Needs Assessment for Antimicrobial Stewardship in a Rehabilitation Hospital: A Retrospective Descriptive Study

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ABSTRACT

Background:
Published antimicrobial stewardship (AS) initiatives have focussed on acute care hospitals. AS may be important in rehabilitation hospitals to reduce unnecessary antibiotic use in patients at risk for infection due to their rehabilitation diagnosis (e.g. stroke, burns, trauma, orthopedic surgery) and prolonged hospital stay.
Objective(s):
To benchmark antibiotic use and identify potential targets for future AS interventions at a rehabilitation hospital.
Methods:
A computerized database retrospective study was conducted at St. John's Rehab Hospital (SJR), affiliated with Sunnybrook Health Sciences Center, Toronto, Ontario. Antibiotic use and microbiology data for all hospitalized patients between July 1, 2015 and June 30, 2016 who were prescribed one or more antibiotics were evaluated. The primary benchmark metrics were days of antibiotic therapy per 1000 patient days, frequency of prolonged antibiotic therapy, identification of most common antibiotics prescribed, and number of cultures sent and processed by microbiology.
Results:
During the study period, 980 antibiotic courses were prescribed in 705/2483 patients (28%; 95%CI:27-30%), with at total of 447 cultures processed by microbiology. A total of 249/705 patients (35%; 95%CI:33-37%) were admitted to SJR on antibiotics, corresponding to 355/980 (36%; 95%CI:33-39%) courses of antibiotics that were active on admission to SJR. The mean days of antibiotic therapy per 1000 patient days was 138±17, with a median duration of therapy of 6 days (IQR:4-8), where 41% (401/980; 95%CI:38-44%) of antibiotics were prescribed greater than 7 days. Fluoroquinolones (27%; 261/980), cephalosporins (26%; 256/980), penicillins (17%; 167/980) and nitrofurantoin (16%; 155/980) were most frequently prescribed. The most common source sent to microbiology for processing was urine (62%; 279/447;95%CI:58-67%), and *Escherichia coli* was the most common urinary bacteria cultured (60%; 168/279;95%CI:54-66%). Few antibiotic courses were de-escalated from intravenous to oral (10%, 10/87;95%CI:4-17%).
Conclusions:
Rehabilitation hospitals may benefit from AS initiatives that evaluate appropriate antibiotic duration, de-escalation opportunities, evaluation of all patients prescribed fluoroquinolones, cephalosporins, and penicillins, assessment of urine samples ordered, drawn and processed, and improved empiric prescribing based on a site-specific antibiogram.

BACKGROUND

Antibiotic Stewardship in Acute Care
- Antibiotic resistance is a global threat to public health.
- Overuse of antibiotics is the major driver of antibiotic resistance.
- Up to 50% of antibiotic use in acute care settings is inappropriate.

Antibiotic Stewardship in Rehabilitation Hospitals – Rationale and Gaps
- The 2017 Accreditation Canada required organizational practice (ROP) for antimicrobial stewardship (AS) has been expanded to include inpatient rehabilitation and complex continuing care .
- Antimicrobial stewardship may be important in rehabilitation hospitals because patients may be at risk for both infection and inappropriate antibiotic therapy as a consequence of their admitting diagnosis for rehabilitation, and prolonged hospital stay.
- Studies benchmarking and evaluating antibiotic use in rehabilitation hospitals are lacking.

OBJECTIVE

- The objective of this study was to assess the use of antibiotics in a rehabilitation hospital to benchmark antibiotic use and identify potential targets for future AS interventions.

METHODS

Study Design and Setting
- Retrospective descriptive study of antibiotic use among inpatients at a 160 inpatient bed rehabilitation facility was performed at St. John's Rehab Hospital (SJR) in Toronto, Ontario.
- SJR provides customized rehabilitation for patients recovering from various injuries, such as amputations, traumatic injuries, cardiovascular surgery, strokes, cancer, complex neurological and orthopedic conditions.
- SJR is home to Canada's only organ transplant rehabilitation program and Ontario's only burn rehabilitation program.
- The study period was July 1, 2015-June 30, 2016.
- Institutional Ethics Board approval for ongoing review of antimicrobial stewardship data for quality improvement initiative was obtained originally in February 2010 and undergoes

METHODS

Patient Eligibility
- All inpatients who resided in the rehabilitation hospital between July 1, 2015 and June 30, 2016, and who were prescribed antibiotics and / or had microbiology results were included.

Data Collection
- Data relevant to antibiotic use were obtained from the Pharmacy database of the facility.
- Data relevant to microbiology workload were obtained from the Microbiology database of the facility.
- The number of patient days per month, the number of hospital admissions, the number of hospital discharges, and the overall average patient length of stay during the study period were obtained from Decision Support at the facility.
- Patient days per month were used to standardize antibiotic use and microbiology workload to 1000 patient days, to allow benchmarking within and between institutions.

Statistical Analysis
- Descriptive analyses were completed using Microsoft Excel 2010 software (Microsoft Corporation, Redmond, Washington) and GraphPad Instat (version 3.05, 32 bit for WIN 95/NT, created September 27, 2000).
- Interval data are reported as means with standard deviation or median with interquartile range (IQR), based on whether or not data passed the test for normality (GraphPad Instat).
- Nominal data are reported as a percentage with a 95% confidence interval (CI).

Outcome Measures
Antibiotics:
- The primary benchmark metrics for antibiotics were days of antibiotic therapy (DOT) per 1000 patient days (PDs), frequency of prolonged antibiotic therapy > 7 days and > 90 days, and identification of most common antibiotics prescribed during the study period.
- The secondary antibiotic outcomes for antibiotics were DOT/1000 PDs categorized by antibiotic class, intravenous antibiotics, oral antibiotics, and days of IV antibiotic therapy saved by parenteral to oral step down.

Microbiology:
- The primary benchmark metric for microbiology was an assessment of workload for processing cultures drawn for inpatients expressed as the number for each source processed by microbiology/1000 PDs.
- An institution specific antibiogram was developed for the most frequent bacteria isolated during the study period.

RESULTS

Demographic Characteristics:
- 2,483 patients were admitted to the hospital, and 2,485 were discharged from the hospital during the study period
- 705 (28%; 95% CI: 27-30%) patients received a course of antibiotics
- 249 (35%; 95%CI:33-37%) patients were admitted to SJR on antibiotics
- Median age of patients on antibiotics was 77 (IQR 66 – 84)
- 424 (60%) patients who received a course of antibiotics were female
- Total number of patient days at the site during study period was 52,551 days, with an overall average patient length of stay of 21 days for all patients admitted during the study period
- The median length of stay for patients who received a course of antibiotics during the study period was 22 days (IQR 14 – 33)

Antibiotic Use:
- Of 980 antibiotic courses prescribed for presumed infection, 41% (401/980; 95% CI: 38 -44%) of courses were for > 7 days and no courses were continued for > 90 days .
- Median duration of antibiotic use was 6 days (IQR 4-8)
- Of the 625 new antibiotic courses started at SJR, the median time from admission to antibiotic start date was 9 days (IQR 5 – 16)
- Oral antibiotics were most commonly prescribed (91%, 891/980; 95% CI: 89 – 93%)
- Of the 87 IV orders, 82 (94%, 95% CI: 89 – 99%) were active on admission to SJR
- Only 9/87 (10%; 95% CI: 4-17%) intravenous antibiotic courses were stepped down to oral therapy.
- 78% (7/9) of the IV to PO step-down courses were in fact from antibiotic courses that were active on admission.

Table 1: Antibiotic Use and Duration of Therapy over Study Period[a]

Antibiotic (ATB) Use	Number of Antibiotic Orders	% of Total Antibiotic Orders	95% Confidence Interval	DOT/1000 Patient-Days in Study Period[b]	Interquartile Range for DOT/1000 Patient-Days[c]
By route:					
Total Antibiotics active on transfer to SJR, any route [d]	355	36	33 - 39	59 ± 16[e,e]	48 - 69
IV Antibiotics active on transfer to SJR	82	8[f]	7 - 10	21 ± 9[e,e]	17 - 25
PO Antibiotics active on transfer to SJR	272	28[g]	25 - 31	38 ± 9[e,e]	32 - 45
Total New antibiotic Initiated at SJR	625	64	61 - 67	79 ± 10[e,e]	68 - 84
Total ATB, any route[d]	980	100		138 ± 17[e,e]	131 - 151
IV	87	9	7 - 11	22 ± 9[e,e]	18 - 26
PO	891	91	89 - 93	116 ± 11[e,e]	112 - 122
By indication:					
IV to PO Step Down	9[h]	10	4 - 17	0.7[i]	0.6 – 1.7
By class[j]:					
Penicillins	167	17	15 - 19	27 ± 10[e,e]	19 - 35
Cephalosporins	256	26	23 - 29	38 ± 11[e,e]	33 - 39
Carbapenems	10	1	0 - 2	2 ± 3[e,e]	0 - 1
Fluoroquinolones	261	27	24 - 29	33 ± 8[e,e]	25 - 40
Vancomycin IV	10	1	0 - 2	2 ± 3[e,e]	0 - 4
Aminoglycosides	0	0	-	-	-
Metronidazole	17	2	1 - 3	2 ± 2[e,e]	0.8 - 3
Nitrofurantoin	155	16	14 - 18	17 ± 7[e,e]	12 - 20
Macrolides	25	3	2 - 4	3 ± 4[e,e]	0.6 - 5
Clindamycin	64	7	5 - 8	9 ± 4[e,e]	6 - 12
Tetracyclines	6	1	0 - 1	3 ± 2[e,e]	0 – 4

DOT = days of therapy; SJR = St. John's Rehab; IV = intravenous; PO = by mouth
[a]Study period was July 1, 2015 to June 30, 2016 (12 months), and the total number of patient days was 52,551.
[b] Median, unless otherwise noted
[c] Calculated from monthly DOT/1000 patient day data
[d] Routes of administration: IV, PO, gastric tube, data for gastric tube not shown: 1 antibiotic order was via gastric tube in patients admitted to SJR on antibiotics and was for metronidazole; and 2 antibiotic orders of antibiotics were via gastric tube in total courses of antibiotic in 2 patients, one receiving oral metronidazole (i.e. patient above who was admitted on oral metronidazole) and one receiving oral ciprofloxacin
[e] Reported as mean ± SD, since data passed the test for normality
[f] The percentage of IV antibiotics active on admission based on the total antibiotics active on admission is 23% (82/355; 95% Confidence Interval: 19 – 27%). The percentage of IV antibiotics active on admission based on the total number of IV antibiotic orders is 94% (82/87; 95% Confidence Interval: 89 – 99%).
[g] The percentage of PO antibiotics active on admission based on the total antibiotics active on admission is 77% (272/355; 95% Confidence Interval: 72 – 81%). The percentage of PO antibiotics active on admission based on the total number of PO antibiotic orders is 31% (272/891; 95% Confidence Interval: 28 – 34%).
[h] 78% (7/9) IV to PO stepdown courses were from IV courses that were active on admission
[i] Number of IV DOT/1000 patient days saved by stepping down to PO
[j] PO Penicillins 141/167 (84%); PO Cephalosporins 215/256 (84%); PO Fluoroquinolones, Metronidazole, Nitrofurantoin, Macrolides, Clindamycin, and Tetracyclines were 100% each

Table 2. Microbiology Workload

Characteristic	Number	Percent	95% Confidence Interval
Source			
Total	447		
Urine	279	62	(58 – 67)
Blood	1	0.2	(0 - 1)
Swab / Wound	167	37	(33 - 42)
Species in Urine			
E. coli total	168	60	(54 - 66)
E. coli NON-ESBL	150	54	(48 - 60)
E. coli ESBL	18		
% E. coli ESBL as % of all urine cultures (18/279)		6	(4 - 9)
% E. coli ESBL as % of number of E. coli in urine (18/168)		11	(6 – 15)
K. pneumoniae	40	14	(10 – 18)
Species in Swab or Wound			
MSSA	76	46	(38 – 53)
MRSA	19	11	(7 – 16)
S. aureus Total	95	57	(49 – 64)

ESBL: extended spectrum ß-lactamase
MSSA: methicillin sensitive *S. aureus*
MRSA: methicillin resistant *S. aureus*

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DISCUSSION

- This retrospective descriptive study assessed antibiotic use in a rehabilitation hospital.
- To the best of our knowledge, this is the first study to provide metrics for antibiotic use in a rehabilitation hospital, and serves to benchmark antibiotic use and identify potential targets for future antimicrobial stewardship interventions in this patient population.
- Approximately 28% of patients admitted to SJR were treated with at least one antibiotic during their admission.
- Oral antibiotics were most commonly prescribed (91%) and therefore, may be important targets for antimicrobial stewardship.
- The most commonly used antibiotics were fluoroquinolones (27%), cephalosporins (26%), penicillins (17%), and nitrofurantoin (16%).
- Although no antibiotic course was continued for > 90 days, 41% of courses were continued for > 7 days, suggesting that evaluation of appropriate duration of antibiotic therapy may be an important antimicrobial stewardship initiative.
- Intravenous to oral step-down antibiotic therapy was implemented in only 10% of IV antibiotic courses.
- However, 94% of IV orders were active on admission to SJR and therefore, opportunities for modification based on appropriateness may be limited. Although it is interesting to note that 78% (7/9) of the IV to PO step-down courses were in fact from antibiotic courses that were active on admission.
- The mean days of therapy per 1000 patient days for antibiotics was 138± 17, and the median duration of antibiotic use was 6 days (IQR 4-8).
- The metric of DOT/1000 patient days for antibiotics corresponds to about 25% of the use seen in our acute care facility (Sunnybrook Health Sciences Centre – Bayview Campus), and therefore, may justify a 0.25 full time equivalent position for an antimicrobial stewardship pharmacist.
- Urine was the most frequent source processed by microbiology (62%), and *E. coli* was the most common bacteria isolated (60%, 11% ESBL *E. coli*).
- The prevalence of MRSA at the facility was 11%.
- Based on our findings, potential targets of future antimicrobial stewardship interventions identified include implementing a prospective audit and feedback initiative of the most frequently used antibiotic classes (fluoroquinolones, cephalosporins, penicillins, and nitrofurantoin); assessing duration of therapy to minimize potentially unnecessary prolonged antibiotic use (>7 days); evaluating the potential to improve parenteral to oral step down antibiotic therapy; and the exploration of initiatives to potentially reduce the number of urine samples for culture and susceptibility ordered, drawn and processed by microbiology.
- Initiatives that should be explored related to urine cultures include education of health care professionals about urinary tract infections versus asymptomatic bacteriuria, implementing microbiology policies that reduce upstream laboratory testing of urine sources sent to microbiology, and prospective audit programs to evaluate patients for whom a urine culture has been ordered with utilization of an annually updated site specific antibiogram.

Limitations:
- Retrospective and descriptive study that analyzed data from a single facility
- Limited 1 year study period
- Associated with a teaching hospital
- Prescriber information identifying infectious diseases consults from referring hospitals not available
- Uncertainty in linking an antibiotic course with a specific culture, or diagnosis (i.e. for UTI)
- Unavailability of microbiology data from referring hospitals
- Despite these limitations, this study provides:
  - Benchmarking data for antibiotic use at a rehabilitation hospital, which has not been done before
  - Identification of potentially problematic issues with antibiotic therapy in a rehabilitation hospital which may benefit from antimicrobial stewardship initiatives
- Future studies evaluating the implementation of antimicrobial stewardship interventions proposed to target one or more areas of potential need identified in this study are planned and will be shared in a future publication.

CONCLUSION

Areas of antibiotic use at this rehabilitation hospital which may benefit from antimicrobial stewardship include potentially excessive use of fluoroquinolones, cephalosporins, penicillins, and nitrofurantoin. Although we did not assess appropriateness in this study, there may be opportunities to reduce duration of therapy, promote parenteral to oral step down therapy, and improve prescribing based on a site- specific antibiogram.

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