El Ouweini A, Bagnnan IA, Babu T, Levien T, Malaeb D. Assessment of intravenous to oral medications conversion practice at a UAE tertiary care hospital: A retrospective observational study. Pharmacy Practice. 2025 Jan-Marc;23(1):2985.
https://doi.org/10.18549/PharmPract.2025.1.2985

**Original Research**

# Assessment of intravenous to oral medications conversion practice at a UAE tertiary care hospital: A retrospective observational study

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Received (first version): 28-Sep-2023 Accepted: 05-May-2024 Published online: 04-Jan-2025

**Abstract**

**Background:** Many patients admitted to the hospital are initially started on intravenous (IV) medications due to their clinical conditions that necessitate only the use of the parenteral route of administration. As the patient's clinical status improves and the patient can tolerate oral intake, drugs can be converted from IV to oral (PO) form. Switching IV to PO treatment, in a timely manner, is an effective and safe approach that leads to improved rational use of medications and contributes to overall cost savings. This study aims to assess the current practices of IV to PO conversion practice in intensive care unit (ICU) settings, with regards to antibiotics, proton pump inhibitors, and acetaminophen. **Methods:** Retrospective, cohort study performed from October 2020 - October 2022 in a tertiary care hospital in the UAE. All patients were admitted to the ICU and had received an IV antibiotic, proton pump inhibitors or acetaminophen for more than 48 hours, were able to eat or tolerate oral formulation and enteral feeding, patients with intact gastrointestinal tract and the absence of bowel abnormalities, adequately absorbed oral medications via the oral, gastric, or nasogastric tube route. **Results:** Most of the study participants were admitted to infectious disease as primary diagnosis, with pneumonia being the most prevalent type of infection followed by Skin and Soft Tissue Infections (SSTIs). Beta-lactams were the most frequently prescribed antibiotic class (52.5%), followed by vancomycin (12.7%). The majority of the patients (84.7%) were able to tolerate an oral diet (either since the time of admission or later after clinical improvement), and 92.4% of them showed clinical improvement. 89% of the patients were good candidates for IV to PO switch, however, the medical team failed to do the switch. The total cost for the total duration of IV therapy was 119,400 AED (USD 32,500). Patients who were not candidates for the IV to PO switch became later able to tolerate oral diet and medications for an average of 3 days. Nevertheless, they were not switched during these days. Thus, upon calculating the costs, we found that 18,377 AED (USD 5000) could have been saved if the IV to PO switch was done timely. Conclusion: Intravenous to peroral conversion practice was infrequent. Improper IV to PO conversion practice was significantly associated with beta-lactams, acetaminophen and PPIs. Awareness of IV to PO conversion practice and short-term training for healthcare teams is vital for better IV to PO conversion practice.

**Keywords:** proton pump inhibitors; acetaminophen; antibiotics, intravenous; oral; cost, intensive care unit

## INTRODUCTION

Many patients admitted to the hospital are initially started on intravenous (IV) medications due to their clinical conditions that necessitate only the use of the parenteral route of administration. As the patient's clinical status improves and the patient can tolerate oral intake, drugs can be converted from IV to oral (PO) form. Switching IV to PO treatment, in a timely manner, is an effective and safe approach that leads to improved rational use of medications and contributes to overall cost savings.[1,2] Drugs with high bioavailability are good candidates for IV to PO switch. For drugs with similar plasma exposure (area under the curve (AUC) oral/AUC intravenous is 90% or more), intravenous and oral routes of the same drug at the same dose are bioequivalent.[1-3] Timely IV to PO switch has major advantages for the patient that include easier ambulation and reduced risk of intravascular catheter infection due to shorter line dwell times and less endoluminal contamination. This approach also offers advantages to the healthcare professionals such as reduced preparation time and risk of needle injuries. Moreover, IV to PO switch helps the hospital and society to reduce the hospital stay, healthcare cost, and environmental waste.[4-7] Additionally, a timely switch of antimicrobials is considered an easily attainable antimicrobial stewardship intervention that results in a more resourceful use of antimicrobials.[6,8] Moreover, thousands of IV Proton Pump Inhibitors (PPIs) and Acetaminophen doses are being administered on an annual basis. Many of these IV doses were administered to patients who were candidates for oral intake or who received other medications given through the oral route and thus were eligible to receive PO medications. In a pharmacoeconomic study, using IV instead of PO PPI therapy would cost an incremental $708,735 per year to gain one additional Quality-Adjusted Life Year in high-risk ulcer hemorrhage patients.[9] After 72 hours of initial

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www.pharmacypractice.org (eISSN: 1886-3655 ISSN: 1885-642X)

stabilization in hospitalized patients, 83% of them would be needlessly administered intravenous antibiotics, resulting in a twofold increase in treatment expenses. While certain concerns exist, specific categories of antimicrobial drugs, like quinolones, maintain comparable oral bioavailability to their IV counterparts, even when administered to critically ill patients.[10] Despite these facts, the overuse of IV administration, when oral formulations may be more appropriate, is highly common.[11] The primary impediment to transitioning from IV to PO antibiotic therapy lies in the misperception that intravenous treatment confers a lower risk of reinfection. Prescribing clinicians commonly initiate therapy with IV antibiotics and paracetamol, maintaining this regimen until the patient's discharge, which may impact the duration of hospitalization. Moreover, conflicting guidelines exist regarding the criteria and optimal timing for transitioning to oral antibiotics.[12-15] To the best of the investigators' knowledge, the prevalence and factors of IV to PO conversion practice were not adequately investigated in tertiary care hospitals in the UAE. This study aims to assess the current practices of IV to PO conversion practice in intensive care unit settings, with regards to antibiotics, proton pump inhibitors, and acetaminophen.

## MATERIALS AND METHODS

### Study Design

Retrospective, cohort study performed from October 2020 - October 2022 in a tertiary care hospital in the UAE. Eligible patient medical charts were reviewed from the ICU-admitted patients, and information was collected using a data collection sheet. Eligibility criteria included patients aged 18 and above who are admitted to the ICU and had received an IV antibiotic, proton pump inhibitors or acetaminophen for more than 48 hours, were able to eat or tolerate oral formulation and enteral feeding, patients with intact gastrointestinal tract and the absence of bowel abnormalities, adequately absorbed oral medications via the oral, gastric, or nasogastric tube route were included in the study. Patients who were on prolonged course of IV antibiotics due to certain infections such as endocarditis and osteomyelitis, unable to respond to oral medications, with grade three and above mucositis, with unstable conditions, refusing oral medications, and immunocompromized patients (febrile neutropenia on cancer chemotherapy) were excluded from this study.

### Sample size calculation

Using the G-power software, a minimum sample of 297 was deemed necessary, based on a $R^2$ deviation of 5%, an alpha error of 5%, a power of 80%.

### Data collection and variables

A data collection sheet was created to study the variables that were important to assess the current practice of IV to PO shift and its associated factors in the ICU. The data collection sheet was content-validated by a panel of experts including PharmD professors. Data collection was performed by a registered clinical pharmacist and last year pharmD students. A report was extracted from the hospital's electronic medical record for all patients admitted to the ICU and an IV antibiotic, proton pump inhibitors or acetaminophen for more than 48 hours in the specified period. The data collection sheet included several sections: patient demographic characteristics, data about the primary diagnosis, indications for the IV medications, type of infection, the prescribed IV antibiotic, the estimated total cost of IV antibiotics, acetaminophen and PPIs alone and combined, the candidature status of the patient to be shifted from IV to PO, whether the IV to PO shift was done timely and the estimated total cost savgins from IV to PO shift. The appropriateness of the IV to PO switch was based on whether the switch was done for those who were candidates for the switch. The patients were considered candidates for the switch if they were able to tolerate oral diet and/or had overall clinical improvement.

### Statistical analysis

IBM SPSS Statistics for Windows, version 25.0 (IBM Corp., Armonk, N.Y., USA) was used to perform the data analysis. Dichotomous and categorical variables were presented as percentages, and the continuous variables were displayed as mean±standard deviation (SD). Mean values, standard deviations, and frequencies were computed to illustrate current prescribing practices of IV to PO conversion in the intensive care unit in this tertiary care hospital. All factors that showed significance in the bivariate analysis were entered as independent variable. $P < 0.05$ was deemed statistically significant in the final model.

## RESULTS

A total of 118 patients were enrolled in this study. Table 1 provides a summary of the patients' demographic statistics, including age, BMI, gender, and primary diagnosis.

Most of the study participants were admitted to infectious disease as primary diagnosis, with pneumonia being the most prevalent type of infection followed by SSTIs.

Beta-lactams were the most frequently prescribed antibiotic class (52.5%), followed by vancomycin (12.7%). The majority of

Table 1. Sociodemographic Characteristics of Enrolled Patients

| | |
|---|---|
| **Age, mean (±standard deviation)** | 32.67 (±21.93) |
| **BMI (±standard deviation)** | 28.53 (±7.84) |
| **Gender:** | |
| Male | 65 (55.1) |
| Female | 53 (44.9) |
| **Primary Diagnosis** | |
| Infection | 64 (54.2) |
| CVD | 24 (20.3) |
| GI | 12 (10.2) |
| Others | 18 (15.3) |
| **Type of Infection** | |
| Intraabdominal | 9 (7.6) |
| Meningitis | 5 (4.2) |
| Pneumonia | 23 (19.5) |
| Sepsis | 12 (10.2) |
| SSTIs | 14 (11.9) |

Table 2. Prescribed IV Medications

| Medication | No. (%) | Duration of use, days, mean (±SD) |
|---|---|---|
| **Antibiotics** | **64 (54.2)** | 7 (±2.5) |
| Beta-lactams | 62 (52.5) | |
| Vancomycin | 15 (12.7) | |
| Metronidazole | 9 (7.6) | |
| Clindamycin | 2 (1.7) | |
| Azithromycin | 6 (5.1) | |
| Fluoroquinolones | 5 (4.2) | |
| **Acetaminophen** | **65 (55.1)** | 4.5 (±1.2) |
| **PPIs** | **60 (50.8)** | 5.5 (±1.3) |

Table 3. Patients' Clinical Status with regards to IV to PO conversion

| | **No. (%)** |
|---|---|
| **Diet** | |
| Tolerate PO | 100 (84.7) |
| Can not tolerate PO | 18 (15.3) |
| **Clinical Improvement** | |
| Yes | 109 (92.4) |
| No | 9 (7.6) |
| **Candidate of IV to PO Switch** | |
| Yes | 92 (78) |
| No | 26 (22) |
| **Days the patient can tolerate PO, mean (±standard deviation)** | 3 (±1) |
| **Appropriateness for the switch** | |
| Yes | 13 (11) |
| No | 105 (89) |

the patients (84.7%) were able to tolerate an oral diet (either since the time of admission or later after clinical improvement), and 92.4% of them showed clinical improvement. 89% of the patients were good candidates for IV to PO switch, however, the medical team failed to do the switch.

As shown in table 4, the total cost for the total duration of IV therapy was 119,400 AED (USD 32,500). Patients who were not candidates for the IV to PO switch became later able to tolerate oral diet and medications for an average of 3 days. Nevertheless, they were not switched during these days. Thus, upon calculating the costs, we found that 18,377 AED (USD 5000) could have been saved if the IV to PO switch was done timely.

### Bivariate analysis

As evident from table 5, primary diagnosis of infection, CVD, and GI disease was significantly associated with inappropriate IV to PO switch. Additionally, the beta-lactams class was the most significant antibiotics that is unlikely to be switched to PO when it is permissible. Similarly, acetaminophen and PPIs were significantly associated with inappropriate IV to PO switch. Other factors were not significantly associated with the appropriateness of the IV to PO switch.

## DISCUSSION

The majority of hospitalized patients initially given intravenous

Table 4. Estimated Costs of Therapy

| | **Amount in AED** |
|---|---|
| **Total IV Antibiotic Therapy** | 89,100 |
| **Total IV Acetaminophen Therapy** | 17,220 |
| **Total IV PPI Therapy** | 13,080 |
| **Total IV Medications Therapy** | 119,400 |
| **PO Therapy if the shift was done timely** | 16,968 |
| **IV Therapy Spent when the shift was not done** | 35,345 |
| **Savings if the switch was done timely** | 18,377 |

Table 5. Bivariate Analysis of factors associated with Appropriateness for the IV to PO switch

| **Variables** | **Appropriateness for the IV to PO switch** | | **P- value** |
|---|---|---|---|
| | **No** | **Yes** | |
| **Gender** | | | |
| Male | 59 (90.8) | 6 (9.2) | 0.562 |
| Female | 46 (86.8) | 7 (13.2) | |
| **Primary Diagnosis** | | | |
| Infection | 63 (100) | 0 (0) | **< 0.001** |
| CVD | 24 (100) | 0 (0) | |
| GI | 12 (100) | 0 (0) | |
| Others | 6 (31.6) | 13 (68.4) | |
| **Type of Infection** | | | |
| Intraabdominal | 9 (100) | 0 (0) | 0.595 |
| Meningitis | 5 (100) | 0 (0) | 1.000 |
| Pneumonia | 23 (100) | 0 (0) | 0.070 |
| Sepsis | 12 (100) | 0 (0) | 0.357 |
| SSTIs | 14 (100) | 0 (0) | 0.360 |
| **Prescribed IV Medications** | | | |
| **Antibiotics** | | | |
| Beta-lactams | 62 (100) | 0 (0) | **< 0.001** |
| Vancomycin | 15 (100) | 0 (0) | 0.215 |
| Metronidazole | 9 (100) | 0 (0) | 0.595 |
| Clindamycin | 2 (100) | 0 (0) | 1.000 |
| Azithromycin | 6 (100) | 0 (0) | 1.000 |
| Fluoroquinolones | 5 (100) | 0 (0) | 1.000 |
| **Acetaminophen** | 53 (80.3) | 13 (11) | **< 0.001** |
| **PPIs** | 48 (78.3) | 13 (21.3) | **< 0.001** |
| **Diet** | | | |
| Tolerate PO | 87 (87) | 13 (13) | 0.214 |
| Can not tolerate PO | 18 (100) | 0 (0) | |
| **Clinical Improvement** | | | |
| Yes | 97 (88.2) | 13 (11.8) | 0.596 |
| No | 8 (100) | 0 (0) | |
| **Candidate of IV to PO Switch** | | | |
| Yes | 79 (85.9) | 13 (14.1) | 0.069 |
| No | 26 (100) | 0 (0) | |

Numbers in bold indicate significant *p* values

medications can transition to a suitable oral form once they meet clinical stability criteria, as long as they complete the entire course of treatment. This study aimed to evaluate the current practice of conversion from IV to PO antibiotics, acetaminophen, and PPIs. The prevalence of proper IV to PO conversion practice in this study was 11% which was lower than a previous retrospective study conducted in Lebanon.[11] that

had a 26% IV to PO conversion practice, and much lower than the conversion practice in another study conducted in India showed 43.68% IV to PO conversion practice.[16] This variation in the IV to PO conversion practice appropriateness may stem from the inclusion of a smaller sample size in this study. Moreover, factors such as the accessibility of oral medications, the expertise and habits of healthcare providers, and healthcare policies play pivotal roles in influencing the practice of transitioning from intravenous to oral administration. Furthermore, being a retrospective study might have led to the missing of important information during data collection. In this study, 105 of the included patients (89%) were not switched from IV to PO. This could have contributed to complications including catheter-related adverse events, pain, infections, thombus, overhydration, among others.[17] to the patients. In UAE, it is common practice to shift patients to oral antibiotic treatment upon their discharge from the hospital, although patients must undergo 24 hours of monitoring after the switch before being discharged. Equally important is the lost money for failing to do the IV to PO conversion on a timely manner, which was estimated to be 18,377 AED (USD 5000). In fact, this amount was based on the 118 patients only who were included in the study and thus would be much higher when the sample size is larger. In addition, the showed costs in tabe 4 were only estimates of the IV medications costs and not the actual costs. The hospital procures different brands of different IV antibiotics, acetaminophen and PPIs. Hence, the cost is constantly changing. Even within the beta-lactam antibiotics class, different medications have different costs and the costs show only the average cost for all beta-lactams used in the included patient population. This outcome is confiremd from a study conducted in Michigan, which indicated that patients who had their antibiotics switched from intravenous to oral administration were able to reduce their drug expenses by $15,000.[18] In this study, In this study, beta-lactam was the most frequently prescribed antibiotics (52.5%). The reason for this finding could be the fact that most of the patients admitted for infections were diagnosed with pneumonia at the first place, followed by SSTIs, both for which beta-lactams are common empiric treatment options. One of the barriers to the timely transition from intravenous to oral treatment is the lack of familiarity with guideline recommendations, as well as misconceptions and uncertainty about expected outcomes. These challenges were similarly observed in the findings of other two studies.[22,23] where physicians were unaware of the presence of explicit guidelines regarding the appropriate timing for the switch. Patients who were not candidates for the IV to PO switch became later able to tolerate oral diet and medications for an average of 3 days. This finding was consistent with other studies.[24,25] that that also reported the appropriate time for IV therapy to be reassessed between 3 to 4 days.

## LIMITATIONS

This research has a number of limitations. To begin with, the small sample size could diminish the significance of the findings. Another drawback involves the data collection being limited to just one hospital, which constrains the generalizability of the findings to other hospitals in other emirates. Furthermore, the retrospective study design posed a limitation by restricting prospective interactions with patients and raising the rate of missing data and accuracy of collected data. Additionally, the study team lacked access to this data because it was a retrospective study, and not all the necessary information had been documented. For example, the study team could not determine the exact cause of not converting the patients from IV to PO when they meet the criteria for the switch. Additionally, the calculated costs of IV therapy do not show the exact cost of therapy as there are variations in the hospital's formulary as indicated in the discussion section. Therefore, more actual lost costs could have been saved if a timely IV to PO shift had been done. Moreover, this study did not assess in detail the associated factors with the IV to PO conversion practice that were assessed in previous trials.[19,20] such as high temperature, tachypnea, hypotension, tachcardia, complications due to co-morbidities, although these were assessed collectively under clinical improvement. Length of stay is prolonged when inappropriate conversion of IV to PO therapy exists.[21] However, this outcome was not assessed in this study.

## CONCLUSION

In conclusion, the findings of this study underscore the necessity for a systematic approach and well-defined protocols when prescribing IV medications and evaluating treatment decisions. This includes regularly assessing the patient's clinical condition to determine the appropriateness of transitioning from intravenous to oral therapy in everyday medical practice. Future research should aim to gauge physicians' knowledge, attitudes, and willingness to adopt such transitions, with the ultimate goal of establishing a comprehensive and effective guideline for intravenous-to-oral therapy conversion, which can then be implemented through a collaborative team approach. It's worth noting that this study, being retrospective and observational, did not measure any reduction in complications resulting from the switch from intravenous to oral therapy. This highlights the need for prospective research in the future, potentially involving pharmacists in the intervention process.

## DECLARATIONS

### Ethical statement

The study was approved by the Institutional Review Board of Gulf Medical University (Ref: RB/COP/FAC/73/DEC-2022).

### Data Availability Statement

The database cannot be shared publicly but is available upon a reasonable request from the corresponding author.

### Declaration of interests

The authors declare no conflict of interest.

### Funding

This research received no external funding.

## AUTHOR CONTRIBUTIONS

Conceptualization, A.E.O.; methodology, A.E.O.; validation, A.E.O., D.M. and T.L.; formal analysis, A.E.O., D.M. and T.L.; investigation, A.E.O., D.M.; resources, T.L..; data curation, A.E.O, I.B, T.B; writing—original draft preparation, A.E.O, I.B, T.B; writing—review and editing, D.M., T.L.; visualization, A.E.O, D.M.; supervision, D.M.; project administration, A.E.O., D.M. and T.L.; funding acquisition. All authors have read and agreed to the published version of the manuscript.

## ACKNOWLEDGMENTS

None.

## ABBREVIATIONS

Intravenous (IV), Oral (PO), Proton Pump Inhibitors (PPIs), Intensive Care Unit (ICU), Body Mass Index (BMI), Skin and Soft Tissue Infections (SSTIs), Cardiovascular Diseases (CVD), Gastrointestinal (GI).

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