Contemporary Bloodletting in Cardiac Surgical Care

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Background. **Health care providers are seldom aware of the frequency and volume of phlebotomy for laboratory testing, bloodletting that often leads to hospital-acquired anemia. Our objectives were to examine the frequency of laboratory testing in patients undergoing cardiac surgery, calculate cumulative phlebotomy volume from time of initial surgical consultation to hospital discharge, and propose strategies to reduce phlebotomy volume.**

Methods. **From January 1, 2012 to June 30, 2012, 1,894 patients underwent cardiac surgery at Cleveland Clinic; 1,867 had 1 hospitalization and 27 had 2. Each laboratory test was associated with a test name and blood volume. Phlebotomy volume was estimated separately for the intensive care unit (ICU), hospital floors, and cumulatively.**

Results. **A total of 221,498 laboratory tests were performed, averaging 115 tests per patient. The most frequently performed tests were 88,068 blood gas analyses, 39,535 coagulation tests, 30,421 complete blood counts, and 29,374 metabolic panels. Phlebotomy volume differed between ICU and hospital floors, with median volumes of 332 mL and 118 mL, respectively. Cumulative median volume for the entire hospital stay was 454 mL. More complex procedures were associated with higher overall phlebotomy volume than isolated procedures; eg, combined coronary artery bypass grafting (CABG) and valve procedure median volume was 653 mL (25th/75th percentiles, 428 of 1,065 mL) versus 448 mL (284 of 658 mL) for isolated CABG and 338 mL (237 of 619) for isolated valve procedures.**

Conclusions. **We were astonished by the extent of bloodletting, with total phlebotomy volumes approaching amounts equivalent to 1 to 2 red blood cell units. Implementation of process improvement initiatives can potentially reduce phlebotomy volumes and resource utilization.**

(Ann Thorac Surg 2015;99:779–85)

"Nosocomial anemia" from bloodletting for diagnostic laboratory testing was coined in the 1970s to describe patients developing anemia without a notable cause after intensive care unit admission [1]. Although laboratory testing is an essential component of perioperative care, health care providers seldom are aware of the frequency and volume of phlebotomy for routine laboratory testing, and of recent work in medical and surgical settings identifying the association of hospital-acquired anemia and in-hospital morbidity, mortality, and resource utilization [2–4].

After an investigation into the prevalence and outcomes associated with development of hospital-acquired anemia in our health system, we began to critically examine factors contributing to its occurrence. We were not cognizant of the overall frequency of testing and cumulative phlebotomy volumes associated with hospitalization for cardiac surgical procedures. Hence, our objectives were the following: (1) to examine the frequency of laboratory testing in patients undergoing cardiac surgery; (2) to calculate the cumulative phlebotomy volume from the time of initial surgical consultation to hospital discharge; and (3) to propose strategies to reduce overall phlebotomy volume.

Material and Methods

From January 1, 2012 through June 30, 2012, 1,894 patients underwent cardiac surgery at Cleveland Clinic, among whom 1,867 had only 1 hospitalization and 27 had 2 (Table 1). Any laboratory testing performed before or after the above dates was excluded from the analysis. Each laboratory test was associated with a name, blood volume, and information on unique accession numbers. An accession number refers to an individual blood drawing event, and therefore multiple (separately identified) tubes drawn at the same date and time will have the same accession number, and multiple batched tests will be run on an individual accession number.

Cumulative phlebotomy volume from laboratory testing performed in the 76-bed postoperative cardiovascular intensive care units (CVICU) included 7 to 10 mL of discarded blood to clear the line with each accession number for laboratory testing. In the operating rooms the line discard volume was frequently returned to the

Accepted for publication Sept 23, 2014.

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0003-4975/$36.00
http://dx.doi.org/10.1016/j.athoracsur.2014.09.062

Table 1. Patient Characteristics and Operative Features of the Population (total n = 1,921)

Factor	n[a]	No. (%) or Median [25th, 75th percentiles]
Demographics		
Age (years)	1,921	65 [56, 74]
Male	1,921	1,271 (66)
Race	1,921	
Caucasian		1,737 (90)
Black		117 (6.1)
Other		67 (3.5)
Body surface area (m^2)	1,921	2.0 [1.8, 2.2]
Body mass index (kg/m^2)	1,921	28 [25, 31]
Preoperative laboratory values		
Bilirubin (mg/dL)	1,894	0.50 [0.40, 0.80]
Creatinine (mg/dL)	1,916	0.96 [0.80, 1.2]
Blood urea nitrogen (mg/dL)	1,916	18 [15, 24]
Hematocrit (%)	1,913	38 [34, 42]
Comorbidities		
Prior myocardial infarction	1,921	442 (23)
Atrial fibrillation/flutter	1,921	358 (19)
Heart failure	1,921	590 (31)
Endocarditis	1,921	111 (5.8)
Peripheral arterial disease	1,921	308 (16)
Carotid disease	1,921	0 (0)
Diabetes	1,916	
Insulin treated		201 (10)
Non-insulin treated		332 (17)
COPD	1,921	562 (29)
Smoking	1,921	365 (19)
Prior stroke	1,921	160 (8.3)
Clinical presentation		
NYHA functional class	1,795	
I		471 (26)
II		777 (43)
III		420 (23)
IV		127 (7.1)
Emergency surgery	1,921	76 (4.0)
Surgical procedure		
CABG	1,921	613 (32)
Valve procedure	1,921	1,371 (71)
CABG plus valve procedure	1,921	321 (17)
Any aortic root, ascending aorta, or arch replacement	1,921	300 (16)
Other procedures	1,921	169 (8.8)
ITA grafting	1,921	
0		1,506 (78)
1		377 (20)
2		38 (2.0)
Operative features		
Full sternotomy	1,917	1,461 (76)
Minimally invasive	1,917	453 (24)
Myocardial ischemic time (min)	1,921	67 [45, 92]
CPB time (min)	1,921	92 [63, 125]

[a] Number of patients with data available.

CABG = coronary artery bypass grafting; COPD = chronic obstructive pulmonary disease; CPB = cardiopulmonary bypass; ITA=internal thoracic artery; min = minutes; NYHA = New York Heart Association.

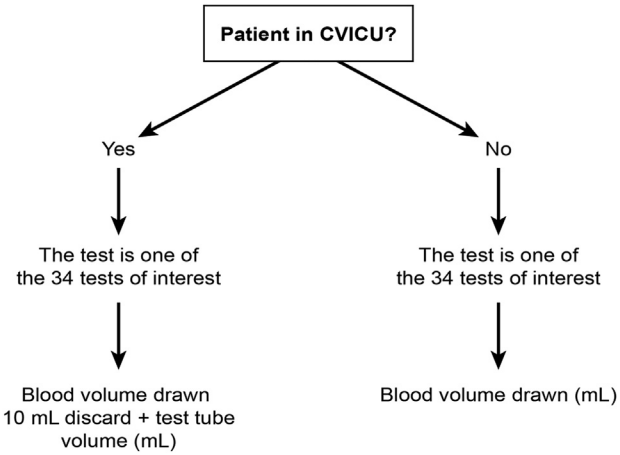

Fig 1. Algorithm for phlebotomy volume. (CVICU=cardiovascular intensive care unit.)

patient; hence, we did not account for additional phlebotomy volume beyond the laboratory testing volume. Preoperative standardized testing and postoperative testing after discharge from the CVICUs were performed by Phlebotomy Services through direct venipuncture without the need for discard volume. Estimated phlebotomy volume was calculated separately for the CVICUs (assuming a 10-mL discard volume), hospital floors, and overall with an algorithm (Fig 1). (In this study, we have used the term "phlebotomy" to mean blood draws for testing from any site, venous or arterial, although we recognize that the origin of the Greek word is "vein".) All data used in this study have been approved for use in research by the Institutional Review Board, with patient consent waived.

Results

Frequency of Laboratory Testing

A total of 221,498 laboratory tests were performed during the study period, averaging 115 tests per patient. The most frequently performed diagnostic tests were 88,068 blood gas analyses, 39,535 coagulation tests, 30,421 complete blood counts, and 29,374 metabolic panels (Table 2).

Table 2. The Most Commonly Performed Laboratory Tests[a]

Type of Test	No. (%)
Blood gas (arterial or venous)	88,068 (40)
Coagulation tests[b]	39,535 (18)
Complete blood count, with or without differential	30,421 (14)
Metabolic panels	29,374 (13)
Blood culture	11,739 (5.3)
Blood type and screen	8,422 (3.8)
Potassium level	4,108 (1.8)

[a] Accounting for 95% of laboratory tests performed. [b] Prothrombin time and partial thromboplastin time.