Home iv antibiotic therapy through a medical day care unit

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M GOURDEAU, L DESCHÊNES, M CARON, M DESMARAIS. Home intravenous antibiotic therapy through a medical day care unit. Can J Infect Dis 1993;4(3)158-162. An out-patient parenteral antibiotic therapy program provided through a medical day care unit was evaluated in a tertiary care hospital. From July 11, 1988 to December 31, 1990, 122 patients were treated either on site at the unit or at home with self-administered intravenous antibiotics. In all, 142 courses of parenteral antibiotics (mostly cephalosporins and clindamycin) were given for a total of 124 infections, mostly bone and soft tissue infections (67 of 124, 54%). The duration of out-patient therapy ranged from two to 62 days with a mean duration of 9.4 days if treated at the unit, or 13.2 days in the home care model (1476 patient-days). Vein access was peripheral and catheters remained functional for an average of 4.9 days (range 0.5 to 22 days). Only two patients experienced adverse drug reactions that necessitated modification of treatment. One other case was readmitted to the hospital for surgical debridement. The average cost per patient-day was $66 compared with $375 for in-hospital therapy. This program proved to be safe, efficient, and cost-effective.

Key Words: *Ambulatory clinics, Antibiotics, Home care*

Antibiothérapie intraveineuse à domicile par l'entremise d'une unité de soins ambulatoires

RÉSUMÉ: Un programme d'antibiothérapie parentérale pour patients non hospitalisés, dispensé par une unité de soins ambulatoires a été évalué dans un hôpital de soins tertiaires. Entre le 11 juillet 1988 et le 31 décembre 1990, 122 patients se sont administré une antibiothérapie intraveineuse, soit sur place, au centre de soins ambulatoires, ou à domicile. En tout, 142 traitements antibiotiques parentéraux (des céphalosporines et de la clindamycine pour la plupart) ont été administrés, pour un total 124 infections qui touchaient surtout les os et les tissus mous (67 sur 124, 54 %). La durée du traitement chez les patients non hospitalisés a varié de deux à 62 jours, avec une moyenne de 9,4 jours s'ils étaient traités au centre de jour ou de 13,2 jours s'ils étaient traités à domicile (1476 patients-jours). L'accès veineux était périphérique et les cathéters sont demeurés fonctionnels durant 4,9 jours en moyenne (entre 0,5 et 22 jours). Seulement deux patients ont manifesté des réactions indésirables qui ont entraîné une modification du traitement. Un autre sujet a été admis de nouveau à l'hôpital pour un débridement chirurgical. Le coût moyen par patient par jour a été de 66 $, contre 375 $ pour le traitement administré à l'hôpital. Ce programme s'est révélé sûr efficace et économique.

OUT-PATIENT INTAVENOUS ANTIBIOTIC THERAPY CAN BE A cost-effective, efficacious, and safe form of treatment (1,2). Reports of such programs appeared as early as 1978 (3,4), and since then, various models of treatment facilities have been developed in Canada (5,6).

In November 1987, to solve the problem of overcrowding in emergency rooms in the Province of Quebec, the Ministry of Health recommended several measures, including the establishment of three pilot medical day care units. The principal objective of these units was to investigate and treat patients on an out-patient basis, using all the facilities provided by a hospital, but only in the daytime. The opportunity was therefore taken to develop an out-patient parenteral antibiotic therapy program within the unit established in our hospital, a tertiary referral centre in traumatology and neurological diseases. We report our experience of this pilot project.

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PATIENTS AND METHODS

The program consisted of two models. In the first, the patient stayed at home, with the patient or a family member being competent in the administration of intravenous antibiotics. In the second model, the patient visited the unit to receive parenteral antibiotics once or twice daily (occasionally supplied by an oral dose at night). The latter strategy was reserved for short course intravenous treatment (less than 10 days), administration of unstable or toxic drugs (eg, amphotericin B), or for patients without family support or who were unable or unwilling to administer the medication at home (eg, patients with severe hand arthritis). The patients were referred to the unit, either during hospitalization or without hospitalization, if their medical condition was stable.

Criteria for selection of a patient included: absence of an effective oral treatment; educability and motivation of the patient or family member (in the first model); lack of specific contraindications such as intravenous drug abuse; and stability of the patient's medical and psychological condition.

Teaching and care of patients were provided by a pharmacist and an attending physician, as well as by several nurses working at the unit who were skilled in intravenous techniques. Each patient was given written instructions summarizing all the information taught concerning intravenous administration techniques, specific adverse reactions, intravenous site care, and how to reach the personnel on duty. The unit was open from 08:00 until 18:00 Monday to Friday and, if needed, on weekends. A nurse was available until midnight, while a pharmacist and a physician were on call 24 h a day. Between midnight and 08:00, the patient was instructed to go to the emergency room.

All antibiotics were prepared in minibags under a laminar flow hood and refrigerated until used. They were dispensed according to their stability in the amount necessary until the patient's next visit. For patients treated at home, all other supplies needed for intravenous therapy (including heparin) were also provided. Peripheral intravenous catheters (Cathlon) were preferred to central lines. Initially, they were changed twice a week, but due to the reluctance of patients to have a functional catheter replaced, and because infections related to small peripheral venous catheters are now relatively rare, the guidelines were revised. Duration of catheter use was extended indefinitely. Patients were educated concerning possible complications, and catheters were changed whenever signs of phlebitis, suspicion of infection or a malfunction occurred.

Patients were scheduled for a follow-up visit at least once a week. They were examined by the attending physician. Laboratory monitoring or any other necessary investigation was carried out, along with inspection of the intravenous site and wound, and dressing changes. Information on techniques and adverse events were revised by the nurse and the pharmacist, who would then coordinate a further supply of medication, according to the physician's prescription. Medical records of all patients referred to the unit for intravenous antibiotic therapy from July 11, 1988 to December 31, 1990 were reviewed in the present study.

TABLE 1
Type of infection treated

Type of infection	Number of infections (number of patients)		Percentage
Skin/skin structure	35	(35)	28.2
Bone and joint	32	(31)	25.8
Urinary tract	29	(28)	23.4
Respiratory tract	11	(11)	8.9
Abdominal and pelvic	6	(6)	4.8
Endovascular/bacteremia*	4	(4)	3.2
Miscellaneous†	7	(7)	5.7
Total	124	(122)	100

**Endocarditis (1), vascular graft infection (1), gonococcemia (1), meningococcemia (1); †Central nervous system infections (3), severe herpes infections in immunosupressed patients (4)*

Costs related to the program were estimated as follows: amounts listed for antibiotics were the actual acquisition costs at the time; pharmacy preparation costs included the time required by a technician to prepare all doses; and materials costs included everything needed for the preparation and administration of the antibiotics (syringes, needles, minibags, administration sets, catheters, heparin lock solution, alcohol pads, sterile gauze pads, adhesive tape, etc). Pharmacist time consisted of the time required to instruct the patients, and to coordinate and prepare medication given on control visits. Nursing time represented the time spent teaching antibiotic administration techniques and taking care of the patients during both follow-up visits and duty calls.

RESULTS

From July 11, 1988 to December 31, 1990, 124 patients, including 52 patients treated daily at the unit, were enrolled in the program. Two of these patients were treated twice and two received intravenous antibiotic prophylaxis before an invasive manoeuvre, for a total of 126 courses of treatment in 124 patients. Reasons for rejection of a candidate included: lack of sufficient dexterity or hygiene; poor mobility or lack of transport; no perceived need on the part of the patient for prolonged parenteral antibiotic therapy; and a history of substance abuse or psychological instability. Fifty-two per cent (64 patients) were referred by clinical microbiologists and 48 of the remaining 60 by internists affiliated with the hospital. Surgeons usually preferred clinical microbiologists to refer their patients to the program, taking charge of them conjointly once they were enrolled. Most patients referred by clinical microbiologists originally came from surgeons. There were 54 female and 70 male patients. The mean age of the

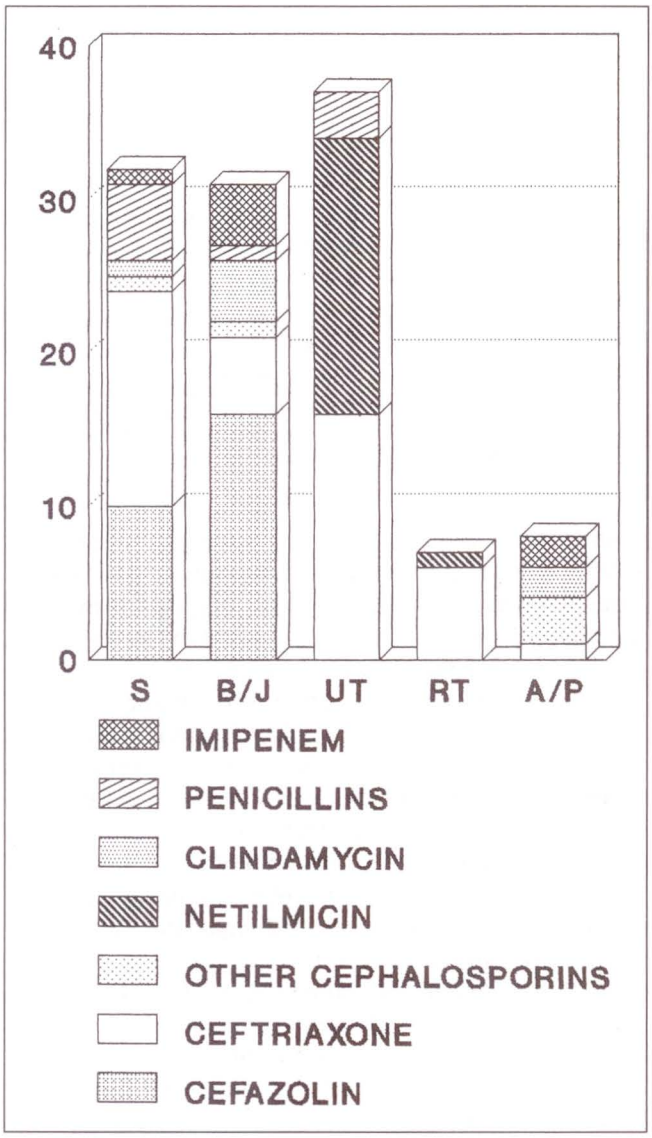

Figure 1) *Principal antibiotics used by type of infection: S Skin/skin structure; B/J Bone/joint; UT Urinary tract; RT Respiratory tract; A/P Abdominal/pelvic*

patients was 41 years, with a range of three to 74 (median 40). Duration of out-patient care ranged from two to 62 days (excluding the two cases of prophylaxis, each of which lasted less than 24 h), with a mean treatment duration of either 9.4 days if treated at the unit, or 13.2 days in the home care model.

The mean duration of intravenous catheter life was 4.94 days, ranging from 0.5 to 22 days, including those patients at the beginning of the project, when catheters were automatically changed twice a week. No cases of catheter-related infection were detected (excluding catheter colonization at removal). Assuming that all of these patients would have been hospitalized for the same length of time, the total number of days of hospitalization saved for this 29-month period was 1476 days.

The medical day care unit treated a wide variety of infections during this period (Table 1), with bone, joint

TABLE 2
Antimicrobial agents used

Agent	Number of times prescribed	Percentage
Cephalosporins	79	55.6
Ceftriaxone	45	
Cefazolin	28	
Others*	6	
Netilmicin	18	12.7
Clindamycin	18	12.7
Penicillins†	9	6.4
Imipenem	7	4.9
Acyclovir	4	2.8
Pefloxacin‡	3	2.1
Erythromycin	1	0.7
Vancomycin	1	0.7
Amphotericin B	2	1.4
Total	142	100

**Cefoxitin (3), cefuroxime (1), ceftazidime (1), cefotaxime (1); †Cloxacillin (5), ampicillin (3), penicillin G (1); ‡Under investigation at that time*

and soft tissue infections predominating, as experienced in other programs (7-9). Urinary tract infections were also frequently treated but, except for one case of renal abscess, all of these patients began their treatment at the unit. Mean length of intravenous antibiotic therapy was 4.4 days, followed by oral medication. A wide variety of antimicrobial agents was prescribed (Table 2). Agents most commonly used were those offering an extended half-life (with a thrice daily dosing or less), an extended spectrum allowing monotherapy of polymicrobial infections, and a relative lack of toxicity (mostly cephalosporins and clindamycin). Combinations of two antibiotics were given to 12 of the patients, and six others required modifications of treatment, for a total of 142 courses of parenteral antibiotics administered for 124 infections. On a few occasions, patients were given oral antibiotics either at night because of the short half-life of the antibiotic administered intravenously at the unit (eg, cloxacillin, erythromycin), or in combination with intravenous antibiotic treatment (eg, ciprofloxacin, clindamycin). Figure 1 shows the principal antibiotics used by site of infection. Adverse reactions requiring a modification of treatment occurred in two patients: one experienced a rash due to cefazolin and the other a recurrent phlebitis due to vancomycin. One patient was re-hospitalized because of lack of improvement of a foot cellulitis (following a dog bite) which required surgical debridement.

The total costs of the program are listed in Table 3. Pharmacy preparation costs were based on the mean cost per dose prepared (an average technician time of 11 mins per dose and a $10/h median rate) multiplied by the total number of doses. Mean daily cost was calculated depending on the number of doses of antibiotics given each day. Pharmacist costs for instruction (average of 60 mins per patient) and coordination of the

program (30 mins for every control visit) were based on a $22/h median rate. Nursing personnel costs were based on an average time of 6 h per patient for instruction and control visits at a median cost of $15/h. The total estimated cost for running this program during two-and-a-half years was $98,123.58 with a mean cost per patient-day of $66.48 and a mean cost per treatment of $778.77. If all these patients had been hospitalized, the estimated costs for hospital room charges alone (at $375 per day) multiplied by the total number of out-patient days would have amounted to $550,548.

TABLE 3
Costs related to the program

Cost components	Total	Mean per day	Mean per patient
Antibiotics	$ 66,644.75	$ 45.15	$ 528.92
Pharmacy preparation	$ 6,314.00	$ 4.28	$ 50.11
Material provided	$ 9,860.93	$ 6.68	$ 78.26
Pharmacist time*	$ 3,454.00	$ 2.34	$ 27.43
Nursing time*	$ 11,850.00	$ 8.03	$ 94.05
Total	$ 98,123.68	$ 66.48	$ 778.77

**Pharmacist and nursing time have been extrapolated from data collected between July 11, 1988 and April 15, 1989*

DISCUSSION

Because of the setting offered by this medical day care unit and with the help of published experiences in this area, the program was easy to start and is running well. Staff who are aware of the condition of each patient are available around the clock. The program offers an easy approach to treatment without increasing the risk to patients, many of whom can return to work or go back to school sooner. With motivated and educated patients, adequate training can be accomplished in less than 24 h. The majority of patients to whom this service is offered choose to participate, and with the increasing popularity of this program, many patients request it of their physicians even before it is offered. This is particularly true for patients suffering from chronic osteomyelitis who have already experienced lengthy intravenous antibiotic therapy in the course of hospitalization.

The principal problem encountered is a financial one. A detailed separate budget of this program was not initially planned and it soon became a burden for the department of pharmacy, which had to justify this increase in their budget even though they supported the program unconditionally. We are aware that our estimate of hospitalization costs is crude. If the patient had been hospitalized, the choice of antibiotics could have been different (but this is not actually included in our calculation) and the actual duration of parenteral antibiotic therapy might have been shorter due to the pressure of discharging one patient to make room for another. Despite this, the potential for savings is considerable. Our results demonstrate an approximate hospitalization cost of at least five times that of the out-patient cost per day. However, because of global budgets for hospitals, some hospital administrators argue that this kind of program increases rather than decreases the costs. The system must assume the cost of both the discharged patient and the hospitalized one. The financial participation of private insurers had not been solicited yet, but is a current practice. Other benefits to the patient, such as improved quality of life, increased productivity, allowing access of other patients to hospital and therefore reducing congestion in the emergency room, must all be taken into consideration. For these reasons, our hospital administration has been very supportive.

One present limitation of this program is the lack of continuity between home care services and the care provided by this unit because these two services come under different jurisdictions. For this reason, and because home care services are unwilling or unable to participate, many patients with reduced or limited mobility or who live too far from the hospital cannot enroll in the program.

We are also concerned by the underuse of this program by certain medical services in our hospital. As physicians become increasingly comfortable with this mode of treatment, the number of patients should increase although the impact of alternative oral antibiotic regimens on the management of infections classically treated with parenteral antibiotics may mean that the need is not as great. There is the risk of providing intravenous antibiotic therapy to patients for whom this procedure may not be needed. Consequently, we recommend that this kind of program be under the supervision of an infectious disease physician. This will ensure quality control, particularly in regard to the criteria for the screening and acceptance of patients, and the choice and duration of therapy. This experience offered an opportunity to optimize treatment of infectious diseases. For example, aminoglycosides and trimethoprim-sulfamethoxazole were used instead of ceftriaxone as first-line agents for acute pyelonephritis, and a shorter period of time for the administration of intravenous antibiotics was often possible whenever the patient was not too severely ill and could tolerate an oral medication.

There is better compliance and tolerance when a drug can be given without interfering with sleep patterns. It is not surprising that the most commonly used antibiotics in out-patient intravenous therapy are ceftriaxone, cefazolin, and clindamycin (7-9). However, the use of portable, programmable infusion pumps may greatly facilitate the use of antimicrobial agents with a short half-life (10,11).

The marketing of new antimicrobial agents can have a considerable impact on an out-patient parenteral antibiotic program. Ceftriaxone has been particularly

helpful in the daily treatment of ambulatory patients at the unit. However, the use of cefazolin to treat staphylococcal infections is favoured because of its lower cost and minimal inhibitory concentration in comparison with ceftriaxone. The advent of quinolones probably will not jeopardize out-patient parenteral antibiotic programs. One must be cautious in the use of oral quinolones as monotherapy for *Staphylococcus aureus* osteomyelitis (12,13). Oral quinolones have not been conclusively shown to be as effective as parenteral antibiotics for acute osteomyelitis due to Gram-positive bacteria. Even if suboptimal surgical debridement is a more common cause of clinical failure, failure related to the development of resistance by *S aureus* to quinolones (14) and superinfections (13) have also been described. It is preferable to treat osteomyelitis more agressively in patients with diabetes or severe peripheral vascular disease for whom an initial regimen of parenteral therapy seems more appropriate (7,15). The recent emergence of quinolone-resistant staphylococci (16,17) may diminish future utility of quinolones in the treatment of *S aureus* osteomyelitis. Out-patient antibiotic parenteral therapy programs also treat an increasing number of patients with acquired immunodeficiency syndrome who need parenteral antimicrobial agents to treat and suppress diverse infections with new or currently available agents (amphotericin B, ganciclovir), which will be an increasing need.

The small Teflon catheters now widely used are associated with far fewer infections than catheters used a decade ago. This is probably related to the low incidence of bacterial colonization on the Teflon catheter (18). Infusion-related phlebitis is a more frequent complication that is associated with an increased risk of infection (19). In our 29-month observation, no catheter-related sepsis occurred despite supervening phlebitis in many cases. We agree with other authors that well-trained patients provide their own intravenous care as well as, if not better than, that provided in the hospital (8,9), and that there is probably a lower risk of infection at home than in a nosocomial setting. However, in immunosuppressed individuals, intravenous peripheral catheters should be routinely replaced twice a week because of the increased risk of catheter-associated bacteremia (20) and the poorer outcome if an infection occurs. In other cases, these catheters need not be routinely replaced, particularly if the patient's veins are inaccessible, or if the only purpose of the patient's visit to the unit is to replace a properly working catheter.

In summary, this program was found to be safe, efficient, and cost-effective. We hope that government health agencies will also be similarly convinced and that they will provide the financial support and continuity of home-care services that are essential to the survival and widespread use of this form of therapy.

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