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Introduction

At Hull University Teaching Hospitals NHS Trust the Outpatient Parenteral Antimicrobial Therapy (OPAT) team have an active antimicrobial stewardship programme which aims to promote the appropriate use of antimicrobials with a view to:

- Improving patient outcomes
- Reducing resistance
- Decreasing infections caused by multi drug resistant bacteria

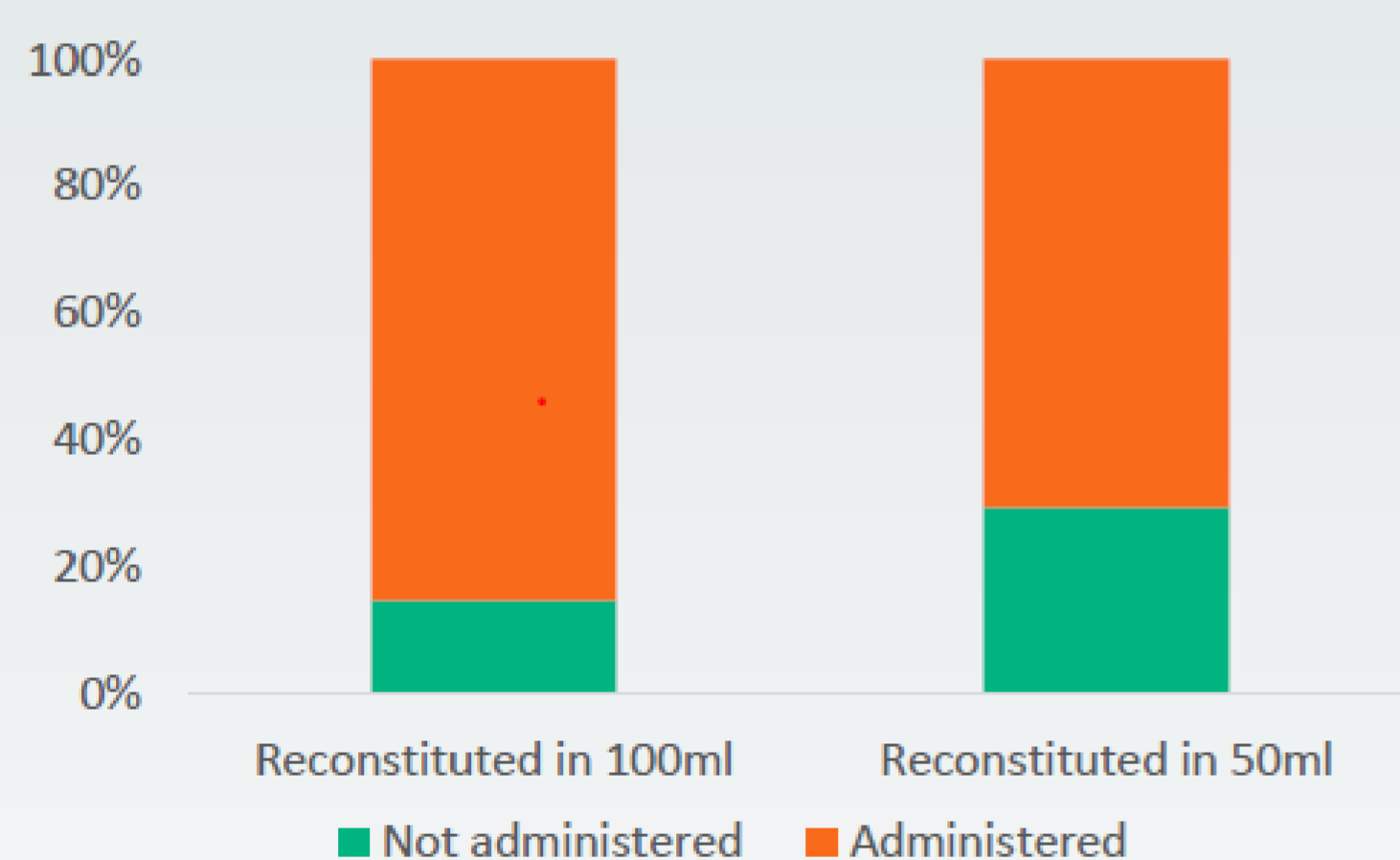
As part of our antimicrobial stewardship research, we became aware of studies highlighting that 40 – 60%¹ of an antimicrobial drug may remain in the intravenous tubing, owing to the residual volume that remains in the line. As such, we wanted to investigate the extent of unintentional underdosing of intravenous antibiotics in our facility with the specific objectives being to assess;

- The prevalence of underdosing
- The volume of antibiotic not being administered
- The cost impact of the discarded antibiotic infusion administered

Prevalence & Volume Being Underdosed

Observational audits confirmed that practice in our Trust reflected what was reported in wider publications² regarding an average residual volume of 16ml remaining in the line. To confirm these observations, we conducted our own analysis of the residual volume of antibiotic in relation to the volume it was reconstituted in (Fig. 1). This highlighted to what extent each patient was being underdosed:

Figure 1 – Delivery of prescribed drug



Of major concern was the accumulative effect of the missed doses highlighted in Box 1 below:

- 1g Ertapenem mixed with 10ml water for injection in 100ml 0.9% sodium chloride (total volume 110ml)
- Prescribed daily at 10am for 12 weeks
- Waste 16ml per intermittent infusion using standard gravity set
- Only 86.4% administered
- 16ml waste = 145.5mg Ertapenem
- 145.5ml Ertapenem x 84 days = 12218.18mg Ertapenem = 12.22g Ertapenem = 12 missed doses

We believe that our reported underdosing data (Fig. 1) could be having a substantial impact on patient health. This is due to the impact of the underdosing over the course of an entire treatment duration (Box. 1). Combined with the fact that the best management of infections via antimicrobials is dependent on a complex balance of; appropriate antimicrobial, minimum inhibitory concentration (MIC) dose, duration, and frequency of administration¹.

Furthermore, we were also aware that underdosing would negatively impact the Probability of Target Attainment (evaluation of plasma exposure of an antibiotic dosing regimen in a patient population against a target exposure required for efficacy, expressed relative to the MIC for a pathogen) as researched by the drug manufacturers. This was due to the fact we weren't administering in accordance with recommendations outlined in the SPC¹.

Improvement Strategy

Based on the analysis of data, we explored strategies for improvement including introducing post infusion line flushing via the use of the SafeSet Flush administration set, to ensure that the patient received the total prescribed dose as advised by the NIVAS line flushing guidance^{3,4}. As an OPAT Service Manager this included giving due consideration to the impact on our budget, nursing time and feedback from the nursing team regarding the solution introduced:

Budget

Continuing with the example of underdosing Ertapenem (Box 1), which calculated a 14.6% underdose, we reviewed the cost implications of our current situation versus introducing a gravity administration set that would permit the line to be flushed ensuring full prescribed dose delivery:

Figure 2 Comparative calculations based on 516 infusions p/a with Ertapenem 1g costing £31.65 and the 14.6% wastage costing £4.62 per infusion.

Current situation – resulting in underdosing

Total costs of standard gravity sets	Total cost of drug wastage	Total cost of gravity sets & drug wastage
£252.84	£2,383.92	£2636.76

Flushing the line – ensuring total dose delivery

Total costs of SafeSet Flush and flush Syringe	Total cost of drug wastage	Total cost of gravity sets & drug wastage
£635.81	£0.00	£635.81

Total saving of £2000

Nursing Time & Feedback

Two solutions were identified that would enable the OPAT team to deliver the total prescribed dose;

Use a flushing bag

Requires spiking a flush bag after each antibiotic infusion.

Concerns:

- Potential for air embolus
- The need to continuously monitor to prevent fluid overload
- Increased nursing time

Use SafeSet Flush

SafeSet Flush with upstream needlefree injection port and air stop filter, enabled us to flush the line without the risk of giving patients an air embolus and by attaching a measured volume flush syringe to the Caresite needlefree valve, only the residual volume of antibiotic is displaced, the patient does not receive unnecessary fluids. As the flush solution can be loaded into the drip chamber in one push and allowed to infuse at the same rate as the antibiotic, it also had minimum impact on nursing time.

Conclusion

Having introduced SafeSet Flush over 2 years ago, it has proven popular with OPAT staff and enabled the problem of underdosing of antibiotics to be overcome with increased likelihood that the Probability of Target Attainment of the antimicrobial is routinely achieved; ensuring the best likelihood of quick recovery for OPAT patients.

When considering the clinical impact of underdosing and the associated impact on our budget, it was also a more cost-effective solution over wasting costly drugs and has minimum impact on nursing time.

References:

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