ORIGINAL ARTICLE

# Safety and efficacy of home intravenous antibiotic therapy for patients referred by the hospital emergency department

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The authors declare no conflict of interest in relation with the present article.

**Objective:** To analyze the safety and efficacy of home intravenous antibiotic therapy (HIVAT) for patients with infections discharged from the emergency department and referred to the home hospital program.
**Methods:** Prospective study of patients referred to the home hospital program of Hospital de Sabadell for HIVAT between January 2008 and June 2011. We compared 2 groups: patients referred by the emergency department and patients referred by any other department or service. Variables analyzed included age, sex, mean stay in the program, Barthel index, route and method for administering the antibiotic, type of infection, microorganism isolated, antibiotic prescribed, early and late readmission rates, and complications (medical and those associated with venous access). HIVAT was self-administered by the patient (or home caregiver) through an elastomeric infusion device.
**Results:** We studied 409 patients and 492 courses of HIVAT; 92 patients were referred by the emergency department and 400 came from other care units. Emergency patients were older, had greater functional impairment, a shorter stay in the program, a higher rate of urinary tract infection, and a lower rate of *Pseudomonas aeruginosa* infection. Referral from the emergency department was not associated with higher risk of readmission to hospital, worse infection course or outcome, or development of a health-care-associated infection.
**Conclusions:** Self-administered HIVAT is safe and effective for patients discharged from emergency care. This therapeutic option is not associated with a worse course of infection or higher rates of hospital readmission for emergency patients in comparison with those referred by other departments. [Emergencias 2013;25:31-36]

**Key words:** Home care services, hospital based. Elastomeric infusion pump. Emergency health services. Anti-infective agents.

## Introduction

Hospital emergency departments (EDs) are often overcrowded and in a state of collapse, thus delaying admissions to hospital wards. In an attempt to remedy this situation, observation rooms and short stay areas[1] have appeared in recent years where it is possible to diagnose, treat and stabilize certain conditions so these patients can be assigned directly to home hospitalization (HH) programs with the same safety and efficacy[2] as if they were hospitalized.

HH programs constitute a safe, efficient and cost-effective method for home intravenous antibiotic therapy (HIVAT) to treat severe infection in clinically stable patients[3-7]. However, there is little research on the efficacy and safety of HIVAT patients referred directly from the ED without previous conventional hospitalization[8], and it is unknown whether this modality constitutes a risk factor for poor clinical outcome or hospital readmission. We therefore performed a prospective study on the efficacy and safety of HIVAT in a sample of patients treated by our HH unit, and compared the results obtained in two groups: patients referred by the ED and patients referred by any other department or service.

## Method

In October 2007, a prospective register of all HIVAT patients of our center, Hospital de Sabadell,

was established. The register's main variables include demographic data (age, sex, city of residence and source of admission), type of infection and microorganisms isolated, Barthel Index score, the antibiotics administered (dose, duration and route of administration), venous access used, clinical course and treatment complications. The present study analyzed all patients included in the register attended between January 2008 and June 2011. The source of these patients was different hospital departments or services: wards, outpatient clinics, day hospitals and the ED. They were divided into two groups: those referred for HIVAT by the ED and those referred by any other department or service.

The criteria for admission to the HHP for HIVAT included confirmation of the diagnosis of infection requiring intravenous antibiotic therapy, clinical and hemodynamic stability, absence of psychiatric disorder, good family support, patient and / or caregiver consent to be included in this healthcare modality, residence in the area covered by the program, availability of contact telephone and no mental disability of the patient and / or caregiver that could affect understanding of the risks of intravenous drug use. Following assessment by the medical team and agreement by the referring department of service, the intravenous antibiotic treatment to be self-administered at home was established. When possible, blood samples were collected for laboratory cultures, before or on admission to the program. Each patient was assigned a physician and a nurse from our unit and given a fact sheet on unit times and phone contact numbers.

All patients had proper venous access with Abbocath® peripheral catheter for short-duration treatment or peripherally inserted central venous catheter (CVC) for more prolonged treatment. Infusion devices used were three types of portable and disposable continuous infusion elastomeric pump: Intermate SV® 200, Intermate XLV® 250 or Intermate LV® 250. The selection of one or other device was made according to the physical-chemical characteristics of the product to be infused. We also took into consideration the stability of the antibiotic preparation once reconstituted, both at room temperature or in a refrigerator (2-8°C), data which were provided by our hospital pharmacy. For this reason, some antibiotic doses were kept refrigerated for transport to the home and before administration there.

In our unit, HIVAT is based on self-administration of the antibiotic by the patient and/or caregiver after a process of training by nursing professionals. So, before leaving the hospital the patient and/or caregiver are familiar with the device and connecting the elastomeric pump to the venous access. This information was also provided in written form. After signing informed consent, the patient was admitted to the HH program. For patients referred directly from the ED, the first dose of intravenous antibiotic was administered in the hospital to rule out possible allergic reactions to the drug. Once at home, the patient was visited for medical follow up daily or on alternate days according to the patient's clinical status. A nurse was responsible for conservation, preparation and dilution of the antibiotic, and for resolution of incidences in venous access, as well as monitoring vital signs and taking blood samples for microbiological analysis when necessary.

Any medical complications in HIVAT patients or unplanned hospital readmissions within 30 and 90 days of admission to the program were recorded. Identifying possible readmissions after ED discharge was conducted by review of electronic medical records and by telephone follow-up. We also recorded health care-associated infectious complications (defined as new infections documented during or before three months after discharge), cases of poor evolution of underlying disease or worsening infection, and those that developed venous access complications (phlebitis, thrombosis, extravasation or accidental removal).

The characteristics of ED-referred HIVAT patients versus the rest were compared using Student's t test for continuous variables or chi-square test for dichotomous variables. We also performed univariate analysis using chi-square test and logistic regression to identify the association between ED-referral and the risk of complications during HH or hospital readmission. All analyzes were performed using SPSS version 18.

## Results

In the period between January 2008 and June 2011 there were 92 episodes of HIVAT in 89 patients referred from the ED and 402 episodes in 320 patients referred from other departments or services (284 episodes in hospitalized patients, 90 day hospital episodes and 28 episodes in patients from other sources).

The differences between ED-referred and other HIVAT patients are shown in Table 1. ED-referred patients were older, showed greater functional impairment and a higher proportion had peripheral venous access. With respect to mode of antibiotic

administration, over 97% of patients in both groups self-administered the treatment. Patients referred from the ED had a greater proportion of UTIs and lower percentage of bone/joint or intra-abdominal infections. Finally, there were significant differences between the two groups in relation to the main microorganisms detected (ED-referred patients showed more enterobacteriaceae and less pseudomonas) and the antibiotics used (a greater proportion of ED-referred patients used ceftriaxone and a smaller proportion used antipseudomonal drugs or aminoglycosides and combinations of antibiotics than the rest). *Pseudomonas aeruginosa* was detected in proportionally more patients from other sources, mainly due to referrals from the pulmonology day hospital.

Table 2 shows the percentage of HIVAT patients needing hospital readmission or presenting medical complications according to referral source. No significant differences were found between the two groups in most clinical variables and evolution. Similar results were observed in subgroups of patients with respiratory infection or UTI, except for a slight increase ($P = 0.05$) in care-associated infections in ED-referred patients with respiratory infection. ED-referred patients presented a non-significantly higher incidence of venous access complications (33.7% versus 25.0%, $p = 0.09$). Logistic regression showed that these complications were related to the use of peripheral lines [OR 7.5 (95% CI 4.5 - 12.7), $P < 0.001$] and duration of treatment [OR 1.2 (95% 1.1-1.3), $P = 0.002$ for every 10 additional days of treatment], but not with the fact of ED-referral [OR 0.8 (95% CI 0.5 - 1.5), $P = 0.6$]. Venous access complications were mild in all cases and resolved in 93% of cases by the nursing staff in the pa-

**Table 1.** Differential characteristics of patients undergoing home intravenous antibiotic treatment (HIVAT) according to source of referral: the emergency department or other departments or services

| Variable | ED-referral (n = 92) n (%) | Non-ED-referral (n = 400) n (%) | *P* |
|---|---|---|---|
| **Variables** | | | |
| Age [years (mean ± SD)] | 69.4 (18.2) | 63.3 (20.5) | 0.005 |
| Female sex | 28 (30.4) | 135 (33.8) | NS |
| Average stay [days (mean ± SD)] | 11.1 (9.1) | 21.3 (21.4) | < 0.001 |
| Barthel Index [score (mean ± SD)] | 77.2 (30.5) | 86.5 (21.7) | 0.05 |
| **Route of administration** | | | |
| Central line | 18 (19.6) | 246 (61.5) | < 0.001 |
| **Method of administration** | | | |
| Self-administration | 90 (97.8) | 397 (99.3) | NS |
| **Type of infection** | | | |
| Respiratory | 39 (42.4) | 160 (40.0) | NS |
| Urinary tract | 39 (42.4) | 33 (8.3) | < 0.001 |
| Cutaneous | 5 (5.4) | 12 (3.0) | NS |
| Bone/joint | 2 (2.2) | 48 (12.0) | 0.005 |
| Bacteremia | 2 (2.2) | 22 (5.5) | NS |
| Intra-abdominal | 3 (3.3) | 68 (17.0) | 0.001 |
| Other | 2 (2.2) | 57 (14.3) | 0.001 |
| **Microorganisms** | | | |
| Enterobacterias | 18 (19.6) | 43 (10.8) | 0.02 |
| Enterobacteriaceae ESBL[3] | 12 (13.0) | 23 (5.8) | 0.01 |
| Pseudomonas aeruginos | 7 (7.6) | 103 (25.8) | < 0.001 |
| Pneumococcal | 6 (6.5) | 8 (2.0) | 0.02 |
| EStaphylococcus aureus MSSA[4] | 1 (1.1) | 10 (2.5) | NS |
| Staphylococcus PCN[5] | 0 (0) | 32 (8.0) | 0.005 |
| Staphylococcus aureus MRSA[6] | 1 (1.1) | 11 (2.8) | NS |
| **Most common antibiotics** | | | |
| Ertapenem | 19 (20.7) | 67 (16.8) | NS |
| Meropenem | 9 (9.8) | 51 (12.8) | NS |
| Ceftriaxona | 35 (38.0) | 65 (16.3) | < 0.001 |
| Cefepime/ceftazidime | 12 (13.0) | 115 (28.8) | 0.002 |
| Piperacilina-tazobactam | 12 (13.0) | 31 (7.8) | NS |
| Vancomicina/teicoplanin | 5 (5.4) | 49 (12.3) | NS |
| Daptomycin | 0 (0) | 9 (2.3) | NS |
| Aminoglycosides | 4 (4.3) | 66 (16.5) | 0.003 |
| Quinolones | 1 (1.1) | 8 (2.0) | NS |
| Quinolones | 3 (3.3) | 77 (19.3) | < 0.001 |

SD: standard deviation. NS: Not significant. [3]ESBL: Extended spectrum beta-lactamase. [4]MSSA: methicillin-sensitive *Staphylococcus aureus.* [5]PCN: plasmacoagulase negative staphylococci. [6]MRSA: methicillin-resistant Staphylococcus aureus.

**Table 2.** Factors associated with complications or hospital readmission in patients receiving home Intravenous antibiotic therapy (HIVAT) according to source of referral for HIVAT

| | Urinary tract infection | | | Respiratory Infection | | | All infections | | |
|---|---|---|---|---|---|---|---|---|---|
| | ED (n = 39) n (%) | Other sources (n = 33) n (%) | p' | ED (n = 39) n (%) | Other sources (n = 160) n (%) | p' | ED (n = 92) n (%) | Other sources (n = 400) n (%) | p[1] |
| **Readmission** | | | | | | | | | |
| Unexpected readmission to hospital | 3 (7.7) | 1 (3.0) | NS | 7 (17.9) | 13 (8.1) | 0.07 | 12 (13.0) | 37 (9.3) | NS |
| Readmission within 30 days of discharge | 3 (7.7) | 4 (12.1) | NS | 5 (12.8) | 24 (15.0) | NS | 8 (8.7) | 39 (9.8) | NS |
| Readmission within 30 days of discharge NS | 5 (12.8) | 6 (18.2) | NS | 10 (25.6) | 51 (31.9) | NS | 16 (17.4) | 82 (20.5) | NS |
| **Medical Complications** | | | | | | | | | |
| Care-associated infection[3] | 0 (0) | 0 (0) | NC | 3 (7.7) | 2 (1.3) | 0.05 | 3 (3.3) | 6 (1.5) | NS |
| Poor evolution of infection | 1 (2.6) | 0 (0) | NS | 0 (0) | 2 (1.3) | NS | 2 (2.2) | 8 (2.0) | NS |
| Poor evolution of underlying disease | 2 (5.1) | 1 (3.0) | NS | 4 (10.3) | 9 (5.6) | NS | 7 (7.6) | 18 (4.5) | NS |
| Venous access complications | 8 (20.5) | 13 (39.4) | 0.08 | 15 (38.5) | 43 (26.9) | NS | 31 (33.7) | 100 (25.0) | 0.09 |
| – In patients with peripheral line | 8 (20.5) | 10 (50.0) | 0.08 | 15 (45.5) | 31 (39.7) | NS | 30 (40.5) | 69 (44.8) | NS |
| – In patients with central line | 0 (0) | 3 (23.1) | NS | 0 (0) | 12 (14.6) | NS | 1 (5.6) | 31 (12.6) | NS |

[1]All values of p <0.1 are specified. NS: not significant. NC: not calculable.

tient's home. Detailed analysis of venous access complications in the 74 ED-referred patients, peripheral channel carriers, showed that 30 (40.5%) had some kind of complication, including phlebitis (10 patients), extravasation (9 patients), obstruction (6 patients) or accidental removal (5 patients). The percentages of each of these complications in non-ED-referred patients was not significantly different.

## Discussion

HIVAT programs have been in operation since the 1980s around the world and in Spain. Over the years, these programs have become safer and more effective; they are intended to save hospital costs[9,10] and improve patient quality of life[11]. While many previous studies have included variable proportions of HIVAT patients referred from the ED, very few have specifically analyzed the effectiveness and safety of HIVAT[12-14].

The first aspect we would highlight is the high number of respiratory infections, as well as the different proportion of UTI, musculoskeletal or intra-abdominal infection according to the source of the patients. These differences, not previously identified by other authors, were due in our case to the recruitment of patients with bone/joint or intra-abdominal infections from the department of surgery and joint protocols between the HHP unit and the ED for direct referral, without hospitalization, of uncomplicated pyelonephritis, as reported in other centers[15].

In terms of micro-organisms detected, we would highlight the greater proportion of extended-spectrum beta-lactamase (ESBL) enterobacteriaceae in ED-referred patients. In our opinion, ED physicians knowing the need for hospital isolation of these patients may have contributed to increased referral to the HH unit from the ED. We also believe the high proportion of patients treated with carbapenems could be due, at least partially, to this circumstance.

Besides providing information on ED-referred patients, the present study has other relevant characteristics. Unlike in most of the studies performed to date, the antibiotic was administered almost exclusively by the patient or caregiver. Since HIVAT was first conceived, self-administration has been described as a possible mode of treatment, but only a few studies analyzed and confirmed its safety[16,17] and none have involved the exclusive use of elastomeric infusion devices.

As mentioned, ED-referred patients showed a non-significant trend to a higher incidence of venous access complications, which could be related with increased use of peripheral catheters. The incidence of venous access complications in patients with central lines was low in both groups, which suggests that handling of these catheters by trained patients or caregivers is safe. By contrast, the proportion of patients with peripheral venous access complications, both ED-referred and the others, was around 40%, although they were mild in all cases and the vast majority were resolved in the patient's home. However, this requires further study and more detailed analysis to determine possible causes or predisposing factors.

Finally, we did not find higher rates of hospital readmissions in ED-referred patients, despite being older and with lower Barthel index scores; both circumstances have been associated with a

higher rate of hospital readmission in previous studies[5].

Our study also has certain limitations. Despite analyzing a prospective series of case, the study is observational and not randomized. Thus, although we observed similar inter-group medical complications and readmission rates in a stratified analysis by type of infection, we cannot rule out the possibility that there were differences in severity of the process or other characteristics between the two groups, which would limit the validity of our results. In addition, the small number of events in some groups with complications hinders drawing reliable conclusions.

In conclusion, in our series of clinically stable ED-referred HIVAT patients self-administering antibiotic treatment at home using elastomeric infusion pumps, this modality proved safe and effective, with results similar to those reported in other studies where the antibiotic was administered by HH unit staff[18,19]. Direct admission to the HH program from the ED also presents a number of advantages: it alleviates ED overcrowding and reduces the costs and risks of conventional hospitalization (nosocomial infections, confusional syndrome and declining functional ability). In our opinion, proper infectious process protocols in the ED could help increase the number of referrals to HH programs of many clinically stable patients with infectious diseases requiring parenteral antibiotic treatment.

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## Eficacia y seguridad del tratamiento antibiótico domiciliario endovenoso en pacientes con patología infecciosa procedentes del servicio de urgencias

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**Objetivo:** Analizar la eficacia y seguridad del tratamiento antibiótico domiciliario endovenoso (TADE) en infecciones de pacientes procedentes del servicio de urgencias.
**Método:** Estudio prospectivo de los pacientes ingresados para TADE en la unidad de hospitalización a domicilio (HaD) del Hospital de Sabadell entre enero del 2008 a junio del 2011. Se comparan dos grupos: pacientes derivados desde urgencias frente a pacientes procedentes de otros dispositivos asistenciales. Las variables analizadas fueron edad, sexo, estancia media, índice de Barthel, vía y forma de administración del antibiótico, tipo de infección, microorganismo aislado, antibiótico utilizado, índices de reingreso precoz y tardío y complicaciones médicas y asociadas al acceso venoso. El TADE se autoadministró por parte del cuidador y/o el paciente mediante dispositivos de infusión elastoméricos.
**Resultados:** Se reclutaron 409 pacientes que generaron 492 episodios de TADE, 92 procedentes de urgencias y 400 de otros dispositivos asistenciales. Los procedentes de urgencias presentaron una edad más avanzada, mayor deterioro funcional, una estancia media más corta, mayor proporción de infecciones urinarias y menor porcentaje de infecciones por *P. aeruginosa.* La procedencia de urgencias no se asoció a un mayor riesgo de reingreso hospitalario, a una peor evolución de la infección, ni a un incremento de las infecciones asociadas a cuidados sanitarios.
**Conclusiones:** El TADE autoadministrado es eficaz y seguro en pacientes procedentes de urgencias, sin asociarse a una peor evolución de la infección ni a un mayor reingreso hospitalario que los procedentes de otros dispositivos. [Emergencias 2013;25:31-36]

**Palabras clave:** Hospitalización a domicilio. Bombas elastoméricas. Urgencias. Antimicrobianos.