxime, cefotaxime, cefixime, or ceftriaxone, or a penicillin/β-lactamase inhibitor such as ampicillin/sulbactam, with or without erythromycin [6]. These regimens are generally efficacious against the pathogens most commonly responsible for community-acquired LRTIs. These organisms include *S. pneumoniae, H. influenzae*, *M. catarrhalis*, or atypical organisms such as *Legionella* species, *C. pneumoniae*, and *M. pneumoniae* [9, 10]. If *Pseudomonas aeruginosa* is suspected—which is unusual in community-acquired infections, except in those affecting patients with AIDS—ceftazidime or piperacillin is used in combination with an aminoglycoside, such as gentamicin or tobramycin, or a fluoroquinolone such as ciprofloxacin or ofloxacin.

The empirical treatment of LRTIs of nosocomial origin differs significantly from that of community-acquired infections because many other pathogens may be involved in nosocomial infections, including *P. aeruginosa, Staphylococcus aureus*, and common and uncommon Enterobacteriaceae species. The patient’s defenses against infection may also be compromised by the condition that led to hospitalization. It makes sense to divide nosocomial lung infections into two separate treatment groups: one including patients in whom infection with *P. aeruginosa* is not a concern and a second including patients in whom infection with *P. aeruginosa* is highly suspected or proven.

Monotherapy with a carbapenem (e.g., meropenem or imipenem/cilastatin), a third-generation cephalosporin (e.g., cefotaxime, ceftriaxone, or cefixime), an extended-spectrum penicillin with or without a β-lactamase inhibitor (e.g., piperacillin, ticarcillin, piperacillin/tazobactam, or ticarcillin/clavulanate), or a fluoroquinolone (e.g., ofloxacin, ciprofloxacin) is adequate in the first group [8], while dual-agent therapy is indicated in the second group.

Dual-agent therapy usually combines a carbapenem, such as meropenem or imipenem/cilastatin, an antipseudomonal penicillin, such as piperacillin or ticarcillin, or a third-generation cephalosporin with antipseudomonal activity, such as ceftazidime, with an aminoglycoside or fluoroquinolone. In patients with serious pneumonia of pseudomonal origin, monotherapy with fluoroquinolones, such as ofloxacin and ciprofloxacin, or a carbapenem, such as imipenem/cilastatin, has been associated with a high incidence of clinical failures and the emergence of resistance [11, 12].

The use of meropenem monotherapy in the treatment of nosocomial LRTIs has not been associated with the emergence of resistance or an increased incidence of clinical failures in two clinical trials involving over 300 patients [13, 14]. However, if a fluoroquinolone or carbapenem is selected when a *Pseudomonas* species is a possible pathogen, it is prudent to combine it with another drug, such as piperacillin or ceftazidime, or an aminoglycoside, respectively.

### Antimicrobial Streamlining: Principles

Antimicrobial streamlining is an appropriate approach to managing the care of the patient with a serious infection who has passed the acute phase of illness. A dramatic improvement in the patient’s condition is often observed in the 24- to 48-hour period after the initiation of intravenous antimicrobial therapy. At this time, a rapid transition to an oral agent may be considered. This switch can often be made as early as day 2 to day 4 of hospitalization [15, 16].

Patients who have the ability to receive oral medication, as well as to absorb the drug following administration, should be considered for streamlining. Even patients with nasogastric tubes can be given oral antimicrobials either as crushed tablets or as a suspension formulation, if available. The time at which the patient is switched to oral antimicrobial therapy will vary, depending on patient-specific factors, and the suggestions here are intended as general points to consider with regard to streamlining.

Selection of an efficacious antimicrobial agent requires consideration of the agent’s pharmacodynamic profile. For example, the aminoglycosides and fluoroquinolones demonstrate concentration-dependent bactericidal activity. It is necessary, therefore, to maximize the ratio of the peak concentration to the MIC [17–19]. β-lactam drugs exhibit concentration-independent activity and are most effective when their concentrations are maintained above the MIC for 60%–70% of the
dosing interval for community-acquired organisms and for 100\% of the dosing interval for nosocomial pathogens [17, 20]. The bactericidal effect of the \( \beta \)-lactam drugs is not dependent on the ratio of peak concentration to MIC for an organism [21]. Examples of agents appropriate for community-acquired LRTIs are second- and third-generation cephalosporins such as cefuroxime, cefotaxime, ceftizoxime, and ceftriaxone. Some agents that can be considered for therapy for nosocomial LRTIs are imipenem, meropenem, cefazidime, cefotaxime, ceftizoxime, ceftriaxone, ampicillin/sulbactam, and piperacillin/tazobactam.

The primary difference between an antimicrobial administered parenterally and orally is the time needed for dissolution and absorption following oral administration. The issue of reduced bioavailability with oral agents can be overcome by administering a dose that will result in adequate concentrations at the site of infection. For example, the intravenous dose of ciprofloxacin is 400 mg, while the corresponding oral dose is 500 mg; the higher oral dose compensates for the reduced bioavailability of the oral formulation. Antimicrobials will exert the same activity in the body regardless of how they are administered, provided that they are administered in a pharmacodynamically logical manner.

**Antimicrobial Streamlining and Cost-Containment**

Antimicrobial streamlining facilitates cost-containment in a number of ways. First, streamlining to oral antimicrobials reduces drug-administration costs and acquisition costs during hospitalization. Second, early substitution of oral for parenteral antimicrobials reduces the number of adverse events that are of nosocomial origin, such as catheter-related infections, pulmonary embolism, deep-vein thrombosis, and phlebitis. Third, the switch to oral antimicrobials may allow expedited discharge, reducing total hospital costs.

A major benefit of the streamlining of antimicrobial therapy is the potential for lowering costs. In addition to a reduction in drug-acquisition costs, savings in pharmacy, nursing, and intravenous technician time can be realized by switching to oral antimicrobials. Time savings may be translated into position reductions, overtime reduction, avoidance of hiring unnecessary employees, and the availability of more time to perform other necessary patient care tasks.

Supply costs, including those for catheters and administration tubing sets, are also reduced. The expense of additional laboratory tests associated with extended administration of some parenteral antimicrobial agents, such as determining antimicrobial serum concentrations, can be avoided. The current standard of practice requires the replacement of intravenous tubing sets and catheters every 72 hours; therefore, cost savings can be realized if the transition to oral therapy is made on or before day 3 of parenteral therapy. This is true even if antimicrobials are administered by an intravenous push or “bolus” technique, as this rarely involves direct venipuncture and an indwelling catheter must be placed for drug administration. The drugs are more concentrated with use of this method of administration, which increases the risk of venous irritation, phlebitis, and catheter failure.

The major cost savings from antimicrobial streamlining center around the avoidance of catheter-related infections and earlier hospital discharge. More than 20 million vascular catheters are inserted annually in patients admitted to hospitals in the United States. More than 50,000 episodes of line sepsis occur annually [22], and management of a single episode of catheter-related sepsis can cost $4,000—$6,000 [23]. In addition, a direct correlation has been found between the occurrence of catheter-related bacteremias and the duration of intravenous catheter placement [24].

At Hartford Hospital (Hartford, CT), a 900-bed teaching hospital, 662 cases of bacteremia were reported by the section of epidemiology between 1986 and 1988. Of these, 277 (42\%) were caused by staphylococci: 173 (26\%) by \( \textit{S. aureus} \) and 104 (16\%) by \( \textit{Staphylococcus epidermidis} \). Of the 277 cases, 105 (38\%) were attributed to organisms isolated directly from both catheter tip and blood. The cost of treatment for these staphylococcal infections was estimated to range from $420,000 to $630,000 over the 3-year period [2]. These estimates of costs of care for catheter-related infections further strengthen the rationale for early conversion to oral antimicrobial therapy whenever possible.

The early transition to oral therapy can lead to more rapid hospital discharge. For example, Ehrenkranz and colleagues [15] reported that the recommendation of streamlining to physicians could reduce patients’ length of stay in the hospital. In this study, physicians at three nonteaching, general medical/surgical hospitals were randomized to receive a suggestion to switch patients to oral antimicrobial therapy or to receive no special instruction for a 9- to 12-month period. Interventions were made by a nurse working closely with an infectious disease physician.

Physicians of medically stable patients with pneumonia or in whom the new appearance of purulent sputum had been noted and who were receiving a minimum of 3 days of parenteral antimicrobial therapy were approached. A total of 82 cases supervised by 47 physicians were included in the study; in 53 (65\%) of these cases an intervention was made. In 42 (79\%) of the cases in which interventions were made, the physicians withdraw parenteral antimicrobials within 48 hours of contact. Patients of physicians who received interventions and ordered a switch from parenteral to oral antimicrobial therapy had their hospital stay reduced by 2.4 days, as compared with that of patients of physicians who did not receive intervention.

Similarly, Weingarten and co-workers [25] found a potential reduction in hospital stay associated with the switch to oral antimicrobials in a retrospective review of 503 pneumonia cases. The investigators determined that in 166 (33\%) of 503 cases, patients were at “low risk” of developing complications and were therefore candidates for a switch to oral antimicrobial...
therapy on day 3. It was estimated that if these patients had been switched to oral therapy, they could have been discharged on day 4 of hospitalization, reducing length of stay by 50%.

Paladino and associates [16] reported success with a streamlining program. One-hundred five patients with “serious infections” (including 27 with LRTIs) who were expected to require a minimum of 8 days of therapy were evaluated. Fifty-two of these patients were randomly assigned to switch to an oral regimen after 72 hours of parenteral therapy, while the control group continued their initial parenteral regimen. Although there was no statistically significant difference in mean length of stay between the two groups, several patients were discharged early because of initiation of the oral regimen, and drug-associated costs were reduced by $293 per patient.

Ramirez and colleagues [26] demonstrated a reduction in length of stay for 75 of 120 patients with community-acquired pneumonia who were enrolled in a “switch therapy” program. The mean length of stay decreased from 6 days for historical controls to 4 days for study patients, saving 148 days of hospitalization.

Hendrickson and North [27] reported similar results in a study in which 20 patients with either community-acquired pneumonia (16 of 20) or a complicated urinary tract infection (4 of 20) initially received ceftriaxone (1 g daily) and were switched to oral therapy with cefpodoxime proxetil (200 mg twice daily) when clinically stabilized. A mean reduction in length of stay of 2.5 days for those patients with pneumonia was achieved, and a cost savings of $46 (including costs for drug acquisition, pharmacy preparation and delivery, and nursing administration, as well as auxiliary costs) was realized per patient switched to oral therapy, when compared with figures pertaining to 20 patients in a matched control group who received no pharmacy intervention and continued with parenteral therapy.

It has been estimated that reduction of the length of stay resulting from streamlining antimicrobial therapy saves between $884 and $1,291 in hospital bed and drug costs per patient [15, 16, 26]. In these early switch-therapy studies, patients were monitored for 30 days post-discharge, and there were no reports of relapse or worsening of clinical conditions [16, 26, 27].

In community-acquired LRTIs, the causative organisms are identified in only 40%-50% of cases, while the causative pathogens are more frequently identified in nosocomial LRTIs [6, 10, 26]. Even when a specific pathogen cannot be identified, the conversion to oral therapy can be made simply by selection of an oral regimen with a spectrum of activity identical to that of the empirical parenteral regimen; several studies have shown that this course can be successful [15, 16, 26-28].

Selecting an Oral Antimicrobial for Streamlining

Many oral antimicrobial agents may be used alone or in combination in streamlining. Some older oral agents, including aminopenicillins (amoxicillin and amoxicillin/clavulanate), first-generation cephalosporins (cephalexin, cefadroxil, and cephradine), trimethoprim-sulfamethoxazole, clindamycin, and metronidazole, are rapidly and nearly completely absorbed to produce clinically adequate serum levels. Some newer second- and third-generation cephalosporins (cefuroxime axetil, cefixime, and cefpodoxime proxetil) are less bioavailable than the older agents, but their extended half-lives permit less frequent dosing [29, 30].

The use of oral β-lactam drugs is accompanied by some potential pitfalls, including a delay in the time to peak concentration; the use of lower doses (e.g., for cefuroxime, 1.5 g every 8 hours parenterally vs. 500 mg every 6 hours orally), with resultant lower peak concentrations (124 mg/L and 3.6 mg/L, respectively); and the possibility of gastrointestinal intolerance of higher doses of these agents, including nausea and diarrhea. The fluoroquinolones (ciprofloxacin and ofloxacin), macrolides (clarithromycin), and azalides (azithromycin), which have become available in the last decade, have also demonstrated significant efficacy in the treatment of LRTIs.

Third-generation oral cephalosporins are beginning to play a significant role in antimicrobial streamlining regimens. Cefixime (200 mg twice daily) and cefpodoxime proxetil (200 mg twice daily) have optimal pharmacodynamics for this use, since their serum concentrations exceed the MIC90 for many common pathogens seen in community-acquired LRTIs, including S. pneumoniae, M. catarrhalis, H. influenzae, and Klebsiella species. These agents exceed the time above the MIC90 achieved with intravenous cefuroxime and equal that of intravenous cefotaxime [28]. It should be noted here that if S. aureus is a known or highly suspected pathogen, these agents, most notably cefixime, have very poor activity against it and should not be considered an option for therapy [29, 31].

Ramirez and colleagues [26] reported a 99% cure rate in a study in which an oral third-generation cephalosporin was used for early streamlining in 75 hospitalized patients with community-acquired pneumonia. Initial parenteral therapy was with either cefixime (1 g every 12 hours) or ceftriaxone (1 g every 24 hours). Patients were switched to oral cefixime (400 mg once daily) when clinical improvement was apparent (usually by day 3), observed for 24 hours, and then discharged if stable. As previously discussed, Hendrickson and North reported similar results when cefpodoxime proxetil was used as the oral component of a streamlining program [27].

The newer macrolides also have a place in the management of community-acquired LRTIs. Although their bioavailabilities are relatively low (40% and 50%, respectively, for azithromycin and clarithromycin), both agents demonstrate exceptional ability to concentrate in pulmonary tissues [32, 33]. While azithromycin has a higher penetration ratio in alveolar macrophages, there is no difference in the actual concentrations of both drugs in that tissue. The higher penetration ratio of azithromycin is caused by its lower serum concentrations [34]. The efficacy of azithromycin has been demonstrated to be equal to that of more traditional oral
agents (amoxicillin, cefaclor, and erythromycin) in multiple trials [35–38]. The long half life (>60 hours) of azithromycin allows once-daily dosing over 5 days. This regimen is likely to increase compliance with therapy after discharge.

Clarithromycin has also been shown to be equal in efficacy to azithromycin and to several traditional agents (ampicillin and erythromycin) in the management of LRTIs [39–42]. In addition, clarithromycin exhibits high serum and tissue concentrations against organisms associated with community-acquired LRTIs. Although the incidence of Legionella species in community-acquired pneumonia is relatively low (1%–5% of cases) [43], the role of the new macrolides in the management of these infections should not be overlooked. There are several in vitro models demonstrating efficacy of both azithromycin and clarithromycin against Legionella species and some limited clinical data supporting the use of clarithromycin in the treatment of this infection [44–47].

When compared to erythromycin and clarithromycin, azithromycin is slightly less active against Legionella species (MIC50 values: 1.15 mg/L, 0.25 mg/L, and 2 mg/L, respectively) [48]. These agents have had a tremendous impact on the management of pneumonia and chronic bronchitis in the outpatient setting and could also prove useful for streamlining therapy for patients requiring hospitalization.

The oral fluoroquinolones have a significant role in streamlining because of their expanded gram-negative spectrum and excellent bioavailabilities (~70% and 100%, respectively, for ciprofloxacin and ofloxacin). Ofloxacin offers greater gram-positive bacterial and chlamydial activity than ciprofloxacin, as well as freedom from significant interaction with xanthines (e.g., theophylline, theobromide, and caffeine), while ciprofloxacin exhibits significantly more intense microbiological activity against P. aeruginosa and most gram-negative bacteria than ofloxacin. Both agents have shown activity against Legionella pneumophila strains and may play a role in managing such suspected infections [47, 49].

In lung infections caused by Pseudomonas species when step-down therapy is appropriate, clinically stable patients who can receive oral antimicrobials should probably be given ciprofloxacin because its area under the plasma concentration curve above the MIC for P. aeruginosa far exceeds that of oral ofloxacin [50, 51]. It is emphasized, however, that neither ciprofloxacin nor ofloxacin has sufficient activity against Pseudomonas species to make them adequate single agents in the initial treatment of pseudomonal lung infections.

Initially, fluoroquinolones are usually combined with a second drug (e.g., piperacillin or ceftazidime), making the difference in antipseudomonal activity of the fluoroquinolones unimportant [52]. Only for the clinically stable patient who has received an adequate course of parenteral therapy and whose host-defense mechanisms are intact can a single oral fluoroquinolone be successful for completion of therapy.

Paladino and colleagues [16] found equal efficacy for 52 patients with serious infections who were switched to oral ciprofloxacin on day 3 of hospitalization and 53 control subjects whose empirical parenteral regimens were maintained. Hirata-Dulas and co-workers [53] found equal efficacy in streamlining therapy with use of intravenous-to-oral ciprofloxacin vs. intravenous-to-intramuscular ceftriaxone for nursing home–acquired LRTIs in 50 patients.

Gentry and associates [54] reported a 70% success rate among 100 patients with nosocomial or community-acquired pneumonia treated with intravenous ofloxacin and then oral ofloxacin. Sanders and colleagues [55] found that hospitalized patients with pneumonia responded very well to oral ofloxacin: 56 of 69 evaluable patients were microbiologically cured (intent-to-treat group, 56 of 75) with an exclusively oral ofloxacin regimen, whereas 44 of 64 evaluable patients in an empirical-therapy control group were microbiologically cured (intent-to-treat group, 44 of 72).

The results of an Austrian prospective, comparative study of ofloxacin vs. doxycycline or amoxicillin/clavulanate for patients with LRTIs demonstrated comparable clinical and microbiological cure rates between the groups. A total of 101 patients received intravenous ofloxacin (for 3–4 days) and then oral ofloxacin (for 4–7 days) and were compared with 60 patients receiving either intravenous doxycycline followed by oral doxycycline or intravenous amoxicillin/clavulanate followed by oral amoxicillin/clavulanate [56].

Although oral antimicrobials would be preferred for the reasons stated previously, certain patient populations with gastrointestinal abnormalities (e.g., diabetic or HIV-related enteropathy or short-bowel syndrome) may not be candidates for the oral route of administration. In these cases streamlining from a broad-spectrum combination of parenteral agents to monotherapy with a narrow-spectrum parenteral agent may be appropriate (e.g., cefazolin for gram-positive infections or ceftizoxime for nonpseudomonal gram-negative infections).

For example, a study conducted at Hartford Hospital over a 7-month period during the implementation of our streamlining program demonstrated that of 625 patients receiving combination therapy, 340 (54.4%) could be switched to a single agent. Recommendations for this change were made and implemented in 281 patients (82.6%), resulting in a cost savings of $39,000 for the hospital [57]. In some more complicated cases, patients may require continuation of parenteral antimicrobial therapy on an outpatient basis, in which case home iv therapy is an option for treatment. Appropriate parenteral agents usually include aminoglycosides, penicillins, cephalosporins, and carbapenems. Of the carbapenems, meropenem has been shown to be well tolerated when administered as either infusions or rapid “bolus” injections [58].

A final consideration regarding oral antimicrobial therapy is the potential for drug-drug or drug-food interactions. In the case of fluoroquinolones, where chelation with polyvalent cations could reduce absorption, the patient and/or primary caregiver can be provided with explicit instructions about not consuming antacids, sucralfate, dairy products, multivitamins, or...
iron supplements at least 2 hours before or following the administration of the antimicrobial. The administration of the β-lactam drugs with food may increase or decrease bioavailability (e.g., cefoxime axetil and loracarbef, respectively), and the patient should be counseled about the administration of these antimicrobials around meal time [29]. As a final note, the likelihood that higher doses of cephalosporins will produce nausea may be reduced if these agents are given with food.

Antimicrobial Streamlining: Benefits for Patients

Oral therapy also allows increased mobility for the patient, thus reducing the overall occurrence of adverse events such as deep-vein thrombosis and pulmonary embolism. The patient also benefits from the early switch to oral therapy because this permits earlier removal of a painful catheter, earlier mobility, and an earlier return to usual activity. Although direct benefits to the patient resulting from streamlining antimicrobial therapy are difficult to quantify, the ability to return to the familiar surroundings of his or her home environment earlier can have a positive impact on the patient’s quality of life.

Some factors that can contribute to improved quality of life include restoration of autonomy and mobility. While hospitalized, patients surrender a component of control over what happens to them, and having an intravenous catheter in place can anchor the patient to the bed during medication administration. Earlier discharge from the hospital after switching to an oral antimicrobial agent enables the patient to participate more fully in his or her own health care.

Conclusions

Although the practice of early streamlining of antimicrobial therapy is in its infancy, available data from clinical studies clearly support the safety and efficacy of this approach to the management of LRTIs in hospitalized patients. Antimicrobial streamlining can result in substantial reduction of hospital expenditures by reducing both the resources used and the patient’s total length of stay. Such cost reductions have not been shown to compromise the patient’s recovery. These considerations are clearly important in the current climate of economic restraint in the health care system. Implementation of an effective streamlining program can have a substantial impact on reducing hospital expenditures.

References


