Pending Laboratory Tests and the Hospital Discharge Summary in Patients Discharged To Sub-Acute Care

Stacy E. Walz, MS¹, Maureen Smith, MD, MPH, PhD^{1,2,3}, Elizabeth Cox, MD, PhD⁴, Justin Sattin, MD⁵, and Amy J. H. Kind, MD^{1,6,7}

¹Department of Population Health Sciences, University of Wisconsin School of Medicine & Public Health, Madison, WI, USA; ²Department of Family Medicine, University of Wisconsin School of Medicine & Public Health, Madison, WI, USA; ³Department of Surgery, University of Wisconsin School of Medicine & Public Health, Madison, WI, USA; ⁴Department of Pediatrics, University of Wisconsin School of Medicine & Public Health, Madison, WI, USA; ⁵Department of Neurology, University of Wisconsin School of Medicine & Public Health, Madison, WI, USA; ⁶Department of Medicine, Geriatrics Division, University of Wisconsin School of Medicine and Public Health, Madison, WI, USA; ⁷United States Department of Veterans Affairs, William S. Middleton Memorial Veterans Hospital, Geriatric Research Education and Clinical Center (GRECC), Madison, WI, USA.

BACKGROUND: Previous studies have noted a high (41%) prevalence and poor discharge summary communication of pending laboratory (lab) tests at the time of hospital discharge for general medical patients. However, the prevalence and communication of pending labs within a high-risk population, specifically those patients discharged to sub-acute care (i.e., skilled nursing, rehabilitation, long-term care), remains unknown.

OBJECTIVE: To determine the prevalence and nature of lab tests pending at hospital discharge and their inclusion within hospital discharge summaries, for common sub-acute care populations.

DESIGN: Retrospective cohort study.

PARTICIPANTS: Stroke, hip fracture, and cancer patients discharged from a single large academic medical center to sub-acute care, 2003–2005 (N=564)

MAIN MEASURES: Pending lab tests were abstracted from the laboratory information system (LIS) and from each patient's discharge summary, then grouped into 14 categories and compared. Microbiology tests were subdivided by culture type and number of days pending prior to discharge.

KEY RESULTS: Of sub-acute care patients, 32% (181/564) were discharged with pending lab tests per the LIS; however, only 11% (20/181) of discharge summaries documented these. Patients most often left the hospital with pending microbiology tests (83% [150/181]), particularly blood and urine cultures, and reference lab tests (17% [30/181]). However, 82% (61/74) of patients' pending urine cultures did not have 24-hour preliminary results, and 19% (13/70) of patients' pending blood cultures did not have 48-hour preliminary results available at the time of hospital discharge.

CONCLUSIONS: Approximately one-third of the sub-acute care patients in this study had labs pending at discharge, but few were documented within hospital discharge summaries. Even after considering the availability of preliminary microbiology results, these omissions remain common. Future studies should

focus on improving the communication of pending lab tests at discharge and evaluating the impact that this improved communication has on patient outcomes.

KEY WORDS: laboratory tests; hospital discharge; sub-acute care.

J Gen Intern Med 26(4):393–8

DOI: 10.1007/s11606-010-1583-7

© Society of General Internal Medicine 2010

INTRODUCTION

Clinical laboratory (lab) tests are an essential part of medical care, guiding approximately 70% of medical decisions¹. A lab test that was ordered during hospitalization for which the result has not returned prior to patient discharge is known as a pending lab test. General medical patients frequently (41%) leave the hospital with pending lab tests². As many as 9.4% of these pending lab test results are abnormal and would change the patient's care². Despite the high number of pending lab tests at hospital discharge for general medical patients, these tests are often omitted from the hospital discharge summary³, the only document mandated by The Joint Commission to convey the patient's care plan to the next setting of care^{4,5}.

High quality complete discharge communication is especially critical for the highly vulnerable sub-acute care (skilled nursing, rehabilitation, long-term care facility) population^{6,7}, the largest categories of whom have primary diagnoses of hip fracture and stroke^{8,9}. These individuals are often unable to advocate for themselves and have complex medical problems that need to be followed closely¹⁰. These patients may have more lab tests performed because of their complex medical problems, and more dire consequences if abnormal results are not addressed. Sub-acute care populations have not been specifically examined in previous studies of the prevalence and communication of pending labs. Because of the high potential risk for negative consequences, it is critical to examine whether sub-acute care populations experience similar pending lab and discharge summary communication rates as those of previously examined general medical populations.

In addition, previous studies have not addressed the clinical reality that preliminary microbiology culture results are often

Received July 13, 2010

Revised October 29, 2010

Accepted November 2, 2010

Published online November 30, 2010

available with which clinical decisions may be made. Generally, significant microbes from blood cultures are detected within 48 hours of collection, with negative cultures allowed to incubate for 5 days¹¹⁻¹⁴. Significant microbes from urine cultures are usually detected within 24 hours of collection, with negative cultures allowed to incubate for 3 days¹². Because microbiology cultures are the most prevalent type of pending lab test in the general medical population² and previous studies made no assessment of the availability of preliminary culture results, these studies may have overestimated the prevalence of clinically important pending lab tests.

The objectives of this study were to determine the frequency and nature of pending labs for adults discharged to sub-acute care, and to examine how often these pending labs were included in the hospital discharge summary. A secondary objective was to identify and determine the frequency of preliminarily available microbiology culture results for this population.

METHODS

Study Sample

We identified all hospitalized patients from a single large academic medical center who were >18 years old, had a primary diagnosis of stroke, pelvis/hip/femur fracture, or cancer, and were discharged to a sub-acute care facility in 2003, 2004, or 2005. These diagnostic groups were chosen to represent some of the most common primary diagnoses in sub-acute care patients^{8,9}. We used the International Classification of Diseases, 9th edition (ICD-9) diagnosis code in the first position on the acute hospitalization discharge diagnosis list to establish primary diagnoses. ICD-9 codes 431, 432, 434, and 436 were used to identify stroke; 805.6, 805.7, 806.6, 806.7, 808, and 820 were used to identify pelvis/hip/femur fracture (hereafter called "hip fracture"); and 153, 153.0-153.9, 154, 154.1 (colon and rectal), 162, 162.0-162.9 (lung), 174, 174.0-174.9 (female breast), 185, and 185.0-185.9 (prostate) were used to identify cancer. Administrative data compiled for all study patients prior to discharge were used to identify discharges to sub-acute care facilities (skilled nursing, rehabilitation, or long-term care facility). On internal testing, >95% reliability of this discharge field was noted. Hospital administrative data was used to obtain discharge year, patient gender, and patient age. Prior to exclusions, the initial sample size was 612.

Five patients were excluded because they did not have a discharge summary; 10 because they were discharged to hospice or comfort care; 19 because their discharge summary did not reflect a diagnosis of stroke, hip fracture, or cancer; 2 were <18 years old; and 12 because their discharge summary did not reflect discharge to a sub-acute care facility, for a final sample of 564. Patients discharged to hospice or comfort care were excluded because there was not a curative focus for their care and few diagnostic tests were ordered. For the 12 patients who had two eligible hospital stays during the study period, each discharge summary was treated individually.

At the study hospital during the period of interest, the majority (>90%) of discharge summaries were dictated by residents in various stages of training using information obtained from both a paper medical record and an electronic laboratory reporting system. Medical transcriptionists tran-

scribed the dictation to an electronic document, which was then reviewed and edited by the resident, and sent for final review, editing, and approval by the attending physician. No standardized templates were in general use for creation of discharge summaries and no prompts for inclusion of pending labs were present. No other formalized physician communication (phone, fax, etc.) took place between the study hospital's physician teams and the sub-acute care facilities. However, a verbal, undocumented, non-standardized nurse-to-nurse hand-off may have occurred. The Institutional Review Board at the University of Wisconsin approved this study with a waiver of consent.

Identification of Pending Lab Tests

The Laboratory Information System (LIS) is a computer software system that allows for tracking of clinical lab specimens from the time of order to the time of result reporting¹⁵. The LIS includes information on specific lab tests requested; the date specimens were received in the lab, date results were reported, lab test results and category, and ordering provider. LIS data were obtained on each study patient to allow for the identification of pending lab tests. A test was considered pending if ordered during the patient's hospitalization and the result returned on or after the first post-hospital calendar day. This conservative definition did not capture those test results that returned on the same calendar day that the patient was discharged, but after the patient had actually left the hospital. However, this definition ensured that all tests labeled as pending truly were pending at discharge. Preliminary culture results were considered available if >48 hours for blood cultures or >24 hours for urine cultures had passed between culture order and hospital discharge.

Lab test categories included: hematology, coagulation, chemistry, urinalysis, endocrinology, flow cytometry, toxicology, immunology, molecular diagnostics, reference lab testing, transfusion, histocompatibility, microbiology, and other¹⁶. These categories are generally accepted in clinical lab practice, and are used by the study hospital's lab. Representative lab tests within each category are shown in Appendix 1. Because pending microbiology cultures were so prevalent, we differentiated these into distinct types: urine, blood, fungal, wound, sputum, spinal fluid, surveillance, and joint fluid. For the purposes of this study, we excluded other diagnostic tests such as cytology, pathology, radiographic, and computed tomography because their results are managed by separate electronic or paper systems and not included in the LIS.

Abstraction and Coding Process

Hospital Discharge Summaries. Three trained medical abstractors, using standardized abstraction protocols, forms, and manuals, separately reviewed all (N=564) sample discharge summaries for page length, hospital service, and the presence or absence of notation of pending lab tests. Inter-rater agreement was good; Cohen's phi for abstractor reliability was 0.7 for the presence/absence of pending lab tests. All pending lab tests noted within discharge summaries were abstracted verbatim into electronic abstraction forms,

categorized into 1 of 14 lab test categories (Appendix 1) using a standardized protocol, and entered into an electronic database. The discharge summary abstractors were blinded to the contents of the LIS data.

Laboratory Data. One trained medical abstractor, using standardized abstraction protocols, forms, and manuals, reviewed all LIS data for the presence or absence of pending lab tests. Eleven percent of randomly selected LIS data was re-abstracted by a second trained abstractor. Cohen's phi for abstractor reliability was 0.9 for the presence/absence of pending lab tests, and kappa was 0.9 for number of pending lab tests per patient. All pending lab tests noted within LIS data were abstracted verbatim onto paper abstraction forms, categorized into 1 of 14 lab test categories (Appendix 1) using the same standardized protocol as above, and entered into an electronic database.

Data Linkage. Abstracted LIS data were linked to the abstracted discharge summary components and patient factors, such as gender and diagnosis, via the unique combination of the patient's medical record number and date of hospital discharge. The linkage was accomplished using SAS version 9.1¹⁷.

Analysis

First, we calculated the prevalence of pending lab tests and preliminary microbiology culture results within LIS data and the prevalence of pending lab test documentation within sample discharge summaries. Next, for each patient with a pending lab test in the LIS data, we compared the pending lab test category with that obtained from the patient's discharge summary. The LIS data were utilized as the "gold standard." Discharge summary omissions of specific pending lab test categories were recorded for each patient. Omission frequencies were calculated for each lab test category, with patients assembled into groupings of "no pending lab test categories omitted" or "pending lab test categories omitted." Thirteen patients with >1 pending lab and whose discharge summary noted some but not all of those pending labs were included in the "pending lab test categories omitted" category because of their exposure to an omission of at least some potentially important pending lab data within the discharge summary. Preliminary microbiology cultures contained in the LIS data were

also recorded and assessed for each patient. Analyses were performed using SAS version 9.1¹⁷ and STATA version 11¹⁸.

RESULTS

Patient and Discharge Summary Characteristics

Of the 564 eligible patients within this study, 213 (38%) had a primary diagnosis of stroke, 308 (55%) had a primary diagnosis of hip fracture, and 43 (7%) had a primary diagnosis of cancer (Table 1). Patients were more often female (63%), with a mean age of 73 years (SD 15.6). Patients were discharged in nearly equal numbers across study years: 34% in 2003, 35% in 2004, and 31% in 2005. Discharge summaries originated from a variety of hospital services including neurosurgery, neurology, orthopedic surgery, and general internal medicine, and were, on average, 3.5 pages long (SD 0.9).

Prevalence of Pending Laboratory Tests

Pending labs were common at the time of hospital discharge within this patient sample. Of the 564 patients in this study, 181 (32%) were discharged with pending laboratory tests (Table 1). Hip fracture patients were the most often discharged with pending labs (35%), followed by stroke patients (29%) and cancer patients (23%). The most common categories of lab tests pending at the time of discharge were microbiology (150 patients [27%]), distantly followed by reference lab testing (30 patients [5.3%]) (Table 2). Table 2 also highlights that urine cultures constituted the majority of pending microbiology cultures (74 patients [13%]), followed by blood cultures (70 patients [12%]). Of note, 82% (61/74) of patients with pending urine cultures did not have 24-hour preliminary results and 19% (13/70) of patients with pending blood cultures did not have 48-hour preliminary results available at the time of hospital discharge.

Omission of Pending Laboratory Tests in Discharge Summaries

Pending labs were frequently omitted from patient discharge summaries (Table 3). Overall, pending labs identified by the LIS

Table 1. Study Sample Characteristics for Stroke, Hip Fracture and Cancer Patients Discharged to Sub-acute Care Facilities, 2003-2005 (N=564)

Characteristics	Total N=564	Stroke N=213	Hip fracture N=308	Cancer N=43	p-value
Males, % (N)	37 (211)	46 (98)	33 (100)	30 (13)	0.004
Age (in years), mean (SD)	73 (15.6)	70 (14.3)	74 (16.8)	73 (9.8)	0.02
Year of discharge, % (N)					
2003	34 (191)	34 (72)	35 (107)	28 (12)	0.30
2004	35 (200)	40 (85)	33 (100)	35 (15)	
2005	31 (173)	26 (56)	33 (101)	37 (16)	
Discharge summary length (in pages), mean (SD)	3.5 (0.9)	3.5 (1.1)	3.5 (0.9)	3.1 (0.6)	0.01
Patients with pending lab tests at discharge, % (N)	32 (181)	29 (62)	35 (109)	23 (10)	0.14

Table 2. Prevalence of Pending Laboratory Tests Within Hospital Laboratory Information System and Within Hospital Discharge Summaries for Stroke, Hip Fracture and Cancer Patients Discharged to Sub-acute Care Facilities, 2003–2005 (N=564)

Laboratory test categories	LIS* (N=564) % (N [†])	Patient discharge summary (N=564) % (N [†])
Overall	32 (181)	5.0 (28)
Microbiology	27 (150)	2.3 (13)
Urine cultures	13 (74)	0.5 (3)
Blood cultures	12 (70)	0.9 (5)
Fungal cultures	2 (11)	0.0 (0)
Wound cultures	0.9 (5)	0.0 (0)
Sputum cultures	0.5 (3)	0.0 (0)
Spinal fluid cultures	0.5 (3)	0.0 (0)
Surveillance cultures	0.3 (2)	0.0 (0)
Joint fluid cultures	0.2 (1)	0.0 (0)
Culture type not specified	—	0.7 (4)
Reference lab testing	5.3 (30)	0.5 (3)
Immunology	1.4 (8)	0.7 (4)
Coagulation	0.4 (2)	1.1 (6)
Molecular diagnostics	0.2 (1)	0.2 (1)
Chemistry	0.2 (1)	0.0 (0)
Toxicology	0.0 (0)	0.9 (5)
Urinalysis	0.0 (0)	0.5 (3)
Hematology	0.0 (0)	0.2 (1)
Endocrinology	0.0 (0)	0.2 (1)
Other	0.2 (1)	0.0 (0)

* LIS=Laboratory Information System

† Note that patients could be discharged with multiple laboratory tests pending from different categories

were omitted from 89% of discharge summaries. For the two most common categories of pending lab tests, microbiology and reference lab testing, the omission frequencies were 95% and 93%, respectively. Microbiology cultures without preliminarily available results were also omitted from discharge summaries frequently; 98% for urine cultures and 77% for blood cultures. For the remainder of the lab test categories, absolute numbers of tests were low, but omission rates remained high.

DISCUSSION

Within the sub-acute care population studied, 32% of all patients had pending lab tests, and the vast majority of these were omitted from hospital discharge summaries. Microbiology

cultures were the most common type of lab pending at the time of hospital discharge, and many of these did not have preliminary results available by the day of patient discharge. The majority (82%) of these pending cultures without preliminarily available results were urine cultures.

Similar to previous studies of general medical populations^{2,3}, our study provides evidence that pending lab tests in sub-acute care populations are common at the time of discharge, but are frequently omitted in written discharge communications. The sub-acute care population, in particular, is high risk. Complicated transitions (i.e., a visit to the emergency department or a re-admission to the hospital within 30 days of discharge) occur frequently in this population⁷. Furthermore, these patients are often unable to advocate for themselves (as co-morbid dementia is common)^{19,20}, and are heavily reliant on good discharge summary communication for a smooth transition to a sub-acute care facility^{6,7}. If key information regarding pending lab tests is left out of the discharge summary, important follow-up of critical lab results may not occur, possibly leading to medical errors and patient harm, with increased risk of re-admission.

This study is the first to look closely at preliminarily available microbiology results. Preliminary culture results are available to clinicians in the LIS, and clinical decisions may be made based upon preliminary results. However, even taking this into consideration, discharge summary omissions of pending microbiology tests remain high. After excluding cultures for which preliminary results were available, 24-hour urine culture results were not available for 82% of patients with pending urine cultures and 48-hour blood culture results were not available for 19% of patients with pending blood cultures at the time of hospital discharge.

Hip fracture patients are at increased risk of re-hospitalization within 30 days for complications such as wound infection, septicemia, and pneumonia²¹. Among acute stroke patients discharged to sub-acute care, 20% either return to the emergency department or are re-hospitalized during the first 30 days following discharge, and 19–25% of these returns are due to infections such as aspiration pneumonia and urosepsis⁷. The high prevalence of poorly communicated pending labs for vulnerable sub-acute care patients found in this study, especially urine and blood cultures, raises significant patient safety concerns given the present poor state of discharge communication⁵. Further study is needed to determine the impact that

Table 3. Discharge Summary Omissions of the Most Common Pending Laboratory Tests for Stroke, Hip Fracture and Cancer Patients Discharged to Sub-acute Care Facilities, 2003–2005 (N=564)

Pending laboratory test categories	Patients with pending laboratory tests in Laboratory Information System (LIS) N*	Pending laboratory test category omissions in discharge summary % (N)
Overall	181	89 (161)
Microbiology (total)	150	95 (142)
Preliminary results not available - urine cultures	61	98 (60)
Preliminary results not available - blood cultures	13	77 (10)
Reference lab testing	30	93 (28)
Immunology	8	75 (6)
Coagulation	2	50 (1)
Molecular diagnostics	1	100 (1)
Chemistry	1	100 (1)
Urinalysis	—	—
Other	1	100 (1)

* Note that patients could be discharged with multiple laboratory tests pending from different categories

such pending lab omissions have on post-hospital patient outcomes. Of specific interest is whether the omission of pending culture results is associated with post-discharge infectious complications and re-hospitalizations.

Our approach has some limitations. We used a very conservative definition for “pending” (lab tests which returned on or after the first post-discharge day), and there were likely instances where laboratory test results came back later in the same day that a patient was discharged. Our approach would not have labeled these tests as pending and may have resulted in underestimation of the problem of pending labs at discharge.

We did not assess whether the results of the pending lab tests were actionable, i.e., would have changed patient management, as some others have done^{2,3}. However, our unique focus on preliminarily available microbiology results strengthens the argument that pending labs are clinically significant. We recognize that preliminarily available microbiology results can be incomplete, yet we included them because preliminary lab results are widely utilized to inform clinical decision-making²²⁻²⁴.

In our study, we did not specifically assess whether physicians were aware of the pending lab test. We also did not assess whether a separate communication (such as a phone call or fax) relayed the pending lab test to the sub-acute care facility. However, previous studies have shown that physicians are often displeased with their lab test results management system²⁵, and that separate physician-to-facility communication rarely occurs²⁶⁻²⁸. As such, we suspect that only a small proportion, if any, of the pending labs were communicated outside the standard discharge summary channels.

The use of data from a single, large, academic teaching hospital may limit the generalizability of these results. In contrast to smaller hospitals, clinical laboratories at large, academic teaching hospitals have sophisticated lab testing capabilities and infrequently need to send out tests for processing. The number and category of lab tests pending at the time of discharge, and pending lab test omissions from the discharge summary may be different at smaller hospitals due to the differences in clinical laboratory size and testing availability. Therefore, our study of an academic center may underestimate the prevalence of pending labs at smaller hospital facilities with fewer resources.

Many opportunities exist to improve the communication of pending lab tests to the next setting of care. For example, automated laboratory systems such as the LIS may become an important tool for improving communication of pending lab tests at hospital discharge because it captures lab tests that are truly “collected and pending.” This makes it ideal for automating their inclusion in the discharge summary, the only mandated communication directed to the next provider of care⁵. Another opportunity pertains to the designation of the party responsible for the follow-up of pending labs. Hospital policies generally do not explicitly state who is responsible for following up on a pending lab test—the ordering hospital-based provider or the provider caring for the patient post-discharge²⁹. Most often, these are two different people⁶. A formal designation of this responsibility may be important to ensure prompt attention to lab results which return after the patient’s discharge and to maximize timely and appropriate post-hospital patient care.

Findings from this study and others could be used to design targeted interventions to improve the communication of pending lab tests at discharge. Identifying patients with complex medical problems being discharged to sub-acute care facilities could subsequently trigger a more comprehensive discharge and care transition procedure. This might involve a dedicated professional (such as a geriatric nurse practitioner) managing the discharge process and personally communicating key information, including pending lab tests, to the next setting of care.

In conclusion, this study’s findings highlight an important shortcoming in discharge summary communication which may adversely affect sub-acute patient care. Future studies should focus on improving the communication of pending lab tests at discharge, and evaluating the impact that this improved communication has on patient outcomes.

Acknowledgments: The authors would like to acknowledge the contributions of key people who helped make this project a success: Patty Horstmeier, Donald Wiebe, Wen-Jan Tuan, Patrick Ferguson and Peggy Munson.

Funding for this project was provided by the University of Wisconsin (UW) Hartford Center of Excellence in Geriatrics and the UW Health Innovation Program. Dr. Kind is supported by a K-L2 through the NIH grant 1KL2RR025012-01 [Institutional Clinical and Translational Science Award (UW-Madison) 1UL1RR025011 (KL2) program of the National Center for Research Resources, National Institute of Health]. Additional support was provided by the Health Innovation Program and the Community-Academic Partnerships core of the University of Wisconsin Institute for Clinical and Translational Research (UW ICTR), grant 1UL1RR025011 from the Clinical and Translational Science Award (CTSA) program of the National Center for Research Resources, National Institutes of Health. The project described was supported by Award Number K23AG034551 from the National Institute on Aging. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institute on Aging or the National Institutes of Health.

We presented an earlier version of the manuscript as a poster at the American Geriatrics Society Annual Meeting in Orlando, Florida, in May 2010.

Conflicts of Interest: None disclosed.

Corresponding Author: Stacy E. Walz, MS; Department of Population Health Sciences, University of Wisconsin School of Medicine & Public Health, Madison, WI, USA (e-mail: sewalz@wisc.edu).

REFERENCES

1. Forsman RW. Why is the laboratory an afterthought for managed care organizations? *Clin Chem*. 1996;42:813–6.
2. Roy CL, Poon EG, Karson AS, et al. Patient safety concerns arising from test results that return after hospital discharge. *Ann Intern Med*. 2005;143:121–8.
3. Were MC, Li X, Kesterson J, et al. Adequacy of hospital discharge summaries in documenting tests with pending results and outpatient follow-up providers. *J Gen Intern Med*. 2009;24:1002–6.
4. The Joint Commission. Standard RC.02.04.01. Available at: <http://www.jointcommission.org/>. Accessed October 20, 2010.
5. Kripalani S, LeFevre F, Phillips CO, Williams MV, Basaviah P, Baker DW. Deficits in communication and information transfer between hospital-based and primary care physicians: implications for patient safety and continuity of care. *JAMA*. 2007;297:831–41.
6. Coleman EA. Falling through the cracks: challenges and opportunities for improving transitional care for persons with continuous complex care needs. *J Am Geriatr Soc*. 2003;51:549–55.

7. **Kind AJ, Smith MA, Frytak JR, Finch MD.** Bouncing back: Patterns and predictors of complicated transitions 30 days after hospitalization for acute ischemic stroke. *J Am Geriatr Soc.* 2007;55:365–73.
8. **Deutsch A, Fiedler RC, Granger CV, Russell CF.** The Uniform Data System for Medical Rehabilitation report of patients discharged from comprehensive medical rehabilitation programs in 1999. *Am J Phys Med Rehabil.* 2002;81:133–42.
9. **Deutsch A, Fiedler RC, Iwanenko W, Granger CV, Russell CF.** The Uniform Data System for Medical Rehabilitation report of patients discharged from subacute rehabilitation programs in 1999. *Am J Phys Med Rehabil.* 2003;82:703–11.
10. **Sahyoun NR, Pratt LA, Lentzner H, Dey A, Robinson KN.** The changing profile of nursing home residents: 1985–1997. *Aging Trends.* 2001;4:1–8.
11. **Jardine L, Davies MW, Faoagali J.** Incubation time required for neonatal blood cultures to become positive. *J Paediatr Child Health.* 2006;42:797–802.
12. **Kaplan RL, Harper MB, Baskin MN, Macone AB, Mandl KD.** Time to detection of positive cultures in 28- to 90-day-old febrile infants. *Pediatrics.* 2000;106:E74.
13. **Martinez JA, Pozo L, Almela M, et al.** Microbial and clinical determinants of time-to-positivity in patients with bacteraemia. *Clin Microbiol Infect.* 2007;13:709–16.
14. **Shah SS, Downes KJ, Elliott MR, Bell LM, McGowan KL, Metlay JP.** How long does it take to "rule out" bacteremia in children with central venous catheters? *Pediatrics.* 2008;121:135–41.
15. **Harrison JP, McDowell GM.** The role of laboratory information systems in healthcare quality improvement. *Int J Health Care Qual Assur.* 2008;21:679–91.
16. **McPherson RA, Pincus MR, Henry JB.** *Henry's Clinical Diagnosis and Management by Laboratory Methods.* 21st ed. Philadelphia: Saunders Elsevier; 2007.
17. Cary NC, ed. *SAS Statistical Software.* 8.2. SAS Institute; 2002.
18. Stata Corporation. *Stata Statistical Software.* 8.0 ed. College Station, TX: Stata Corporation; 1999.
19. **Hickey A, Clinch D, Groarke EP.** Prevalence of cognitive impairment in the hospitalized elderly. *Int J Geriatr Psychiatry.* 1997;12:27–33.
20. **Weaver FM, Guihan M, Hynes DM, Byck G, Conrad KJ, Demakis JG.** Prevalence of subacute patients in acute care: results of a study of VA hospitals. *J Med Syst.* 1998;22:161–72.
21. **Jencks SF, Williams MV, Coleman EA.** Rehospitalizations among patients in the Medicare fee-for-service program. *N Engl J Med.* 2009;360:1418–28.
22. **Berild D, Mohseni A, Diep LM, Jensenius M, Ringertz SH.** Adjustment of antibiotic treatment according to the results of blood cultures leads to decreased antibiotic use and costs. *J Antimicrob Chemother.* 2006;57:326–30.
23. **McIsaac WJ, Moineddin R, Ross S.** Validation of a decision aid to assist physicians in reducing unnecessary antibiotic drug use for acute cystitis. *Arch Intern Med.* 2007;167:2201–6.
24. **Swanson JM, Wood GC, Croce MA, Mueller EW, Boucher BA, Fabian TC.** Utility of preliminary bronchoalveolar lavage results in suspected ventilator-associated pneumonia. *J Trauma.* 2008;65:1271–7.
25. **Poon EG, Gandhi TK, Sequist TD, Murff HJ, Karson AS, Bates DW.** "I wish I had seen this test result earlier!": dissatisfaction with test result management systems in primary care. *Arch Intern Med.* 2004;164:2223–8.
26. **Isaac DR, Gijsbers AJ, Wyman KT, Martyres RF, Garrow BA.** The GP-hospital interface: attitudes of general practitioners to tertiary teaching hospitals. *Med J Aust.* 1997;166:9–12.
27. **Meara JR, Wood JL, Wilson MA, Hart MC.** Home from hospital: a survey of hospital discharge arrangements in Northamptonshire. *J Public Health Med.* 1992;14:145–50.
28. **Pantilat SZ, Lindenauer PK, Katz PP, Wachter RM.** Primary care physician attitudes regarding communication with hospitalists. *Am J Med.* 2001;111:15–20.
29. **Wahls T, Haugen T, Cram P.** The continuing problem of missed test results in an integrated health system with an advanced electronic medical record. *Jt Comm J Qual Patient Saf.* 2007;33:485–92.

APPENDIX

Table 4 shows categories and representative examples of laboratory tests

Table 4. Categories and Representative Examples of Laboratory Tests¹⁶

Category	Category
Representative examples	Representative examples
Hematology	Immunology
Hematocrit	Anticardiolipin antibodies
Complete blood count (CBC)	Serum protein electrophoresis
White blood cell (WBC) differential	
Hemoglobin	Molecular diagnostics
Red blood cell (RBC) count	Prothrombin gene mutation
Coagulation	Factor V Leiden gene mutation
Prothrombin time (PT)	Reference lab testing
Partial thromboplastin time (PTT)	Acid fast bacilli smear & culture
Protein C or S	Serum aldosterone
Lupus anticoagulant	Renin
Chemistry	Transfusion
Plasma glucose	ABO/Rh typing
Total cholesterol	Antibody screen
Gamma glutamyl transferase (GGT)	Crossmatch
Troponin	
Urinalysis	Histocompatibility
Urinalysis (chemical analysis)	Human leukocyte antigen (HLA) class I typing, A, B, C loci
Microscopic analysis of formed elements in urine	Microbiology
	Cultures (blood, urine, wound, fungal, other)
Endocrinology	Antimicrobial sensitivity
Total testosterone	<i>Clostridium difficile</i> antigen
Parathyroid hormone	
Follicle stimulating hormone	Other
	Erythrocyte sedimentation rate (ESR)
Flow cytometry	Point-of-care (POC) glucose
Immune deficiency profile	
Toxicology	
25-hydroxy Vitamin D	