ORIGINAL ARTICLE

Preanalytical Errors in the Central Laboratory of a University Hospital Based on the Analysis of Year-Round Data

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SUMMARY

Background: Preanalytical errors cause a decrease in the accuracy of clinical laboratory results. We analyzed preanalytical errors (preAEs) made in the clinical laboratory of a university hospital.
Methods: All samples received in a centralized laboratory from January 1, to December 31, 2018, were analyzed retrospectively. The categories of preAEs were improper request, incorrect labeling, improper collection/transport, inadequate sample volume, inappropriate container, hemolysis, and sample clotting. The rates of preAEs in these categories were calculated according to sample type, laboratory subunit, department, sampling place, sampling time, and patient age.
Results: Of 1,082,014 samples received and analyzed by the laboratory, 6,848 (0.63%) were classified as having preAEs. The most frequent categories of preAE were hemolysis (44.6%), sample clotting (30.8%), and inadequate volume (16.7%). The most frequent preAE category for whole-blood and serum/plasma was clotting and hemolysis, respectively. The most frequent preAE category in the blood bank, clinical chemistry, immunology, and test referral service laboratory subunits was hemolysis, in the hematology subunit it was sample clotting, and in the microbiology and urinalysis subunits it was inadequate sample volume. Surgical departments had a higher rate of preAEs than did non-surgical departments (p < 0.0001). Samples drawn in the sampling room showed the lowest frequencies of preAEs (0.01%). Samples drawn on general wards from 5 pm to 5 am, when duty nurses perform sampling, showed a preAE rate of 2.80%. The rate of preAEs increased with patient age.
Conclusions: This analysis of preAEs is the most comprehensive to date. Our findings will promote the provision of high-quality laboratory services to clinicians and their patients.
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Supplementary Tables and Figures

Supplement 1. Categorization of variables.

Categorization	Variables	Comments
Category of pre-analytical error	**Improper request**	e.g., double request, incomplete request, incorrect request and incorrect time request
	Incorrect labelling	e.g., wrong label, two labels on one sample and incorrect identification
	Improper collection/transport	e.g., sampling time error, venous blood sampling for gas analysis, needless resample, inappropriate transport
	Inadequate sample volume	e.g., insufficient sample volume and empty tube
	Inappropriate container	e.g., wrong container, broken container, container with opened lid, syringe with needle for blood gas analysis
	Hemolysis	grossly hemolyzed
	Sample clotting	
Sampling place	**Outpatient**	
	Emergency room	
	General ward	
	Intensive care unit	
Type of samples	**Whole blood**	e.g., citrate anticoagulated, EDTA anticoagulated, and plain bottle
	Serum/plasma	e.g., SST, PST, and heparin bottles
	Stool	
	Respiratory sample	e.g., endotracheal sputum and bronchial washing
	Swab	e.g., nasal swab, skin swab, and ulcer swab
	Tissue	
	Urine	e.g., spot urine and timed urine
	Body fluid	e.g., cerebrospinal fluid, ascitic fluid, and pleural fluid
Subunits of laboratory	**Blood bank**	
	Clinical chemistry	
	Hematology	
	Immunology	
	Microbiology	
	Molecular genetics	
	Urinalysis	
	Referring test	
Department	**Chest surgery**	Surgery
	General surgery	Surgery
	Neurosurgery	Surgery
	Obstetrics and gynecology	Surgery
	Ophthalmology	Surgery
	Orthopedics	Surgery
	Otolaryngology	Surgery
	Plastic surgery	Surgery
	Urology	Surgery
	Cardiovascular center	Non-surgery
	Dermatology	Non-surgery
	Endocrinology	Non-surgery

Supplement 1. Categorization of variables (continued).

Categorization	Variables	Comments
Department	Family medicine	Non-surgery
	Health-care center	Non-surgery
	Internal medicine	Non-surgery
	Neurology	Non-surgery
	Pediatrics	Non-surgery
	Psychiatry	Non-surgery
	Rehabilitation	Non-surgery
	Emergency medicine	Emergency medicine
Sampling time	Ordinary working hour	8 am - 5 pm on Monday-Friday
	Shift working hour	5 pm - 8 am of the next morning on Monday-Friday
	Evening-night time	5 pm - 5 am
	Early morning time	5 am - 8 am
	Weekend	Saturday - Sunday
Patients' age	0 - 9 years old	
	10 - 18 years old	
	19 - 64 years old	
	≥ 65 years old	

Supplement 2.

|	No. of preAE		No. of total sample		preAE rate (%)	
	Outpatients	Inpatients [*]	Outpatients	Inpatients [*]	Outpatients	Inpatients [*]
Non-surgery	32	3,298	294,495	246,915	0.011	1.336
Cardiovascular center	2	397	41,430	34,606	0.005	1.147
Dermatology	0	25	3,863	693	0	3.608
Endocrinology	7	36	74,738	3,070	0.009	1.173
Family medicine	0	31	12,604	3,363	0	0.922
Health-care center	6	0	64,715	0	0.009	0
Internal medicine	19	2,168	111,104	150,414	0.017	1.441
Neurology	1	383	14,685	21,131	0.007	1.813
Pediatrics	1	149	20,540	21,718	0.005	0.686
Psychiatry	0	64	3,528	6,971	0	0.918
Rehabilitation	0	45	517	4,949	0	0.909
Surgery	20	2,287	104,036	157,263	0.019	1.454
Chest surgery	1	88	1,178	7,038	0.085	1.25
General surgery	4	350	15,986	28,954	0.025	1.209
Neurosurgery	1	738	4,717	50,287	0.021	1.468
Orthopedics	6	692	18,027	37,497	0.033	1.845
Obstetrics and gynecology	1	139	16,518	13,596	0.006	1.022
Ophthalmology	0	10	5,488	360	0	2.778
Otolaryngology	3	107	9,398	7,373	0.032	1.451
Plastic surgery	0	49	2,653	3,100	0	1.581
Urology	2	114	30,071	9,408	0.007	1.212
Emergency medicine	4	1,207	62,246	217,055	0.006	0.556

Abbreviations: preAE - preanalytical error.
[*] - Inpatients included all hospitalized patients from emergency room, intensive care units, and general wards.
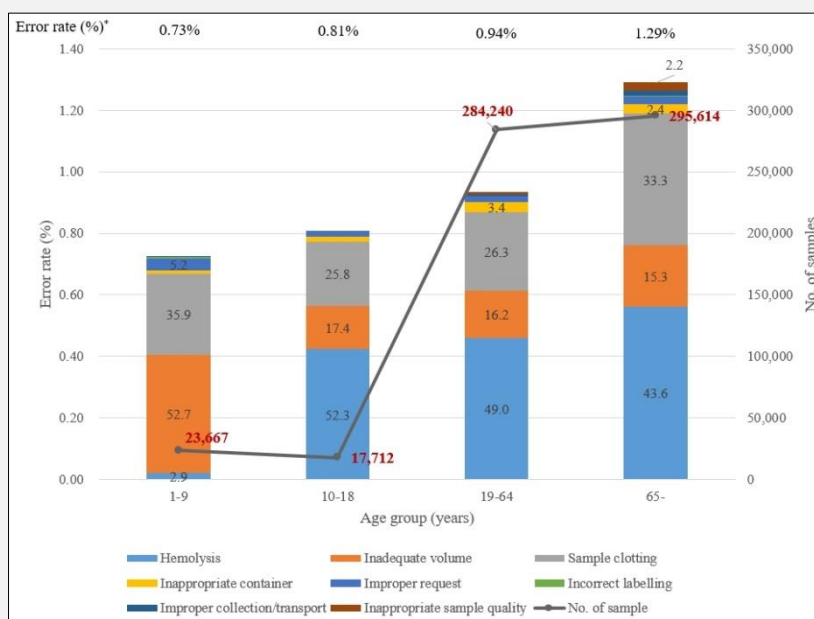
Supplement 3. Preanalytical error rates according to the patient age group for inpatients.

* - the number of samples with errors divided by total number of samples and multiplying by 100 (%).
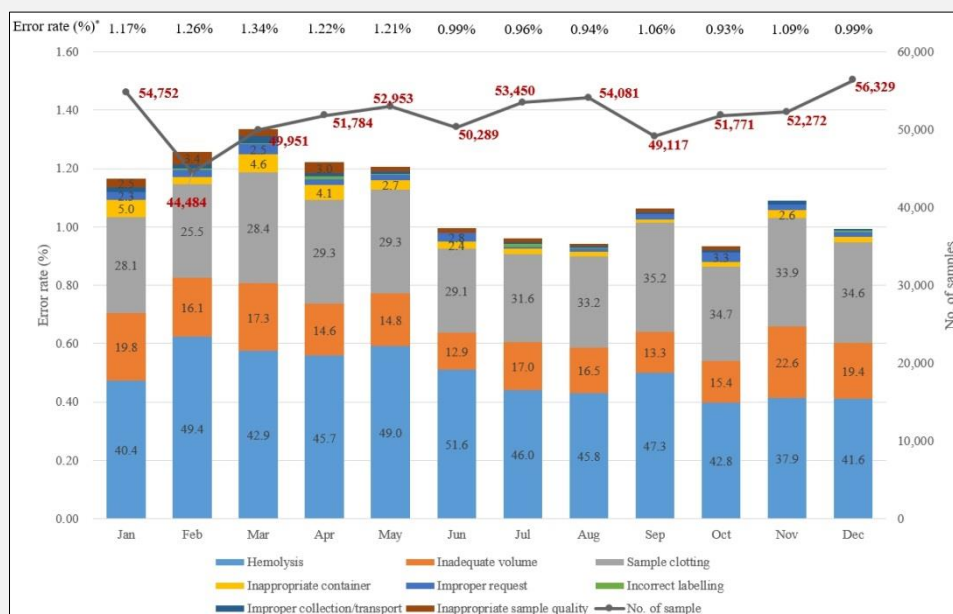
Supplement 4. Preanalytical error rates by month for inpatients.

* - the number of samples with errors divided by total number of samples and multiplying by 100 (%).