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Original Article

Instant messaging for outpatient intramuscular antibiotic therapy adherence: proof of concept

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Abstract

Objective: Outpatient antimicrobial therapy works but often requires in-person oversight. Advancements enable seamless communication. We used instant messaging to track adherence, cost, efficacy, and adverse events for outpatient intramuscular antibiotic therapy.

Material and methods: We invited eligible inpatients with bacterial isolates susceptible to ceftriaxone, cefepime, ceftazidime, meropenem, or ertapenem and a positive clinical response to infection to join the study. Participants received antibiotics and submitted daily photos of the used vial through an instant messaging application. After treatment, we conducted virtual follow-ups on days 14 and 28. We asked subjects about adverse events or ongoing symptoms. Any concerns prompted a recommendation to come back for additional evaluation. We calculated the economic impact using the number of outpatient days as reduced hospitalization days, the cost of materials, and nursing personnel expenses.

Results: A total of 30 patients were included; 90% of the subjects showed good adherence, while five exhibited protocol deviations. We observed a 38.3% reduction in hospital costs. Treatment failure occurred in 13.7%, resulting in one readmission. We found no significant adverse events.

Discussion: Integrating WhatsApp enhances healthcare through a free, user-friendly model. It boosts communication, privacy, and antibiotic effectiveness, improving outcomes. Our low-cost approach aids monitoring, particularly in resource-limited settings. Some limitations include no control group, specific intramuscular criteria, and limited expertise. These findings guide future projects and IT-based care models.

Conclusions: The 90% adherence rate in this study serves as a proof-of-concept for instant messaging as an adherence tool for timely deviation identification and enhancing institutional savings during outpatient antibiotic therapy.

Key words: Ambulatory care facility; anti-bacterial agent; intramuscular injection; social media; patient compliance; outpatient parenteral antimicrobial therapy.

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Introduction

Since its creation in 1974, outpatient parenteral antibiotic therapy (OPAT) has grown exponentially and is being used in several countries. It is a safe and effective tool that benefits patients and institutions [1–8]. Patients can promptly return to their daily activities with greater comfort and privacy, psychological and nutritional benefits, and a reduced risk of acquiring a nosocomial infection. Institutions benefit from early hospital discharges, increased hospital bed availability, and cost and supply reduction [9,10].

Infusion centers where patients receive daily or weekly medication report adherence rates of 87-92%; unplanned admissions, reported as treatment failure, in 6-12%, and antibiotic-related adverse effects in 10% of patients. Care models have also been implemented at home, where relatives are trained to administer the parenteral medication with frequent visits by medical staff for follow-up [9,11–15].

Due to the advancement of information technologies and instant messaging applications, communication is easier and faster. Most of the research regarding OPAT describes face-to-face care provided by healthcare personnel; however, the applicability of these technologies in promoting new care models is not entirely understood [16–18].

There is limited evidence on this follow-up strategy; thus, we decided to use an instant messaging app as a substitute for in-person follow-up and determine the impact of remote monitoring on

adherence, cost, efficacy, and adverse events in outpatient intramuscular antibiotic therapy.

Methodology

Study design

We conducted an observational, longitudinal, prospective, single-center study at the Hospital Universitario Dr. José Eleuterio González, a tertiary-care teaching hospital in Monterrey, Mexico. It is an 800-bed hospital that provides care to adult and pediatric patients in 20 wards that might transition to OPAT. The local research ethics committee approved the study protocol with registration number MI21-00003.

Participants

Adult patients ≥ 18 years with a confirmed bacterial infection and microbiological isolates susceptible to cefepime, ceftazidime, meropenem, ceftriaxone, or ertapenem, who were able and willing to receive a single daily intramuscular dose of antibiotic according to their glomerular filtration rate, were considered eligible and invited to participate. We made sure that the patients had a caregiver knowledgeable in intramuscular application or that they could attend a clinic where the medication could be applied. Additional inclusion criteria required a favorable in-hospital clinical outcome, a device with WhatsApp installed, and constant internet access. Patients who required more than five additional days of antibiotic therapy were excluded.

Study Procedures

After obtaining patient consent and before the patient left the hospital, study investigators, in agreement with the treating physician, would pick the antibiotic, dose, and duration of treatment (the latter based on "shorter is better" recommendations) [10]. A last intravenous dose of their assigned antibiotic was administered on the day of hospital discharge. Participants were asked to match the ambulatory intramuscular antibiotic administration time with their last intravenous dose.

Once at home, participants were contacted daily via WhatsApp for the duration of their antibiotic course. They were asked to provide photographic or video evidence of the antibiotic application (the empty vial or proof of application). After the last day of treatment, the patient was followed up by phone on days 14 and 28 from enrollment.

The application was handled in some participants by relatives who were nurses or had the necessary knowledge and skills to apply intramuscular medication. Those who went to a pharmacy or clinic received the medication from physicians or nurses, but we could not warrant that the person responsible for the application was always the same.

During each contact, participants were questioned regarding new symptoms or adverse events. If present, they were referred for medical reevaluation at the OPAT clinic. If the subjects presented symptoms attributable to infection per the investigators ruling, they were categorized as treatment failures. Participants who missed two or more antibiotic doses were automatically referred to the clinic and eliminated from the remote follow-up.

The potential costs and savings were calculated using the number of outpatient days as reduced hospitalization days. The costs of daily hospitalization per patient included the cost saved in medical supplies, nursing staff, and room charges.

Statistical analysis

Descriptive statistics were used to describe the number of subjects who completed the treatment and follow-up and to estimate the savings from ambulatory therapy. SPSS for MacOS version 25.0 was used for statistical analysis.

Table 1. Demographics, Laboratory values, and infection type for the studied population.

Characteristic	N = 30
Age, years, mean (range)	50 (24-81)
Sex assigned at birth	
Women, n (%)	19 (63.3)
Laboratory values	
WBC × 10^9/L (range)	8.8 (3.6-24.3)
Serum creatinine, mg/dL (range)	2.2 (0.3-19.6)
GFR, ml/min/1.73m^2 (range)*	27.5 (4-148)
Type of infection	
Urinary Tract Infection, n (%)	27 (90)
Pyelonephritis, n (%)	23 (76.7)
Bacteremic, n (%)	***3 (13.3)***
Concomitant ABSSSI, n (%)	***1 (3.3)***
Cystitis, n (%)	4 (13.3)
PD-associated peritonitis, n (%)	1 (3.3)
Prostatic abscess, n (%)	1 (3.3)
Intraabdominal abscess, n (%)	1 (3.3)

WBC: White blood cells; GFR: Glomerular filtration rate; ABSSSI: Acute bacterial skin and skin structure infections; PD-AP: Peritoneal dialysis associated peritonitis; *Calculated with CKD-EPI formula.

Results

Subjects

From March 2021 to March 2023, 127 patients were assessed for eligibility: 97 patients were ineligible because of pending medical procedures or administrative impediments; 30 participants accepted to participate and were recruited (mean age, 50 years; 19 women [63.3%]) and followed daily for an average of

3.9 days. Demographic data and baseline laboratory values such as white blood cells, serum creatinine, and microbiological isolates were obtained (Table 1).

A total of 27 subjects had an enrollment diagnosis of urinary tract infection (90%), of which 3 (10%) had pyelonephritis and secondary bacteremia prior to enrollment. Ertapenem was the most prescribed therapy before and after enrollment; used in 16 patients (53.3%) and 24 participants (80%) respectively. Meropenem and Ceftazidime were used for subjects with decreased glomerular filtration rate whose dose requirements were once daily and the latter was employed to treat a subject with an infection caused by a carbapenemase-producing *Pseudomonas aeruginosa* strain. As for bacterial isolates, *Escherichia coli* was the predominant species, accounting for 77.7% of the cases, whereas *Klebsiella pneumoniae* was identified in three cultures (10%). Extended-spectrum beta-lactamase constituted the predominant susceptibility phenotype, being presumed in 28 isolates (93.3%) (Table 2).

Primary outcome

Adherence to ambulatory intramuscular antibiotic therapy was confirmed in 27 subjects (90%). During the daily follow-up, two readmissions not related to infection were recorded: one due to altered mental status on day two and another due to hypoglycemia on day three after discharge. These patients were classified in incomplete adherence to ambulatory treatment since they had not completed the OPAT.

During the daily follow-up, we registered five treatment deviations: one subject was lost to follow-up, could not be reached, and was thus eliminated (3.3%); one subject applied an incorrect dose (3.3%) and three participants missed one dose (10%) (Table 3).

Secondary objectives

Treatment failure was identified in four participants (13.3%) who completed the antibiotic course: two occurred 14 days after the end of treatment (one continued as an outpatient and one was readmitted) and two at day 28 (both continued ambulatory treatment). There were no serious adverse events related to the antibiotics used.

Considering the number of total antibiotic therapy days, the potential global cost for the institution was 76,733.6 USD if all the subjects stayed hospitalized (a mean of 2,557.7 USD per patient). Considering the cost of medical supplies, nursing staff, and hospitalization charges, the total savings were 29,410.6 USD (38.3%, a mean per patient of 980.3 USD).

Discussion

In the dynamic landscape of modern healthcare, the integration of WhatsApp, a widely embraced cross-platform instant messaging app, presents opportunities and challenges for the medical field since it enables seamless communication and collaboration among healthcare professionals while providing stringent

Table 2. Selected antimicrobial agents and isolated pathogens.

Treatment	N = 30 (%)
Antibiotic, ambulatory days, mean [range]	3.9 [1-5]
Ambulatory	
Ertapenem	24 (80)
Meropenem	5 (16.7)
Ceftazidime	1 (3.3)
Baseline before discharge	
Ertapenem	16 (53.3)
Meropenem	4 (13.3)
Imipenem	7 (23.3)
Piperacillin/Tazobactam	3 (10)
Microbiologic diagnostic sampling	
Urine	27 (90)
Blood	**3 (10)**
Skin biopsy	**1 (3.3)**
Peritoneal fluid	2 (6.7)
Intraabdominal Abscess	1 (3.3)
Bacterial Isolates	
Escherichia coli	23 (76.7)
Klebsiella pneumoniae	3 (10)
Pseudomonas aeruginosa	2 (6.7)
Enterobacter cloacae	1 (3.3)
Polymicrobial	1 (3.3)
Susceptibility phenotype	
ESBL phenotype	28 (93.4)
Carbapenemase-producing *	1 (3.3)
Other	1 (3.3)

ESBL: Extended spectrum beta-lactamase; *Carbapenemase-producing strain susceptible to ceftazidime.

Table 3. Summarized primary and secondary outcomes.

Outcomes	N = 30 (%)
Complete adherence to ambulatory treatment, n	**27 (90)**
Incorrect dose application, n	1 (3.3)
Missed one dose, n	3 (10)
Incomplete adherence to ambulatory treatment, n	**3 (10)**
Eliminated, missed two doses, n†	1 (3.3)
Readmitted*	2 (6.6)
Economic cost difference in USD	
Total cost¥	76,733.6
Mean total cost per patient	2,557.7
Total savings per outpatient days (%)	29,410.6 (38.3)
Mean savings per patient	980.3
Follow-up day 14, n ‡	n = 27 (100)
No complication	24 (88.8)
Treatment failure	2 (7.4)
Outpatient follow-up	1 (3.7)
Readmission	1 (3.7)
Readmission for non-infectious causes	1 (3.7)
Follow-up day 28, n	n = 24 (100)
No complication	21 (87.5)
Treatment failure	2 (8.3)
Death*	1 (4.1)

USD: United States dollar; † Subject was eliminated according to protocol; ¥ Included the cost for supplies, nursing staff, and room charges for all participants considering hospital stay for the whole treatment duration; ‡ Excluding eliminated and readmitted subjects; * Not attributed to infection.

privacy measures and adherence to regulatory guidelines to safeguard sensitive patient information and maintain ethical standards [19].

In the realm of antibiotic adherence, WhatsApp emerges as a promising tool, where healthcare practitioners can employ timely notifications, interactive medication schedules, and informative content to bolster patient compliance, contributing to improved public health outcomes [20,21].

We were able to certify adherence in 90% of the recruited subjects, and while treatment failures were detected, they were promptly noticed and managed. The economic impact was favorable since the savings were significant, and no serious adverse events associated with the use of antibiotics were documented.

Most of the current evidence revolves around outpatient parenteral antibiotic therapy and describes face-to-face supervision by healthcare personnel; however, the results obtained regarding ambulatory adherence and treatment failure with instant messaging follow-up were similar to those previously reported in the literature [9,11,13]. These findings can provide information for future projects and help lay the foundation for new information technology-based care models.

Our study is an easy-to-implement care model since instant messaging applications are simple to use. Specialized training is not needed for outpatient follow-up, and it is a method that can improve the timely detection of adverse events, treatment failure, or deviations. It is also free of charge for all parts, which could benefit patients and healthcare systems, especially in resource-limited settings [22].

However, these findings must be interpreted considering the following limitations: a control group was not included, and we limited the intramuscular route only to those subjects who required one dose per day for no longer than five days. We could not determine if the person responsible for the intramuscular application had the necessary expertise, and most of our patients had urinary tract infections, which are generally considered to have a low bacterial inoculum.

Conclusions

Adherence to ambulatory intramuscular antibiotic treatment was adequately certified using WhatsApp-based follow-up in most of the subjects. Adherence deviations or treatment failures were quickly identified and treated. The estimated economic impact in this small group of patients represented savings for the institution with an easily expandable and replicative model.

Our study is a proof of concept using instant messaging as an adherence tool for outpatient antibiotic therapy clinics.

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Authors' contributions

Joel I. Alcala-González: Methodology, Formal Analysis, Resources, Data Curation, Writing-Original Draft. Adrian Camacho-Ortiz: Supervision, Writing-Reviewing and Editing. Laura M. Nuzzolo-Shihadeh: Writing-Reviewing and Editing. Marco A. Hernandez-Guedea: Supervision, Resources. Luis A. Salinas-Garza: Resources, Data Curation. Eduardo Perez-Alba: Conceptualization, Methodology, Writing-Reviewing and Editing.

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