

Clinical Outcomes of Home Parenteral Antibiotic Therapy Using Accufuser®

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Abstract

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BACKGROUND: In September 2020, the home health care program introduced the elastomeric pump Accufuser® to the home parenteral antimicrobial therapy program as a new means of administering medications. We aim to assess the clinical outcomes of this recent addition in comparison to traditional administration methods.

METHODS: This is a retrospective cohort study conducted at the Adult Home Health Care Services in King Abdulaziz Medical City, Riyadh. We enrolled all the patients who were accepted at the home parenteral antimicrobial program from January 1, 2019 to May 31, 2022. The outcomes of the group of patients who received therapy through Accufuser® and the group that used other administration methods were compared.

RESULTS: We included 285 patients in this study, among whom 167 (58.6%) were females. Eighty-nine (31.2%) patients utilized Accufuser®, while the rest used direct intravenous (IV) (71, 24.9%) and IV piggyback (125, 43.9%). A significant reduction in the duration of visits ($P < 0.00$) and the number of daily visits ($P < 0.00$) was observed in the group that used Accufuser®. Both groups had similar rates of therapy completion ($P = 0.14$). No significant difference was noticed in the rates of complications ($P = 0.57$) or the rates of mortality between the two groups ($P = 0.14$).

CONCLUSION: The Accufuser® device is a safe administration method that reduces both the duration and the number of daily visits.

Introduction

Outpatient and home parenteral antibiotic therapy (OHPAT) programs are accepted modes of providing healthcare with low cost, high efficacy, and high safety [1]. The home parenteral antimicrobial program was adopted in 2004 as part of the Home Health Care (HHC) Department program in King Abdulaziz Medical City (KAMC). The program started with the treatment of patients with diabetic foot who used to require three months of inpatient treatment with intravenous (IV) antibiotics. The program expanded slowly but remained restricted to therapy with once-per-day medications. Later, the program was augmented to cover the treatment of all types of infections and accommodate medications with frequent dosages. The program used a visiting nurse model, wherein a nurse visits the patient's residence and administers the prescribed IV medications at the appropriate time. For most patients, a peripherally inserted central catheter (PICC) was utilized, and the medications were

administered through an infusion bag or direct IV. In 2011, a study by Baharoon et al., which aimed to evaluate the program and its outcomes, reported that the program was both clinically and economically effective [2]. Out of the 155 enrolled patients, 86% completed the program successfully, and only 8.5% had to be readmitted [2]. However, despite its success, the travel time, duration of visits, and frequent daily doses remained tremendous challenges to this model of care.

Since its commencement, the program at KAMC has aimed to expand and adopt new technologies to provide better care, serve more patients, and save resources. In September 2020, the program started utilizing elastomeric infusion devices. The elastomeric pump Accufuser®, a product of Woo Young Medical Co., Seoul, South Korea, was selected to be utilized in the program. This product received Food and Drug Administration (FDA) approval in 2002 and has been in the market since [3]. Given its extensive presence in the market, several studies have been conducted to assess its quality and reliability in

OHPAT programs. These studies assessed the stability of a variety of commonly used antimicrobial agents and concluded that Accufuser® could be safely used to administer a continuous infusion of those agents for up to 48 hours [4], [5], [6], [7], [8], [9], [10]. A study evaluating nurses' experience with Accufuser® reported that 299 nurses (100%) found the pump easy to use, and 270 (100%) found it clinically acceptable [11].

The adoption of new technologies is a means to optimize the care provided to patients and save hospital resources simultaneously. We conducted this study to assess the clinical outcomes of Accufuser®, a newly introduced device, in home parenteral therapy program and its impact on patient care.

Methods

This is a retrospective cohort study conducted at the Adult HHC Service in KAMC in Riyadh. The Adult HHC Service serves more than 800 patients throughout Riyadh City. We evaluated a total of 285 patients who were accepted to the home parenteral antimicrobial program from January 1, 2019 to May 31, 2022. We included all accepted patients who received a minimum of one home visit. All the data were retrieved from the patients' electronic medical records. The study was approved by the institutional review board of King Abdullah International Medical Research Center (RYD-21-419812-113262).

The HHC Department follows strict guidelines in accepting patients into the home parenteral antimicrobial therapy program and utilizing Accufuser® in patient care. Consultations with an infectious disease specialist and a clinical pharmacist must be undertaken prior to referring patients to the HHC. Referral must be done at least 48 hours before the patient's discharge to arrange for venous access and ensure the safety of the administered drugs, as well as to counsel patients and relatives about the program. A PICC was used as a standard measure in most patients. Patient education must be provided during the hospitalization period, which involves instructions on storing the medications and administering them via the infusion pump. During transportation, the medications must be kept in a cooler. A double-checking checklist must be signed by two staff nurses independently.

In September 2020, the elastomeric pump Accufuser® was introduced in the program. Since its introduction, it has been used to administer medications for most patients. In some patients, other administration methods were still utilized even after the adoption of the elastomeric pump due to times of low supply (during the COVID-19 pandemic), the resistance of some patients and caregivers, and preference at times when the medications require a single visit with a short infusion time.

All data analyses were conducted using SAS software version 9.4 (SAS Institute Inc., Cary, NC, USA). Continuous variables were presented as mean and standard deviation (mean ± SD), while percentages and frequencies were used to describe the categorical variables. The statistical analysis included the use of the Chi-square test to measure the association between the two groups (the group that used Accufuser® and the group that used other methods), as well as the completion of therapy, complications, deaths, and daily visits. The Wilcoxon two-sample test was used to compare the duration of visits between the groups. P-values less than 0.05 were considered statistically significant.

Results

Demographics

We studied a total of 285 patients who were referred to the home parenteral antimicrobial program from January 1, 2019 to May 31, 2022. Females accounted for 167 (58.6%) of our sample. Half of our patients were older than 75 years. Over 70% were comorbid with diabetes mellitus (DM). Up to 98 (34.4%) patients suffered from chronic kidney disease (CKD), and 75 (26.3%) had cognitive impairment.

Table 1: Clinical characteristics of all patients in this study

	n (%)
Female	167 (58.6%)
Male	118 (41.4%)
Age	
< 50	30 (10.5%)
50-64	42 (14.7%)
65-74	70 (24.6%)
>=75	143 (50.2%)
DM	205 (72.0%)
CKD	98 (34.4%)
Cognitive Impairment	75 (26.3%)
Deaths	15 (5.3%)
Total	285 (100%)

Outcomes of Therapy

We assessed the safety and benefits of the newly introduced device by comparing the outcomes of the group of patients that used Accufuser® and the group that received medications through other traditional administration methods. A total of 89 (31.2%) patients received their medications through Accufuser®, 71 (24.9%) through direct IV, and 125 (43.9%) through an IV drip.

Table 2: Outcomes of therapy in the group that used Accufuser® and the group that used other administration methods

	IV push / IV piggyback	Accufuser®	P-value
Total number of patients	196 (68.8%)	89 (31.2%)	-
Completion of therapy	177 (90.3%)	75 (84.3%)	0.14
Complications	41 (20.9%)	16 (18.0%)	0.57
Deaths	12 (6.1%)	3 (3.4%)	0.41
Daily visits (> 1 visit/day)	30 (15.3%)	0 (0.0%)	<0.00*
Duration of visits (mean ± SD)	31.4±13.2	17.3±6.13	<0.00**

* Chi-Square test was used to test the association between the groups with the Daily visits.

** Wilcoxon Two-Sample Test was used to compare the duration of visits between the groups.

Table 2 summarizes the outcomes based on the methods of therapy administration. More than 80% of the patients completed their therapy successfully. No significant difference ($P>0.05$) was found in the rate of completion of therapy between the patients who used Accufuser® and those who used other methods. Complications were noticed in 16 (18%) patients who used Accufuser® and 41 (20.9%) in those who used other methods of administration, with no significant difference between the two groups ($P>0.05$). The mortality rate was 12 (6.1%) in the group with the traditional administration methods and three (3.4%) in the group that used Accufuser®, with no significant difference ($P>0.05$). Not all deaths were related to the infection and its treatment, as some of these were attributed to other conditions. Only the deaths related to infection and/or its treatment were counted as complications of therapy.

Usage of other methods was significantly associated with more daily visits than the use of Accufuser® ($P\leq 0.05$). None of the patients in the group that used Accufuser® needed more than one visit daily; however, the group that used other administration methods needed additional daily visits depending on the frequency of the doses of the prescribed medication. Figure 1 presents a visualization of the difference in the duration of visits based on the administration methods used. We did not combine the group of patients that used direct IV and the group that used IV drip because the first method usually takes a shorter time. However, even in this case, Accufuser® was significantly associated with the lowest duration of visit.

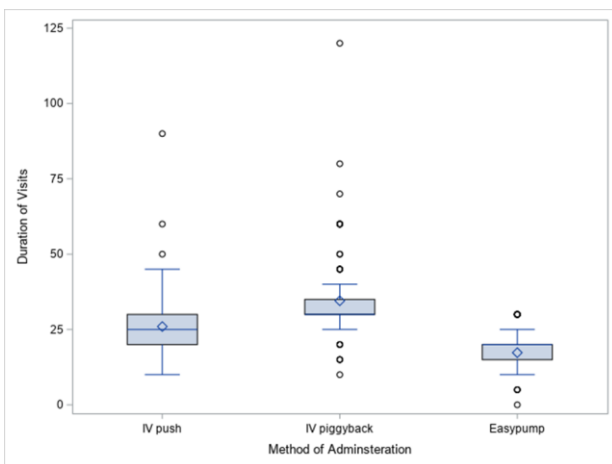


Figure 1: Comparison between durations of visits (in minutes) based on the utilized administration method

Complications of Therapy

In the group of patients that utilized Accufuser®, 18 complications of therapy were observed in 16 (18.0%) patients. As seen in Table 3, The most common complications were related to PICC use, which was seen in seven (7.9%) patients, including two who pulled their own PICCs. Persistent or worsened symptoms were noted in six (6.7%) patients

who had to be readmitted and continued on therapy in the hospital. Sepsis complicated the course of therapy in three (3.4%) patients. Three deaths (3.4%) occurred in the patients who used Accufuser; however, only two of those were related to the current infection; the other case was attributed to another condition. As mentioned above, the mortality rate was not significantly higher than the rate noted in patients who did not use Accufuser® ($P=0.41$).

Table 3: Complications seen in the group that used Accufuser®

Complication	n (%)
PICC-Related	7 (7.9%)
PICC blockage	3 (3.4%)
Pulled PICC	2 (2.2%)
PICC dislodged	1 (1.1%)
PICC site DVT	1 (1.1%)
Persistent or worsening Symptoms	6 (6.7%)
Sepsis	3 (3.4%)
Death	2 (2.2%)
Total	18 (100.0%)

Furthermore, we investigated whether any factor increases or decreases the risk of complications in patients receiving therapy with Accufuser®. As seen in Table 4, gender, being older than 75, DM, CKD, cognitive impairment, and taking drugs that require more than one daily dose were not related to any significant increases in complications of therapy.

Table 4: Factors associated with complications in the group of patients that used Accufuser®

	Complications	No complications	P-value
Gender	16	73	0.53
Male	5 (31.2%)	29 (39.7%)	
Female	11 (68.8%)	44 (60.3%)	
Age ≥ 75 years old	6 (37.5%)	37 (50.7%)	0.34
DM	13 (81.3%)	50 (68.5%)	0.38
CKD	5 (31.3%)	22 (30.1%)	1.00
Dementia	3 (18.8%)	20 (27.4%)	0.75
Frequency ($>1/\text{day}$)	7 (43.8%)	37 (50.7%)	0.62

Statistics of Accufuser® Use

Table 5 presents the diagnoses of the patients who received treatment through Accufuser®. Up to 89 patients were referred with 92 diagnoses. Urinary tract infection (UTI) was the most common diagnosis (32, 34.8%), followed by bacteremia (19, 20.7%) and osteomyelitis (17, 18.5%). Almost half of the cases of bacteremia originated from a UTI (8, 47.7%).

Table 5: Diagnoses of patients who used Accufuser®

Diagnoses	n (%)
UTI	32 (34.8%)
Bacteremia and sepsis	19 (20.7%)
Urosepsis	8 (47.7%)
Osteomyelitis	17 (18.5%)
Septic arthritis	8 (8.7%)
Infective endocarditis	5 (5.4%)
Intracranial infection	4 (4.3%)
Soft tissue infection	2 (2.2%)
Liver abscess	2 (2.2%)
Pneumonia	2 (2.2%)
CMV Retinitis	1 (1.1%)
Total	92 (100%)

A total of 82 pathogens were isolated, as seen in Table 6. *Escherichia coli* was the most commonly isolated pathogen (30, 36.6%), followed by *Streptococci* (18, 22.0%) and *Klebsiella pneumoniae* (10, 12.2%). Candida was the only isolated fungus, and it was seen in four patients (4.9%). Varicella-zoster

virus, the only isolated virus, was isolated from one patient (1.2%).

Table 6: Isolated pathogens from patients who used Accufuser® and their sensitivity

Antimicrobial agent	n (%)
Escherichia coli	30 (36.6%)
ESBL	27 (90.0%)
MR	1 (3.3%)
Staphylococcus spp.	18 (22.0%)
ESBL	1 (5.6%)
MRSA	7 (38.9%)
Klebsiella pneumoniae	10 (12.2%)
Panresistant	4 (40.0%)
ESBL	3 (30.0%)
Enterococcus spp.	5 (6.1%)
MR	2 (40.0%)
Candida spp.	4 (4.9%)
Pseudomonas aeruginosa	4 (4.9%)
MR	3 (75.0%)
Proteus mirabilis	3 (3.7%)
MR	3 (100%)
Total	97 (100.0)
Streptococcus spp.	2 (2.4%)
VZV	1 (1.2%)
Other anaerobic gram-negative	3 (3.7%)
Other gram positive	2 (2.4%)
Total	82 (100.0)

Accufuser® was used with a variety of antimicrobial agents, as illustrated in Table 7. Almost half of the patients were treated with carbapenems (45, 46.4%), mainly due to the high rate of resistance among the isolated organisms. Other antibacterial, antifungal, and antiviral agents were also administered successfully through Accufuser®.

Table 7: Antimicrobial agents that were used in the treatment of patients who used Accufuser®

Antimicrobial agent	n (%)
Carbapenems	45 (46.4)
Ertapenem	31 (32.0%)
Meropenem	13 (13.4%)
Imipenem	1 (1.0%)
Carbapenems	45 (46.4)
Tigecycline	8 (8.2%)
Vancomycin	5 (5.2%)
Tazocin	4 (4.1%)
Ampicillin	2 (2.1%)
Ciprofloxacin	2 (2.1%)
Augmentin	1 (1.0%)
Aztreonam	1 (1.0%)
Antifungal	7 (7.2%)
Cefazolin	8 (8.2%)
Ceftazidime	6 (6.2%)
Ceftriaxone	4 (4.1%)
Cefepime	1 (1.0%)
Anti-viral	3 (3.1%)
Acyclovir	2 (2.1%)
Ganciclovir	1 (1.0%)
Total	97 (100.0)

Discussion

HHC is a means of providing high-quality health care that is safe, cost-effective, and minimally invasive to patients' daily lives. Embracing new tools and devices is essential to ensuring the expansion of HHC and improving the quality of care. We assessed the use of the newly introduced device, Accufuser®, in the home parenteral antimicrobial program in the HHC Department at KAMC in Riyadh. We found that Accufuser® does not carry a significant risk of complications of therapy compared with other methods of IV administration. Accufuser® is superior to traditional methods in reducing the duration of visits and the frequency of daily visits. Thus, this new device

allows nurses to visit more patients daily and accommodate patients within further distances. This effect is also supported by a systematic review that studied the use of elastomeric pumps in home IV antimicrobial programs [12].

We used Accufuser® to treat a variety of infections and administer a list of antimicrobials. It was most practical with medications that require slower administration or frequent daily doses without visiting the patient for each dose. Almost half of the patients were treated with carbapenems, given the high resistance seen among the isolated pathogens. This is in line with a finding in another study that evaluated home antimicrobial programs and found that carbapenems were the most commonly used agents [13].

Most of the complications observed were related to the use of PICC lines. None of the reported complications were specifically related to the Accufuser®; however, adherence to therapy may be questionable in patients who failed to improve. Nonetheless, those complications were not significant when compared to the complications reported with the use of other administration methods. Accufuser® can be used safely in patients with advanced age, cognitive impairment, DM, CKD, and medications with frequent daily doses. In a study that evaluated the use of elastomeric pumps in a university hospital in Switzerland, most of the complications observed were adverse reactions to the prescribed medications [14].

There is a paucity of research evaluating experiences of using electrometric pumps in home parenteral antimicrobial programs. Most studies have evaluated the use of those pumps in home chemotherapy and pain therapy programs. This can be attributed to the assumed stability issues of some antimicrobial agents. However, many studies have proven the stability of many agents in different elastomeric pumps [4], [5], [6], [7], [8], [9], [10].

Conclusion

We believe that the Accufuser® device is a safe method of administering antimicrobial therapy at home. It significantly reduces the duration and frequency of visits. Taking this effect into account, further studies may be needed to evaluate the cost-effectiveness of this device. Further research to evaluate the experience of health care providers and patients (and their caregivers) may provide further insights as well regarding the impact of this device on the HHC program.

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