Please note: this is shared by Stewardship at Children's Hospital Colorado as an example of a business plan. We are required to take out specific CHCO cost data, so it has been replaced by $X. This plan is our most complete, but it is from January 2014, so would require updating. This plan was used for an FTE for a pharmacist, but would be applicable to and MD FTE as well with some changes.

Our request if you use this document as any kind of resource is that you send us back your business plan so we can learn from you for our next business plan. For this, or for questions, contact:

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Antimicrobial Stewardship Program, Children's Hospital Colorado

Wise Use Today Preserves Cure Tomorrow

Plea

CHCO MISSION:

...e health of children through the ...high-quality, coordinated programs of ... care, education, research, and advocacy

ASP AIM

Support providers at Children's Hospital Colorado in appropriate antimicrobial prescribing

- Increase safety
- Decrease use of broad spectrum antimicrobials
- Decrease overall use of antimicrobials
- Decrease ADEs
- Contain resistance and *C. difficile* rates
- Contain anti-infective cost
- Contain hospital costs

Primary Drivers

- Enhance patient safety and clinical efficacy by supporting apropriate antimicrobial choice, dose, and duration
- Provide education and information support
- Improve care through collaboration
- Scholarship to inform pediatric dosing, use, and stewardship
- Fulfill national standards
- Compete with other top 10 children's hospitals
- Continue national and international leadership

Secondary Drivers

- Expand rounds to 5 days per week
- Expand indications to all antimicrobials
- Give antimicrobials at correct dose, interval, and duration
- Tailor therapy to organism and susceptibility
- Encourage use of oral antimicrobials when appropriate
- Recognize potential and occurring antimicrobial toxicity
- Monitor anti-infective use and pharmacy spend
- Monitor *C. difficile* infection rates
- Create yearly antibiogram
- Create more clinical care guidelines
- Evaluate clinical care guidelines
- Implement Vigilanz
- Gather information on antimicrobial indications and post-prescriptive interventions and disseminate
- Write grants to support projects in the program
- Review drug use and continue active role in P&T
- Build educational support services
- Mentor fellows, residents, and students
- Seek international opportunities
- Participate in national committees and their associated conferences
- Monitor national recommendations

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Children's Hospital Colorado Stats:	
Beds	414
Yearly Admissions, #	15,000
Yearly Admissions prescribed an Antimicrobial, #	9,578
Yearly Antimicrobial Orders, #	44,863
Yearly Pharmacy Anti-infective Spend	$X million
Excess Patient Anti-infective Charges at CHCO compared to other PHIS hospitals	$X million
Current Cost of ASP	$60,280
Cost of ASP with Pharmacist (1 FTE)	$229,550
Savings of ASP with Pharmacist (1 FTE) minus Cost	$X
Return on Investment - ASP with Pharmacist (1 FTE)	$X

US News and World Report Pediatric Hospitals, Top 10 (Beds)	Pharm D ASP FTE	MD ASP Support
Children's Hospital of Philadelphia (511)	1	NR
Boston Children's Hospital (395)	1.25	NR
Cincinnati Children's Hospital Medical Center (512)	1	0.5
Texas Children's Hospital, Houston (639)	1	NR
Children's Hospital Los Angeles (568)	1	NR
St. Louis Children's Hospital-Washington University (264)	1	NR
Children's Hospital Colorado, Aurora (549; 414 Aurora campus)	**0 (0.2)**	**0.4**
Ann and Robert H. Lurie Children's Hospital of Chicago (288)	1	0.5
Johns Hopkins Children's Center, Baltimore (300)	1	0.5
Unknown: Pittsburgh	NR	NR

All of the US News and World Report Top Ten that responded to our survey have a full time dedicated ASP pharmacist, and we are the third largest!

<u>Needs of CHCO Program:</u>

****Full time ASP pharmacist****

Part time data analyst

Statistical support

Identify need and collaborate on clinical care guidelines, protocols and Epic ordersets. Evaluate each as resources allow.

Support, teach, mentor, evaluate, study, publish

Monitor antimicrobial use by drug type, diagnostic category, unit use and pharmacy spend

Review prescribed antimicrobials and intervene for patient safety, treatment efficacy, resident education or to decrease resistance or cost

Participate in local and national committees, evaluate drug use and formulary changes

Monitor antimicrobial resistance and follow *C. difficile* rates and HAIs. Compile antibiogram.

Enable better prescribing in Epic, including drug file clean up, dose button changes, and antimicrobial indications associated with order. Update CHCO formulary and dosing references. Evaluate indications initiative

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Antimicrobial Stewardship Pharmacist Return on Investment (ROI) Analysis

ONGOING OPERATING EXPENSES	COST SAVINGS AND COST EXPENDITURES
• Clinical Pharmacist (1 FTE)	$150,000
• Physician (0.5 FTE)	$75,350
• Computer/iPad	$700
• Annual ASP Meeting	$2,500
• ASP Training (one time cost only)	$1,000
TOTAL OPERATING EXPENSES	**$229,550**
PROJECTED SAVINGS – ASP WITH 1 FTE PHARMACIST	
• Harmful ADE cost avoidance[1]	$100,260
• Other benefits: nursing satisfaction, improved documentation accuracy, reduced litigation expenses, improved charge capture, patient confidence in care, public relations benefits	$0
• Pharmacy anti-infective budget (decrease by 10%)[2]	$X
• Dose/drug optimization (intervention on 3% of orders at $200 each, 5 days/week).[3] Clinical Care Guideline development[4], streamlining or de-escalation therapy[5], antibiotic use restriction criteria, IV to PO conversion.	$333,000
• Decrease drug resistant infections (HAI) by 10% ($10,000 each).[6] Decrease *C. difficile* infection by 4% ($18,900 per case).[7]	$X
• Potential procedure cost avoidance (single PICC line cost: $X)[8]	$X
• Laboratory test cost avoidance (drug levels)[9]	$X
• Other benefits: patient care quality and safety, fostering a collaborative culture, academic opportunities, gaining national and global recognition	$0
TOTAL PROJECTED SAVINGS WITH 1 FTE PHARMACIST	**$1,461,360**
TOTAL NET SAVINGS:	**$1,231,810**
RETURN ON INVESTMENT (ROI):	**537%**

References for Calculations

1. [1, 2]Calculations are based on total number of antimicrobial orders per year. According to Bates, et al (1995), there was a 5.3% medication error rate and a 0.9% preventable ADE rate. The cost of an ADE = $4,685 (Bates, 1997). Assuming a 5.3% medication error rate and a 0.9% preventable ADE rate, the total number of antimicrobial errors per year is 2,378 and the total number of antimicrobial preventable ADEs per year is 21.4. Assuming ASP can prevent those 21.4 ADEs, projected yearly savings = $100,260/year. **Note that the $4,685 reported cost of an ADE is from 1997. Inflation was not accounted for in the calculations. Malpractice cost is not factored into this calculation.**
2. [3-6]Estimate based on current estimate of anti-infective budget of $X, given $X for 1 of 3 databases; total pharmacy budget is X million.
3. [7]Assuming that the addition of an FTE pharmacist will allow 3% of patients-to-total orders for intervention and extended coverage to 5 days/week, the total projected savings would be (44,863 orders * 0.03 * $200/intervention) = $270,000/year.
4. True cost savings of appendicitis CCG antibiotic change = $X/year.
5. Evaluation and costs analysis of changing nafcillin to cefazolin for MSSA shows a cost savings of $20,000/year (projected cost savings based on 2013 CHCO data).
6. [8-11]CHCO currently has 577 resistant isolates per year. Cost of resistant HAI has ranged from $8,000 - $29,000. If we impact resistant HAI by 10% and assume a $10,000 cost savings for each, we would save $X/year.
7. [12]CHCO currently has 295 *C. difficile* positive tests per year. Pediatric data has shown that there is an excess cost of $18,900 - $93,600. Assuming impact of 4% and cost avoidance of $18,900/case = $X/year.
8. Assuming we can decrease central line placement by 20 central lines/year in the appendicitis population and 20 central lines/year in the MSK infection population, would save $X/year (40 * $300).
9. Vancomycin:
   - Patient charge is $X/level, and assuming the cost of the level is 80% lower than the patient charge, would estimate cost/level = $X/level.
   - There are 158 vancomycin peaks drawn per year. Assuming a decrease in 90% of those levels, we would save $X/year.
   - There are 2,783 other vancomycin levels drawn per year. Assuming 30% of those levels were unnecessarily drawn levels, there are 835 unnecessary levels/year. Assuming ASP can decrease unnecessary levels by 20%, estimated cost savings = $X/year.

   Aminoglycosides:
   - Patient charge is $X/level, and assuming the cost of the level is 80% lower than the patient charge, would estimate cost/level = $X/level.
   - There are 1,223 aminoglycoside levels drawn per year. Assuming 30% of those levels were unnecessarily drawn levels, there are 367 unnecessary levels/year. Assuming ASP can decrease unnecessary levels by 20%, estimated cost savings = $X/year.

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Antimicrobial Stewardship Program Measurement Framework		Estimated Impact Based on Literature
Decreased use of broad antimicrobials	Decrease in days of therapy (DOT) per 1000 patient days and admissions, by drug, unit and diagnostic category, % received antimicrobials	Decrease DOT/1000 patient days by 10%, higher for some antimicrobials in some units
Increase in oral use of bioavailable antimicrobials	Decrease in IV days per patient	Decrease IV use by 1-2 days per patient receiving
Decreased pharmacy anti-infective spend	Total cost per month and cost per inpatient days	10% of pharmacy spend per year
Monitor success of indications	Monitor up-front pharmacy interventions that increase appropriate choice and dose	Increase changes in orders and appropriateness of orders by 10%
Monitor success of post-prescriptive interventions	Monitor number of interventions and intervention category (safety, resistance, education and cost)	Goal: Review 70% of placed orders
Provider surveys	Repeat provider (prescribers and pharmacists) surveys and modify ASP program if indicated	Create new PDSA cycle based on results
Evaluate success of clinical care guidelines	Target specific measures based on CCG	
Decrease/contain antimicrobial resistance and *C. difficile*	Monitor resistant isolates for health care associated pathogens overall and by unit	Decrease HAIs due to DROs and *C. difficile* by 10% and 4%, respectively.

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Background Information on Antimicrobial Stewardship Programs:

1. Primary National Goal: "*The primary goal...is to optimize clinical outcomes while minimizing unintended consequences… including toxicity, selection of pathogenic organisms (such as C. difficile), and the emergence of resistance"* CID Stewardship Guidelines, 2007.
2. CHCO ASP Goal: Support providers at Children's Hospital Colorado in appropriate antimicrobial prescribing, in a manner consistent with CHCO culture, focusing on patient quality and safety, resident education, academic potential to impact pediatric care, and establish a national and global reputation.
3. CHCO needs to equal the ASP support of other top ten US News and World Report Hospitals
    a. Of the US News and Report top ten Pediatric Hospitals, seven responded to inquiries. All have at least 1 full-time pharmacist dedicated to the ASP (range is 1-1.25).
4. Support of the ASP would fulfill national standards.
    a. Joint Commission
    b. Health and Human Services
    c. Centers for Medicaid and Medicare Services
    d. State Regulations (California Antimicrobial Stewardship Program Initiative – Senate Bill 739)
    e. Institute for Health Care Improvement
    f. Infectious Diseases Society of American (IDSA) and Pediatric Infectious Disease Society (PIDS), Society for Healthcare Epidemiology of America (SHEA), and American Society of Health System Pharmacists (ASHP)
5. CHCO cost can be avoided in the following areas:
    a. **Antimicrobial spend.** Data demonstrate stewardship programs decrease the anti-infective budget by 10-30% per year. If we estimate a conservative 10%, this will save CHCO $X/year.
        i. Estimate based on current estimate of anti-infective budget of $2,000,000, given $1,686,492 for one of three databases; total pharmacy budget is 25 million.
    b. **Decrease in infections with resistant organisms and *Clostridium difficile*.** If we achieve a 10% impact on HAIs and a 4% impact on *C. difficile*, will avoid $X/year in cost.
        i. CHCO has Xresistant isolates per year (MRSA, VRE, resistant gram negatives) and X *C. difficile* positive tests per year.
        ii. Data demonstrate a cost savings range of $8,000 - $29,000 per case. If we impact 10% of HAIs, at a cost savings of $X each = $X/year.
        iii. Data demonstrate excess cost of $18,900 - $93,000 per case of *C. difficile*. If we impact 4% of *Clostridium difficile*, at a cost savings of $18,900 per case = $X/year
    c. **Post prescriptive interventions.**
        i. Published data indicate 50-60% of children receive antimicrobials, and 40% of use is inappropriate.
        ii. Published estimates on stewardship interventions range from a savings of $200 to $1,600 per intervention.
        iii. CHCO admits 15,000 per year, of these 9,578 have at least one antimicrobial ordered, for total of 44,863 anti-infective orders per year.
        iv. ASP does a post prescriptive review on Monday, Wednesday and Friday. From August to November 2013, ASP reviewed 2,589 orders (of 10,805 total orders, or 23%), on 1,831 patients, and intervened on 161 patients (9% of reviewed, or 161 patients/10,805 orders=1.5% of patients to total orders).
        v. If assuming low end cost avoidance of $200 per patient and annualizing the number of patients that ASP would have intervened (~500) = $100,000/year for the current ASP program
        vi. Assuming that the addition of an FTE pharmacist will allow 3% of patients to total orders for intervention and extended coverage to 5 days/week, the total projected savings would be (44,863 * 0.03 * $200) = $270,000/year.
    d. **Systematic regimen change through CCGs, ordersets and drug utilization reviews.**
        i. Appendicitis change in antimicrobial from ertapenem to ceftriaxone/metronidazole. This antimicrobial change has been systematically evaluated in 841 patients, has no clinical differences, and saves $X/year in antibiotic cost. Savings were also identified in excess central line placement. In the time period from November 2010 to June 2013, there were a total of 185 appendicitis patients who received a PICC line. Only 58 of them received TPN. This leaves 127 patients with a central line that didn't get used. 127 patients/31 months = 4 patients/month x 12 months = 48 PICCs/year. Assuming we can decrease the placement by 20 PICCs/year), we would save $X/year.
        ii. Review of nafcillin vs. cefazolin for MSSA. A change here can save the hospital $X/year.
        iii. MSK clinical care guideline. This is anticipated to increase microbial diagnosis and standardize care, and is anticipated to decrease PICC line placement, dual antimicrobial therapy, IV treatment days, time in MRI scanner, and length of stay; evaluation is underway. Estimating at least 20 avoided PICC placements/year, adding $X/year in cost savings.
        iv. Ventilator associated infections working group established for 2014.
    e. **Decrease in unnecessary drug levels.**
        i. Vancomycin: The patient charge for a vancomycin level is $212/level, and assuming the cost of the level is 80% lower than the patient charge, would estimate cost/level = $43/level.

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There were 158 vancomycin peaks drawn in 2013 and assuming a decrease in 90% of those levels, we would save $X/year. There were 2,783 other vancomycin levels drawn in 2013 and assuming 30% of those levels were unnecessarily drawn levels, there were 835 unnecessary levels/year. Assuming ASP can decrease unnecessary levels by 20%, estimated cost savings = $X/year. Total costs savings for vancomycin levels = $X/year.

ii. Aminoglycosides (gentamicin, tobramycin, and amikacin): The patient charge is $X/level, and assuming the cost of the level is 80% lower than the patient charge, would estimate cost/level = $X/level. There were 1,223 aminoglycoside levels drawn in 2013 and assuming 30% of those levels were unnecessarily drawn levels, there were 367 unnecessary levels/year. Assuming ASP can decrease unnecessary levels by 20%, estimated cost savings = $X/year.

iii. Sum of total cost savings on drug levels = $X/year.

f. Collaborative work with the microbiology laboratory.

i. Stewardship will participate in the roll out of the new film array for rapid identification of positive cultures; in conjunction, this initiative will save antimicrobial days and allow more appropriate, safer therapy.

ii. Stewardship will be helping with process improvement of antimicrobial susceptibility reporting, which drives choices of antimicrobials on the clinician side, and with the antibiogram, which we hope to make available unit by unit with Vigilanz.

g. **Patient care quality and safety.** This is difficult to measure in terms of cost, but certainly has an impact.

i. Indications: Of the antimicrobials with meningitis/CNS infection, about ½ have dose changed significantly (>15%).

ii. Informing choice in the Pediatric OppAT clinic in order to avoid complications

iii. Informed care through rounds, CCGs, protocols, collaborative environment

6. Short Term Wins of Program to Date:

a. 3 surveys sent and analyzed (post survey will be sent in early 2014)

b. 2 grants successful, 1 submitted but unfunded, 1 submitted and pending

i. Funded: Clinical and Operational Effectiveness and Patient Safety Small Grants Program (part time data analyst)

ii. Funded: Institute for Healthcare Quality, Safety, and Efficiency Certificate Training Program, University of Colorado and Children's Hospital Colorado, competitive one-year program, 5 hours per week (Sarah Parker and Jason Child)

c. 4 IRB/ORRQIRP protocols approved

d. Program/Career development completed

i. 2012-2013: Principles of Clinical Pharmacology, University of Colorado School of Pharmacy in conjunction with the National Institutes of Health, 1.5 hours per week, certificate awarded Spring 2013 (Sarah Parker)

ii. 2013: Institute for Healthcare Quality, Safety and Efficiency Certificate Training Program, University of Colorado and Children's Hospital Colorado, competitive one-year program, 5 hours per week (Sarah Parker and Jason Child)

e. 3 publications (and 3 manuscripts underway)

i. Mitchell, M and **Parker, S**. Concepts in Outpatient Pediatric Antibiotic Use: Practitioners have an Important Role in Stewardship. Colorado Family Practice Journal, 34th Edition, Spring 2013.

ii. **Parker S,** Dowell E, Roe M, Nyquist A. Bugs and Drugs, Contagious Comments. 2011, 2012 and under revision for 2013.

iii. **Sarah Parker** MD, Michelle Mitchell MD, **Jason Child** Pharm D. Cephem antibiotics: wise use today preserves cure for tomorrow. Pediatrics in Review, 34;510-524, 2013.

iv. **Underway:** C. difficile outbreak investigation, Adverse Drug Events in OPpAT clinic, Antimicrobials for appendicitis

f. 5 abstracts at national meetings

i. Samiksha Bansal, MD, Amanda Hoffbeck, Pharm D, Stig Somme, MD, **Sarah Parker, MD**, Alexander Dodd, David A. Partrick, MD. Inpatient Antibiotic Regimen Does Not Affect Postoperative Outcomes in Perforated Appendicitis. American Academy of Pediatrics, Submitted 2013.

ii. Amanda Hoffbeck, Pharm D, Samiksha Bansal, MD, Stig Somme, MD, David A. Partrick, MD, **Sarah Parker, MD**. Western States Pharmacy Conference, 2013.

iii. Jennifer Murphy, BA, Norman Fenn, BSc, Heather Heizer, PA-C, Shannon Hughes, PA, Jason Child, Pharm D and **Sarah Parker, MD**, Outpatient Parenteral Antimicrobial Therapy (OPAT) in Pediatrics: Descriptive Analysis of Adverse Events in Pediatric OPAT to Identify Areas for Quality and Patient Safety Improvement. IDSA, 2013.

iv. Pediatric ASP meeting: Analysis of side effects in a Pediatric OPAT clinic

v. Pharmacy Student Conference: Observed Side Effects in Pediatric OPAT clinic

g. 7 CHCO guidelines/protocols/Ordersets/QI projects participation and authorship

i. Musculoskeletal Infection CCG and orderset: AAOS/POSNA A New Paradigm for Treatment of Life- and Limb-Threatening Pediatric Musculoskeletal Infections #3380, presented Tuesday, October 8, 2013, by Drs. Sumeet Garg and Gaia Georgopoulos (assessment of CCG underway)

ii. Intravenous to Oral Protocol

iii. Community Acquired Pneumonia CCG and orderset

iv. Pediatric Appendicitis (assessment finished, publication underway) CCG and orderset

v. Sepsis Collaborative and orderset

vi. Adverse Drug Events in Pediatric Outpatient Therapy Clinic

vii. Indications associated with 13 pilot antimicrobials in Epic

h. 2 national committees (SHEA, PIDS)

i. 3 Local and 1 International (Arequipa, Peru) Educational Conference Presentations

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	Author and Article	Peds or Adult?	Method	Cost savings or findings	Application to CHCO
	Concrete Dollars				
Drug Resistant infections, HAIs	Goff, Maragakis[13, 14]	Mostly adult	Rolls in attributable death and LOS, attributable cost of resistant HAI (would be even greater if compared to no HAI)	MRSA bacteremia $6,916 MRSA surgical infection $13,901 VRE $12,766 Resistant pseudomonas $11,981-32,949 Other resistant gram negative $3,358-29,379 ESBL or KPC 1.7 fold increase	MRSA X per year (includes ED, outpatient) Resistant *S. pneumoniae* X (not likely to be impacted by ASP)
	Neidell[15]	Adult	Single center study	Charges of resistant infection $15,626-25,573 per patient, and LOS increase by 3.3 days, and higher death rate	
	Roberts[10]	Adult	Compared costs of antibiotic resistant HAI to susceptible, and cutting HAIs altogether	Patients sicker based on APACHE score 54 vs. 40, with higher mortality 18% vs. 3%, OR 2.16 (attributable 6.5%) Had concurrent HAI 72% vs. 10% Longer LOS 24 vs. 8 days Higher cost per day $2098 vs. $1581 Higher total cost of care $58029 vs. $13210 MRSA $46,236 VRE $66,416 Resistant gram negs $25,549 Highly resistant Acinetobacter $97,444 Rate of HAI cut from 13.5% to 10%, which saved 2.7 million ($910,812 for hospital, rest societal)	CHCO micro lab: Enterococci X (many will be HAIs) Resistant gram negs (non-urine, non-CF; many will be HAIs) X (pseudomonas, acinetobacter, achromobacter, stenotrophomonas, klebsiella, serratia, enterobacter) Resistant gram negs (urine) X (pseudomonas, ESBLs; only slight impact by ASP) TOTAL: X
	Perencevich[16]	Adult	Review of cost articles	VAP $ 22,875, Attributable excess LOS 9.6 days CLABSI $ 18,432, Attributable excess LOS 12 days Catheter associated UTI $1,257 Surgical infection $2,533	CHCO VAP/VAE: not collected CHCO CLABSI: X CHCO CAUTI: X CHCO ADE: X TOTAL: X per year
	Aldeyab[8, 9]	Adult and Peds	Studied intervention of decrease FLQ on ESBLs and C. diff	Decrease did impact resistance by 10%	
	Dancer[17]	Adult	Decreased cipro use by 75% and CTX by 95% (via a ban), then studied resistance	C diff reduced by 77%, MRSA by 25%, ESBLs by 17%	
	TOTALS				X resistant infections we might impact; assume decrease of 10% = XX infections, X 10K saved each = $X/year

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Dose/Drug Optimization (Interventions)	Lee[7]	Adult	Cost avoidance study at a VA hospital, includes LOS, labor costs	Drug interaction $1437 Drug allergy prevention/management $640 Adjust dosage $650 Untreated diagnosis $2306 Prevent or manage ADE $50 Drug not indicated $604 Duplication of therapy $3 (does not take into account attributable CDI or HAI)	Stewardship does a post prescriptive review on Monday, Wednesday and Friday. • From September to October 2013, Stewardship reviewed 2,589 orders (of 10,805, or 23%), on 1,831 patients, and intervened on 161 patients (9% of reviewed, 1.5% of total) • If assume low end cost avoidance of $200 per intervened patient = $100,000/year. • This can increase with more days per week of rounds. Assuming that the addition of an FTE pharmacist will allow 3% of patients-to-total orders for intervention and extended coverage to 5 days/week, the total projected savings would be (44,863 orders * 0.03 * $200/intervention) = $270,000/year.
Harmful ADE Cost Avoidance	Bates[1]	Adult	Cost analysis of ADEs and preventable ADEs	For all ADEs reported in a 6 month period, "antibiotics" was the drug class second most often associated with ADEs (24%), only second to analgesics. 5.3% medication error rate and 0.9% preventable ADE rate.	Calculations are based on total number of antimicrobial orders per year. Assuming a 5.3% medication error rate and a 0.9% preventable ADE rate, the total number of antimicrobial errors per year is 2,378 and the total number of antimicrobial preventable ADEs per year is 21.4. Assuming ASP can prevent those 21.4 ADEs, projected yearly savings = $100,260/year. • CHCO antimicrobial medication errors = 44,863 yearly antimicrobial orders*0.053 = 2,378 antimicrobial errors/year • CHCO antimicrobial preventable ADEs = 2,378 yearly antimicrobial errors*0.009 = 21.4 preventable antimicrobial ADEs/year • Total cost savings for preventing 21.4 ADEs = 21.4*$4,685 = $100,260/year. • Note that the $4,685 reported cost of an ADE is from 1997. Inflation was not accounted for in the calculations. • Malpractice cost is not factored into this calculation.
	Kaushal[18]	Pediatric	Cost analysis of ADEs and preventable ADEs	10,778 med orders, 5.7% med errors (616), 1.1% potential ADEs (115) and 26 ADEs (0.24%). Of the 26 ADEs, 19% (5) were preventable. Out of the potential ADEs, 28% were antibiotics.	
	Bates[2]	Adult	Cost analysis of ADEs and preventable ADEs	ADE cost: $2595 for all ADEs, $4685 for preventable ADEs	
	Hug[19]	Adult	Evaluated medication errors where harm came to patient (ADE)	Cost of an adverse drug event was $3420 [range: $2852 (significant ADE), $3650 (serious ADE) and $8116 (life-threatening ADE)] Increases LOS by 3.1 days	
Clostridium difficile	Sammons[12]	Peds	Cost analysis of C. diff	LOS increase of 5.5 -21 days, excess cost of $18,900-93,600 (HO and CO)	In 2012, X of X tests (16%) were positive. If we prevent 4% and use $18,900 based on data to left = $X/year
	Khadem[20]	Mostly Adult	Review of measures and outcomes for large number of studies	Decrease in resistant infections and C diff, review CDiff estimated attributable cost $2000 per episode Decrease in mortality (6.3 vs. 12% and length of stay 6 vs. 9 days) Decrease in overall antimicrobial budget Impact on resistance Improved appropriate dosing	

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Pharmacy Anti-Infective Budget	Goff [13]	Mostly adult	Antimicrobial costs per patient day; Goff reviews various	Yearly net savings of implemented ASP programs based on pharmacy spend per patient day calculations: $4 per patient or $189,000 to $295,440 per year. Hospitals varied sizes, costs, situations	CHCO overall budget X million Anti-infective budget about X million Estimate 10% impact each year, $X/year
	Carling [3]	Adult	Cost of antimicrobials per 1000 patient days	Demonstrated progressive decrease of 30% below baseline (and 40% below projected) over 7 year period, and 15% decrease in use, decrease in C. diff and gram negative, VRE infections. Little change in MRSA	
	DePentima[6, 21]	Pediatric	Evaluated implementation of program over 4 years	Decrease in both targeted and non-targeted antimicrobials in terms of doses per 1000 patient days, from 3089 to 1904. Resistance did not emerge. No cost data.	
	Kaki[4]	Adult	Evaluation of ASP in ICU, systematic review of 24 articles	Reduced antimicrobial utilization from 11-38% depending on drug, decreased antimicrobial cost by %5-10/patient-day, shortened abx therapy	
	Cosgrove[5]	Adult	Evaluation of ASP multiple hospitals	9-16% decline in abx use, Abx days/1000 patient days, from about 614 to 516	
IV to Oral conversion	Goff[22]	Mostly adult	Review of IV to oral studies	IV to oral conversion, reviewed 16 studies, decreases drug cost by $13-293 per patient, decreases LOS by 3.5 days and saves $3000 per patient, saved $60,000-4 million per year for hospital	
	Van Niekerk[23]	adult	IV to PO	Decrease in IV days by 2	
	Jones [24]	Adult VA	IV to PO; used total FLQ days divided into days IV and days PO	20-45% of use was avoidable or could have been oral	
Micro + ASP	Bauer[25]	Adult	ASP pharmacist contacted immediately with result, made change in drug	Use of MRSA vs. MSSA PCR saves 1.7 days of vancomycin, and the LOS decreased by 6.2 days, hospital costs were $21,387 less per episode of SA bacteremia	
	Kollef M, et al: Chest 1999;115:462-74		Relative risk if inappropriately treated of death is 2.37 (95% C.I. 1.83-3.08);		

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	Concrete Statistics				
	Goff[13]	Mostly adult	Review	1.7 million HAIs per year in USA, 100,000 excess deaths. 4.5% of patients develop an HAI, for a rate of 9.3 per 1000 patient days. Accounts for 6.5 billion dollars per year. Overall, 18.4% of GDP in USA is on healthcare, so big chunk on HAIs. 2008 CMS limits reimbursement for reasonably preventable HAIs. Includes targets to use for benchmarking. IDSA says US spends excess 5 billion on antibiotic resistant infections	
	Gerber[26]	Peds	PHIS analysis	In 2010, 524,364 children received 2,089,929 days of antibiotics. CAP, CF, appendicitis and SSTI account for 10% of use, though 1% of diagnoses	
	Goff[22]	Adult		Antimicrobials are 26% of adult hospital budget	
	Kaushal[18]	Peds	Evaluation at peds hospital	Pediatric med errors/ADEs occur in 7% of orders , 28% are in anti-infective	
	Levy[27]	Peds	Study of Peds Hospital	57% of use is inappropriate DOT per 1000pt days range per Abx from 67-97; de-escalation most common reason for inappropriate designation	
			Agencies supporting/requiring ASPs	US News and World Report Survey Joint Commission Health and Human Services Centers for Medicaid and Medicare Services State Regulations (CA bill 739) Institute for Health Care Improvement Infectious Diseases Society of America and Pediatric Infectious Diseases Society, Society for Healthcare Epidemiology of America, American Society of Health System Pharmacists	
	General Quotable numbers				
	Drew[28]		Review	Review covering decrease in resistant infections and C. diff, with decrease in hospital antimicrobial costs of 30%	
	Fishman[29]		Review	Improved clinical outcome, with OR of cure with ASP 1.7 (1.3-2.1)	
	IDSA guidelines[30, 31]		Review	Estimated savings of 200-900K , review of microbial cost savings consistent with above	
	Hollis[32]		Commentary	51 tons of antibiotics consumed daily in the US (80% agri and aquaculture) Annually: 3,290,000 kg consumed by humans 13,540,000 kg consumed by agri/aquaculture	

	CHCO specific				
	Pharmacy spend on anti-infectives		Casey Dugan, one of three databases (the largest)	About $2million	As above
	Bed costs		Ben Brown, finance	Room and board direct costs per patient per day: 8th floor $X or $Xstandard CPCU $X 9th floor $X 6th floor $X CICU intermediate $X CICU intensive $X NICU level II $X NICU level III $ X NICU level IV $X PICU intermediate $X PICU full $X PICU trauma $X	
	PICC costs		Ben Brown, Finance	PICC charge $X, charges ~X. Is using a cost to charge ratio, not clear if includes fixed costs	Per our OpPAT clinic, 33% of PICCS have a complication; cost analysis if complications is underway
	Baseline numbers, beds and admissions		CHCO website and ID universe	CHCO 414 Main beds, 549 total network CHCO admits 15,000/year 9,578 have at least one antimicrobial ordered 44,863 anti-infective orders per year	
	Baseline numbers Jan-Nov 2013 HAIs		CHCO target zero page	CHCO VAP/VAE: not collected CHCO CLABSI: X CHCO CAUTI: X CHCO ADE: X HAI MDRO rates not known	

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