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Inaccurate Communications in Telephone Calls to an Antimicrobial Stewardship Program

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Abstract

Background—Antimicrobial Stewardship Programs (ASPs) decrease unnecessary antimicrobial use, decrease antimicrobial resistance, and improve patient outcomes. Prior approval—requiring approval before using certain antimicrobials in an ASP—depends on the accuracy of patient data communicated from the primary service.

Objectives—To determine the incidence of inaccurate communication of patient data during ASP interactions, describe examples of inaccurate communications, and identify risk factors for inaccurate communication

Design—We utilized a retrospective cohort design. Communicated patient data were evaluated for clinically important inaccuracies using the medical record as a gold standard.

Setting—A tertiary care medical center that utilizes prior approval for restricted antimicrobials

Patients—Inpatients discussed in ASP calls

Intervention—Observational study

Results—39% [CI₉₅ (95% confidence interval) 31% to 48%] of ASP calls contained an inaccuracy in at least one type of patient data (e.g., current antimicrobials); the incidence varied widely across data types. Inaccuracy examples are given to demonstrate their clinical relevance. In

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multivariable analysis, inaccurate communications were more common for calls from surgical services [versus non-surgical services; odds ratio (OR) 2.1, CI₉₅ 1.1–3.9] or if received by Infectious Diseases fellows (versus pharmacists; OR 2.0, CI₉₅ 1.1–3.8).

Conclusions—A high proportion of ASP calls for prior approval included patient data inaccuracies, which have the potential to affect antimicrobial prescribing. While risk factors were identified, these communication errors were common across ASP interactions. Inaccurate communications may compromise the utility of prior approval ASPs in optimizing antimicrobial use.

Keywords

Antimicrobial Stewardship; Communication Errors; Patient Safety

Background

Antimicrobial Stewardship Programs (ASPs) guide the prescribing decisions of physicians caring for inpatients to improve the appropriateness of antimicrobial use[1, 2]. Prior approval is one of several interventions that ASPs may use[1]. In a prior approval system, the use of certain antimicrobials requires approval by ASP practitioners [Infectious Diseases (ID)-trained attending physicians, fellows, or pharmacists]. Approvals are made after the primary service communicates details of the patients' cases to ASP practitioners, who do not directly evaluate patients. Surveys have found that between 40–73% of respondent hospitals use prior approval to improve antimicrobial prescribing[3] (data previously published on Society of Infectious Diseases Pharmacists website, <http://www.sidp.org>), restricting a median of seven antimicrobials[4]. This intervention has been shown to be effective in improving clinical outcomes[5, 6], decreasing antimicrobial-resistant infections[7], improving hospital antimicrobial susceptibility profiles[8], and reducing overall antimicrobial use and costs[5, 7–9].

The success of prior approval programs, however, relies upon the accuracy of the information reported to the ASP practitioner performing the approval. Communication errors during these interactions may lead to inappropriate antimicrobial prescribing (e.g., too broad or incorrect spectra of activity). No study to date has investigated the epidemiology of communication errors during ASP prior approval calls. We performed a retrospective cohort study to determine the frequency of inaccurate communications during telephone ASP interactions at our institution and to define risk factors for inaccurate communications.

Methods

Setting

The study was performed at the Hospital of the University of Pennsylvania, a 625-bed academic medical tertiary care center. The hospital's ASP is active between 8 a.m. and 10 p.m. each day (restricted antimicrobials are released from the pharmacy without approval after hours but require approval the following day). Most broad-spectrum and newer antimicrobials are restricted; prior approval by the ASP is required. Calls for ASP approval are handled by three ID-trained clinical pharmacists (weekdays between 8 a.m. and 5 p.m. and most weekends between 8 a.m. and 12 noon), approximately 9 ID fellows (most weeknights between 5 and 10 p.m. and weekends from either 8 a.m. or 12 noon until 10 p.m.), and occasionally internal medicine residents rotating on the general ID consult service (one night a week). Collectively, we will refer to all of these clinicians as ASP practitioners. An ID attending is available to assist the practitioners in difficult cases. All ASP

practitioners have the opportunity to electronically access laboratory and pharmacy data when they are in the hospital.

The primary services caring for patients contact the ASP via a pager to request a specific antimicrobial(s) or advice on antimicrobial therapy. The ASP practitioners make antimicrobial recommendations that they document on a structured form. Diagnostic recommendations (e.g., send blood cultures) may also be given. Recorded information includes the date and time of the call along with patient data relayed by the caller. If the recommendations include restricted antimicrobials, the ASP practitioners inform the pharmacy of the approval.

Subject selection

Documented telephone calls to the Hospital of the University of Pennsylvania ASP regarding antimicrobial management of inpatients from 1/2/02 to 2/1/02 were eligible for inclusion; calls taken by internal medicine residents were excluded. Since the ID fellows fielded fewer calls than the pharmacists, calls taken by ID fellows were over-sampled with a goal of selecting half the study calls from this group to ensure a more precise estimate of inaccurate communication in the ID fellow subgroup. The forms documenting calls were revised for the study. The forms were collected the day after the call; forms for calls occurring between Fridays and Sundays were collected on Mondays. Approximately 10 calls were selected each day; selection from within the ID fellow and ID pharmacist groups was random. The forms documenting calls were numbered in the order received, then selected based on a computer-generated random number list. More than one call could be selected for each patient during an admission.

Data collection

For each ASP telephone interaction sampled, data were abstracted from both the ASP form documenting the call and the patient's medical record using a structured data collection tool. The medical record included written copies of progress, admission, and consultation notes, as well as electronic records of test results, medication administration, and patient allergies. Only data available to the inpatient team at the time of the call were abstracted from the medical record based on dates of notes, medication orders, and reports of test results. The following data were collected separately from both the medical record and the ASP data card: age; gender; comorbid conditions or treatments (immunosuppressive treatments or conditions at the time of the call, presence of a central venous catheter, renal function or dialysis, and prior history of other major comorbid illnesses); physical examination findings (temperature and blood pressure within 24 hours preceding the call); laboratory results (white blood cell count and proportion of granulocytes, urinalysis, microbiology, and radiology results); consultant reports (ID consult and other consultants); current antimicrobial use (within 24 hours prior to the call); vasopressor therapy (at the time of the call); and patient service characteristics (hospital location, primary hospital service, and length of stay prior to call). The date and time of the call, type of caller, and type of ASP practitioner (i.e., pharmacist or ID fellow) were also abstracted from the form documenting the ASP interaction.

Definitions

Inaccurate communications were defined as clinically significant discrepancies between communication data elements abstracted from the form documenting the call to the ASP and those in the medical record, using the medical record as the gold standard. "Clinically significant" discrepancies were those that the authors *a priori* judged likely to influence antimicrobial prescribing. Communication was defined as the net information that the ASP practitioner recorded on the form documenting the call by the end of the interaction,

including data obtained from computerized records during the call. An operational list of definitions for inaccurate communications (the outcome of interest) was constructed prior to data collection. The definitions were designed to give the benefit of the doubt to the caller; inaccuracies were cases in which patient data recorded from the caller were directly contradicted by medical record data available at the time of the call. We did not define the absence of information documented from the telephone call as an inaccuracy. The major types of inaccuracies examined were microbiological test results (including urinalysis results); radiographic results; current antimicrobials; antimicrobial allergies; patient temperature; renal function and use of dialysis; age; hypotension and use of vasopressor mediation; white blood count; antimicrobial recommendations by non-ASP consultants; presence of central venous catheters; immunosuppression; and other comorbid illnesses (see Appendix for examples of specific definitions of inaccuracies).

Statistical analysis

The proportion of calls with any inaccurate communications was calculated. In addition, we calculated the proportion of calls with specific types of inaccurate communications as defined above. Also, the number of inaccurate communications per call was calculated. Frequency weighting (using the proportion of ASP calls received by ID fellows and pharmacists in the study population) was used when calculating all estimates. Characteristics of the timing of the call, caller, ASP practitioner, and the patient were examined as potential risk factors for communication inaccuracies. The effect of potential risk factors on the outcome—inaccurate communications—was evaluated in bivariable analyses using logistic regression with frequency weighting (as described above) for dichotomous and continuous independent variables. Contingency tables with the chi square test were used for categorical independent variables with more than two categories[10]. A multivariable logistic regression model was built with independent variables that had a p-value less than 0.20 on bivariable testing[11]. We concluded that independent variables were independent risk factors for inaccurate communications if they had a p-value of less than 0.05 in the multivariable model. Associations in bivariable analyses were reported as ORs for direct comparison with the ORs generated by the multivariable model. 95% confidence intervals were also calculated for point estimates in all analyses. All statistical calculations were performed in STATA v8.2 (StataCorp, College Station, Texas).

Results

The disposition of telephone calls to the ASP during the study period is shown in Figure 1. There were 814 documented calls to the ASP between 1/2/2002 and 2/1/2002. Twenty-three calls received by medical residents were excluded, leaving 791 calls to the ASP for sampling. Pharmacists received 78% of the calls; ID fellows received 22%. Of 189 randomly selected ASP calls from the study population (with over-sampling of fellows), medical records were available for 173 (91.5%; the study sample). Pharmacists handled 58% of these calls; ID fellows handled 42%. There were no statistically significant differences between subjects with available charts versus subjects whose charts were not available for known variables (i.e., intensive care unit versus ward patient location, ID fellow versus pharmacist ASP practitioner, call performed on weekend versus weekday, and whether the therapeutic indication for antimicrobials was empiric, definitive, or prophylactic; data not shown).

The overall percentage of ASP calls with an inaccurate communication of patient data was 39% [95% confidence interval (CI₉₅): 31 to 48%]. The percentage of calls with specific types of inaccurate communication is shown in Figure 2. The five types of data with inaccuracy rates of $\geq 4\%$ were current antimicrobials (12.9%, CI₉₅ 7.4% to 18.4%), microbiological data (11%, CI₉₅ 5.9% to 16.4%), temperature (7.8%, CI₉₅ 3.2% to 12.3%),

allergies (5.1%, CI₉₅ 1.4% to 8.7%), and radiographic data (3.5%, CI₉₅ 0.3% to 6.8%). The number of inaccurate communications per call was one for 30% of calls, two for 8% of calls, and three for 1% of calls.

Table 1 lists illustrative cases from the five types of patient data most commonly communicated inaccurately. Specific examples for each type of data were non-randomly chosen to illustrate the potential clinical significance of the inaccuracies.

We next examined whether characteristics of the interaction were risk factors for an inaccurate communication. In bivariable analyses, inaccurate communications were more common when calls to the ASP 1) originated from surgical services versus non-surgical services [(48% versus 34%, $p=0.02$), or 2) were handled by ID fellows versus pharmacists (53% versus 37%, $p=0.04$) (Table 2). The type of service and ASP practitioner remained significant in the multivariable model (Table 3).

Conclusions

This study demonstrated that inaccurate communications occurred in over one-third of calls to an ASP. Our examples of specific inaccurate communications demonstrate the potential clinical significance of inaccuracies. Inaccurate communications during clinician interactions with the ASP occurred across a variety of hospital services, including many different providers, and involved a range of patient data types. However, it appears that calls that either originated from surgical services or were received by ID fellows were more likely to be inaccurate.

Communication errors—“failure(s) of communication”—have been highlighted by the Institute of Medicine as one of 14 types of medical errors that contribute to medical adverse events [12]. However, few studies have examined the communication errors between healthcare workers. One study described the investigation of a pseudo-outbreak of nosocomial infections associated with the initiation of an ASP. The investigators found that clinicians had decreased their threshold for documenting nosocomial infection diagnoses—communicating incorrect information to the ASP—in order to justify antimicrobial orders[13]. The potential for communication errors has also been described in studies of “curbside” consultations (informal interactions in which a consultant gives recommendations regarding patient care based on communicated data without formally examining and assessing the patient). Surveyed specialists have expressed concern that data provided during curbside consults may be incomplete or inaccurate[14, 15].

Our examples of inaccurately communicated patient data demonstrate that the discrepancies detected with our inaccuracy definitions can be significant and have the potential to adversely affect antimicrobial recommendations by the ASP. For example, one call to the ASP inaccurately reported that a patient had methicillin-resistant *Staphylococcus aureus* (MRSA) growing from an endotracheal culture; the medical record showed that the patient did not have a culture with MRSA from any site, and that no endotracheal culture had been sent. Another call stated that a patient had a focal pulmonary infiltrate on a chest radiograph; no chest radiographs had been performed according to the medical record. These communication errors may lead to inappropriate treatment recommendations (e.g., antimicrobials are prescribed when not indicated). Communication errors are not adverse events themselves, but become important if they lead to adverse events (e.g., inappropriate antimicrobial use leading to poor clinical outcomes and antimicrobial resistance). Our study does not directly measure the effect of communication errors on inappropriate antimicrobial prescribing and patient outcomes. However, our detection of a high rate of clinically

significant communication inaccuracies suggests that further study is needed to address these issues.

Communication errors were more likely when calls went to ID fellows compared to ID-trained pharmacists. We hypothesize this is due to three reasons. First, handling calls through the ASP is the main responsibility of the pharmacists, and the same pharmacists have been taking these calls for several years. Therefore, the pharmacists may be more focused and less distracted while taking the calls, and have more experience and training in eliciting accurate information from the caller than the ID fellows. Second, the majority of calls to the pharmacists are taken while they sit in front of a hospital computer, enabling them to directly examine the reports of patient data (e.g., laboratory and radiology data). ID fellows more often take calls either from home, where they had no access to the hospital's computers at the time of the study, or while rounding on the weekend, when there is less time to stop and directly examine patient data. Thus, the pharmacists may more frequently correct the patient information during the call, leading to a net accurate communication by the end of the call (our study outcome definition). The pharmacists involved in the study informed us that, in fact, they often do make such corrections. Third, since ID fellows take calls on nights and weekends, they are more likely to be called by clinicians who are covering the patients (versus primarily caring for them). The covering clinicians are likely less familiar with the patients and thus may be more likely to make communication errors about patient data.

We also found that calls from surgical services to the ASP were more likely to include inaccurate communications compared to calls from non-surgical services. The reason for this finding is less clear, but we will offer several potential hypotheses. It is possible that calls from surgical housestaff are more often from covering physicians than calls from medical housestaff. Since the ASP is directed and partly staffed by physicians trained in medicine, there may be a better rapport between the ASP and medicine housestaff leading to more frank and detailed reporting of patient data. Another unproven hypothesis regards the steep power hierarchy among surgeons[16]. With regard to antimicrobial approval requests, this could render first-year surgical residents feeling less able to contest an attending's or chief resident's charge to obtain certain antimicrobials. Thus, they may feel more pressure to bend a patient's clinical scenario to satisfy the ASP approver.

Our study did not examine the effect of the inaccurate communications on antimicrobial prescribing and patient outcomes. However, these communication errors should be considered by medical centers designing or already using a prior-approval ASP given their potential negative downstream effect. ASP practitioners should directly verify patient data critical to their recommendations (e.g., culture susceptibility results) when feasible. Increasing ASP practitioner direct access to patient data (e.g., by ensuring off-site access to microbiological or other electronically available data) may also limit communication inaccuracies.

Our findings have several potential limitations. There is potential for misclassification of communication accuracy due to incomplete data on the ASP card or in the medical record, errors during abstraction, or misapplication of inaccuracy definitions during the analysis. There is potential for misclassification bias if there was a difference in the accuracy of filling in the ASP card between the ID fellows and pharmacists. Misclassification was limited by using structured ASP cards and data abstraction forms. The definitions were created before data collection; modifications of definitions were only performed to exclude clinically irrelevant discrepancies. Our goal was to ensure that only true, clinically relevant communication errors were identified. Furthermore, we only evaluated communicated data for accuracy; we did not count inadequate communication of patient data as a

communication error (e.g., we did not determine if the callers failed to report critical microbiological results that would change the antimicrobial recommendations). Thus, if misclassification of communication accuracy occurred, it was likely towards detecting fewer inaccuracies. We limited the potential for bias by using structured data collection and analysis tools. Confounding was limited by controlling for measured variables associated with the study outcome (potential confounders) using multivariable modeling. Our sample size was adequate to determine the incidence of inaccuracy with a reasonable degree of precision; our ability to detect the effect of uncommon risk factors may have been limited. Our study is generalizable to academic medical centers that utilize communicated patient data to perform prior approval for antimicrobial use.

In summary, we found a high rate of patient data communication inaccuracies during calls to our ASP. While a surgical service caller and an ID fellow handling the calls are risk factors, the inaccuracies were common across calls with various characteristics. Inaccurate communications during ASP interactions may lead to inappropriate antimicrobial recommendations, in turn limiting the benefit of the program. Further research is needed to determine the effect of inaccurate communications on antimicrobial prescribing and clinical outcomes during ASP interactions.

Human Subject

The Institutional Review Board of the University of Pennsylvania approved the study.

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Appendix: Definitions for inaccurate communications

i. General guidelines

For microbiological data, allergies, current antimicrobials, renal function/dialysis and temperature, only data reported in the medical record before the time of the ASP call will be used in the analysis. The time and date stamp for culture results changes over time as culture results are appended or susceptibility results added. For culture and susceptibility results, we will thus only compare stated positive results with the medical record to avoid misclassifying accurate communications as inaccurate. If radiographic studies are reported, then the final report for radiographic studies performed prior to the time of the ASP card will be examined, even if the final report was not available at the time of the ASP call. If a team reviews a radiograph before it is officially reported, this method will avoid misclassifying the report of that data as inaccurate as long as the initial reading is grossly correct.

ii. Discrepancies in microbiological results

- a. Positive/sent on the ASP card; absent, all negative, or with different (stain type, site or result) in the MR
 - Test for *Clostridium difficile* stool toxin, *Cytomegalovirus* serum antigen, or *Legionella pneumophila* urine antigen
 - Culture or sensitivity result
 - Gram (or other) stain for organisms or white blood cells
- b. Greater than one blood culture bottle positive for coagulase-negative *Staphylococcus* or *Enterococcus* species [or gram stain for gram positive cocci (GPC)] on card; less than one blood culture bottle positive for these organisms (or gram stain for GPC) in the MR.

- c. Test/culture not sent per card; received in MR

iii. Discrepancies in urinalysis (u/a) results

- a. Synonym for purulent urine, or u/a with positive leukocyte esterase (LE) or wbc 10 wbc/hpf on card; but a) < 10 wbc/hpf and negative LE on u/a (in most recent test) or no u/a received, and b) no mention of synonyms suggestive of urine infection in the MR
- b. Synonym for non-purulent urine or < 10 wbc/hpf or negative LE on dipstick testing on card; but synonym for purulent urine or > 10 wbc/hpf or positive LE on dipstick testing (in most recent test) or no u/a received in the MR
- c. Urinalysis not sent per card; received in the MR

iv. Discrepancies in radiographic results

- a. CXR documented as having infiltrate or effusion on card; that finding not present on any CXR or no CXR done per the MR
- b. CT of chest or abdomen/pelvis reported to have pulmonary infiltrate, pleural effusion, collection, bowel thickening or inflammation per card; that finding(s) not present on any CT (of that type), or CT of that body part not done in MR
- c. CXR documented to not have an infiltrate or effusion on card; these findings are present on any CXR in the MR, or no CXR done per the MR
- d. CT of chest or abdomen/pelvis reported not to have infiltrate, pleural effusion, collection, bowel thickening or inflammation per card, but these findings are present on any CT (of that type) in MR, or CT of that body part not done in MR
- e. CXR or CT of chest or abdomen/pelvis not done per card; that type of study done in MR

v. Discrepancies in allergy information

- a. Allergy to antimicrobial(s) or sulfa on card; no allergy to that agent noted in the MR
- b. "No allergies" indicated on card; allergy to antimicrobial(s) or sulfa in MR
- c. Allergy to antimicrobial(s) or sulfa is synonymous with immediate hypersensitivity reaction (i.e., urticaria, angioedema/swelling, anaphylaxis or dyspnea/wheezing) on card; reaction not synonymous with immediate hypersensitivity reaction (or not noted) per MR
- d. Allergy to antimicrobial or sulfa is not synonymous with immediate hypersensitivity reaction on card; reaction is synonymous with immediate hypersensitivity reaction per MR

vi. Discrepancies in current antimicrobials

- a. Antimicrobials administered or active by levels within past 24 hours per card; those specific agents (not just the antimicrobial class) not administered or not active by levels per medical record (including positive vancomycin or aminoglycoside levels in past 24 hours, aminoglycosides given since last dialysis session, or vancomycin given within 7 days if receiving dialysis)

vii. Discrepancies in renal function and dialysis use or type

- a.** Patient with synonym for renal insufficiency per card; creatinine 1.0 in the MR
- b.** Creatinine disparity between card and medical record 50% using the chart value as a baseline and 1) both values not 1.5 or > 4, and 2) patient was not dialyzed within 7 days of call per the MR
- c.** Patient with “normal” renal function per card; creatinine 1.5 in medical record or patient dialyzed within 7 days of the call per the MR
- d.** Patient on dialysis per card; no dialysis within 7 days of call per the MR
- e.** Patient on hemodialysis per card but peritoneal dialysis per the MR, or on peritoneal dialysis per card and hemodialysis per the MR

viii. Discrepancies in temperature

- a.** Discrepancy 3 F between temperature on card and the 24-hour range of temperature in the MR
- b.** Report of “fever” on card; 24-hour maximum temperature in MR < 100.5 F
- c.** Report of “hypothermia” (or synonym) on card; 24 hour minimum temperature > 95 F in MR
- d.** Report of “not febrile” on card; 24-hour maximum temperature 100.5 F in MR

ix. Hypotension or vasopressor medication use

- a.** Report of hypotension or systolic blood pressure (SBP) < 90 or vasopressor medication use on card; SBP ≥ 90 and no vasopressor medication in MR
- b.** Report of SBP ≥ 90 and no vasopressor medications on card; SBP < 90 or use of vasopressor medications in MR

x. Age

- a.** Age difference ≥ 10 years between card and MR
- b.** “Elderly” or synonym on card; age < 65 in MR

xi. White blood cell count

- a.** White blood cell count or granulocyte percentage or band percentage ≥ 50% different on card than in MR using MR as baseline
- b.** Synonym for “abnormal” white blood cell count or granulocyte percentage or band percentage on card; white blood cell count between 4.0–11.0 or bands not between 0–10% or granulocyte cells not between 30–75% (all ranges inclusive of lowest and highest value)
- c.** Synonym for “normal” white blood cell count, granulocyte or band percentage on card; WBC ≥ 50% outside of outer limit of normal range in MR (either higher or lower)

xii. Other antimicrobial recommendations

- a.** Antimicrobial recommendations by infectious diseases attending or fellow (verbally or in formal consult) reported on card; no mention of such recommendations or consult in MR
- b.** Antimicrobial recommendation by other consult service per card; no antimicrobial recommendation by other consult service in MR

xiii. Immunosuppression

- a.** Solid organ or bone marrow transplant per card; no transplant of that type per MR
- b.** “Neutropenic” per card; absolute neutrophil count ≥ 1000 cells per mm^3 in MR
- c.** “Not neutropenic” per card; absolute neutrophil count < 500 in MR
- d.** Absolute neutrophil count < 500 per card; absolute neutrophil count ≥ 500 in MR
- e.** HIV infected per card, with CD4 count $\geq$ or < 200 ; not HIV infected or HIV infected with CD4 count in different category (above/ $=$ or below 200) per MR
- f.** Recent immunosuppressive drug use (steroids, chemotherapy, other) per card; no use of that type of agent per MR
- g.** No transplant per card; status-post solid organ or bone marrow transplant per MR
- h.** No recent immunosuppressive drug use per card; recent use of steroids or chemotherapy or other immunosuppressive drugs per MR

xiv. Central line

- a.** Central venous catheter present per card; not present in MR
- b.** Central venous catheter not present per card; present per MR

xv. Comorbid conditions

- a.** Specific comorbid diagnosis subcategory noted on card; absent or different category in medical record (see subcategories below)

i. Cancer

- 1.** Biliary: liver, gallbladder, pancreas
- 2.** Blood: leukemia, myeloma
- 3.** Bone
- 4.** Breast
- 5.** Endocrine: adrenal, thyroid
- 6.** GI: esophagus, stomach, bowel
- 7.** Head and neck
- 8.** Lymphoma
- 9.** Neurologic: brain or spinal cord
- 10.** Pulmonary: lung or pleura

11. Renal: kidney, ureters, bladder
12. Reproductive: ovary, uterus, cervix, prostate, testicular
13. Skin: melanoma (not basal or squamous cell skin cancer)
- ii. Pulmonary disease
 1. Lung architecture change or damage: pulmonary sarcoid, interstitial lung disease, pulmonary fibrosis, pneumoconiosis, COPD, chronic bronchitis, emphysema, bronchiectasis
 2. Cystic Fibrosis
 3. Tracheostomy
 4. Intubated (current)
- iii. Cardiac disease
 1. Coronary artery disease: based on symptoms (angina), history (MI/ischemia, CABG, angioplasty), or tests (stress, catheterization) or if mentioned as a diagnosis in any note.
 2. Congestive heart failure: based on history (of CHF or admission for CHF), or tests (echo) or if mentioned as a diagnosis in any note
- iv. Hematologic abnormality: thrombocytopenia: any platelet count < 150,000 or if noted as current or past diagnosis in notes
- v. Diabetes mellitus: current or past diagnosis with either Insulin-dependent or non-insulin-dependent diabetes mellitus
- vi. Liver disease: cirrhosis or end-stage liver disease or any chronic disease involving the liver (eg, infectious hepatitis)
- vii. Cerebrovascular disease or intracranial hemorrhage: hemorrhagic or non-hemorrhagic CVA or TIA, or an intracerebral hemorrhage from any cause (including trauma)
- viii. Substance abuse
 1. Alcohol: more than 5 drinks per day or any history of "heavy use" or alcoholism or alcohol abuse
 2. Injection drug use (ever)
 3. Tobacco (smoke)
- ix. Specific surgeries or invasive procedures: e.g., interventional radiology drainage or cholecystectomy) within the past month

x. Trauma

- 1.** Blunt trauma (e.g., motor vehicle collision or fall)
- 2.** Penetrating trauma (e.g., knife or bullet)

Figure 1.
Disposition of telephone calls to the AMP

Figure 2.
Incidence of Inaccurate Communication by Type of Data

Table 1

Selected Examples of Inaccurate Communications

Type of Patient Data	Data communicated from primary service to Antimicrobial Stewardship Program	Data in medical record at time of communication
Current antimicrobials	Patient received vancomycin and cefepime in past 24 hours	Patient has not received any antimicrobials in the past 24 hours
Microbiological data	Endotracheal aspirate culture with methicillin-resistant <i>Staphylococcus aureus</i>	No endotracheal aspirate culture sent; blood and urine cultures were no growth to date
Temperature	Patient is febrile	24 hour maximum temperature is 98.1° Fahrenheit
Allergies to antimicrobials and sulfa	Allergies to penicillin and ciprofloxacin with unspecified reactions	No allergies to medications
Radiographic data	Right mid-lung focal opacity	No chest radiograph or other chest imaging performed

Table 2

Inaccurate Communication Bivariable Risk Factor Analysis

Variable	#	% Inaccurate (95% CI*)	Odds Ratio (95% CI*)	P Value
Patient sex			0.99 (0.49–1.99)	0.97
Male	82	38% (26%–50%)		
Female	91	40% (29%–52%)		
Age			1.29 (0.61–2.73)	0.51
< 65 years	118	41% (31%–51%)		
≥ 65 years	55	36% (22%–51%)		
Length of stay			1.01 (0.48–2.12)	0.98
< 7 days	116	33% (24%–42%)		
≥ 7 days	57	53% (38%–68%)		
Day of call			0.75 (0.31–1.78)	0.51
Weekend call	32	23% (7.0%–38%)		
Weekday call	141	42% (33%–51%)		
ASP practitioner			1.93 (1.04–3.58)	0.04
Pharmacist	101	37% (27%–46%)		
Fellow	72	53% (41%–65%)		
Patient location			1.10 (0.53–2.29)	0.81
ICU	57	49% (33%–64%)		
Ward	116	36% (26%–45%)		
Indication			-	0.83
Empiric	92	41% (30%–52%)		
Definitive	22	48% (23%–73%)		
Prophylactic	11	39% (20%–75%)		
Unknown	48	-		
Service type			2.37 (1.14–4.92)	0.02
Surgical	65	48% (34%–62%)		
Non-surgical	108	34% (24%–44%)		

*
CI denotes confidence interval.

Table 3

Inaccurate Communication Multivariable Risk Factor Analysis

Variable	Adjusted Odds Ratio (95% CI*)	Adjusted P Value
ASP practitioner (= Fellow; versus Pharmacist)	2.0 (1.1–3.8)	0.03
Type of service (= Surgical versus Non-surgical)	2.1 (1.1–3.9)	0.03

* CI denotes confidence interval.