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Quality Data and Errors in a Tertiary Microbiology Laboratory (2017-2020): "The Good, the Bad and the Ugly"

Üçüncü Basamak Bir Hastanenin Mikrobiyoloji Laboratuvarında Kalite Verileri ve Hatalar (2017-2020): "İyi, Kötü ve Çirkin"

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ABSTRACT

Background: In the last century, tremendous developments have happened in laboratory medicine. Even though laboratory errors have declined and quality standards have been defined concordant with technological developments, their routine and continuous monitoring has become main part of laboratory medicine. The aim of this study was to investigate contamination rates, specimen rejection and quality analysis of a microbiology laboratory of a tertiary hospital in a 4-year period.

Materials and Methods: Specimens of Balıkesir Atatürk City Hospital in 2017-2020 that were sent to microbiology laboratories were retrospectively evaluated regarding rejection rates, rejection reasons, blood culture (BC) quality and contamination rates, urine culture (UC) contamination rates. Rejection analysis and contaminations were divided according to rejection reasons and hospital services.

Results: A total of 1,862.038 samples were sent to microbiology laboratory in a 4-year period. Reasons of over 80% of specimen rejections were inappropriate specimen, inappropriate containers, insufficient specimen, and missing sample and/or test request, respectively. Outpatient and internal medicine services covered the majority of rejections, but rejections were significantly lower in intensive care units (ICUs) and surgical services ($p<0.001$). 68.5% of all UC contaminations were detected in outpatient services. The difference of UC contamination rates regarding years ($p=0.846$) and services ($p=0.182$) were not significant. 72.8% of BC contaminations were sourced from ICUs. The difference of BC contamination rates regarding years ($p=0.630$) and services ($p=0.630$) were not significant. False positivity of BCs was 1.1%, failures of first notification were ⩽0.1%, and gram staining-final identification agreement rate was 94.3%. One-vial BC rate was 3.8%, with the majority of neonatal cases (>90%).

Conclusion: Although our rejection and quality rates are below the highest thresholds of quality criteria, a need of training and organization in outpatient units was clear. Similar impropriety was observed in UC contaminations with the same units. BC contaminations in ICUs are thought to be sourced from inappropriate indwelling catheter care.

Keywords: Quality indicators, laboratory medicine, clinical laboratories, quality control, contamination

ÖZ

Amaç: Son yüzyıl laboratuvar tıbbında muazzam gelişmelere sahne olmuştur. Her ne kadar teknolojik gelişmelerle laboratuvar testlerindeki hatalar anlamlı şekilde azaltılmış ve kalite standartları belirlenmiş olsa da, bunların rutin izlemi laboratuvar tıbbının temel unsuru haline gelmiştir. Bu çalışmadaki amaç, dört yıllık süreçte üçüncü basamak bir hastanenin mikrobiyoloji laboratuvarının kontaminasyon, numune reddi ve kalite analizini değerlendirmektir.

Gereç ve Yöntemler: Balıkesir Atatürk Şehir Hastanesi'nin 2017-2020 yılları arasında mikrobiyoloji laboratuvarlarına gönderilen numunelerinin red oranı ve red sebebi ile kan kültürü kalite ve kontaminasyon oranları ve idrar kültürü numunelerinin kontaminasyon oranlarına retrospektif olarak bakılmıştır. Red analizleri ve kontaminasyon oranları red sebebine ve hastane birimlerine göre düzenlenmiştir.

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ÖZ

Bulgular: Mikrobiyoloji laboratuvarlarına dört yıl içerisinde toplamda 1,862.038 laboratuvar numunesi ulaşmıştır. Numune redlerinin %80'inden fazlasının sebepleri sırasıyla, uygunsuz numune, uygunsuz numune kabı, yetersiz numune, kayıp numune/uygunsuz test istemi şeklindedir. Ayaktan hasta ünitelerinden ve iç hastalıkları servislerinden gelen numuneler redlerin çoğunluğunu oluştururken, yoğun bakımlardan ve cerrahi servislerden gelen numunelerde red anlamlı şekilde daha azdır (p<0,001). İdrar kültürlerinin tüm kontaminasyonlarının %68,5'i ayaktan hasta servislerinde görüldü. İdrar kültürlerinde yıllara göre (p=0,846) ve servislere göre (p=0,182) kontaminasyon oranları anlamlı bulunmadı. Toplam kan kültürü kontaminasyonlarının %72,8'i yoğun bakım ünitelerindendi. Kan kültürlerinde yıllara göre (p=0,630) ve servislere göre (p=0,630) kontaminasyon oranları anlamlı bulunmadı. Kan kültürlerinde yalancı pozitiflik %1,1, pozitifliğin ilk bildirimindeki hatalar ⩽%0,1 ve gram boya-son tanımlama uyum oranı %94,3'tü. Tek şişe kan kültürü oranı %3,8'di ve çoğunlukla neonatal olgulardı (>%90).

Sonuç: Her ne kadar numune red oranları kalite standartlarında belirtilen sınırların altında kalsa da, ayaktan hasta ünitelerinde numune yönetimi hususunda eğitim ve düzenleme gerekliliği açıktır. Aynı birimlerde benzer uygunsuzluk idrar kültürü kontaminasyonunda da görülmektedir. Yoğun bakım ünitelerindeki kan kültürü kontaminasyonunun yetersiz invazif kateter bakımından kaynaklandığı düşünülmektedir.

Anahtar Kelimeler: Kalite indikatörleri, laboratuvar tıbbı, klinik laboratuvar, kalite kontrol, kontaminasyon

Introduction

Advanced technological and scientific improvements have created a massive alteration in diagnostic methods that have directly affected the design and spectrum of clinical laboratories. Such widening landscape of clinical laboratories also caused a specific evolution in their accuracy and quality information. Introduction of computers, advanced automization and utilization of informatics have yet resulted with simplifying quality control (QC) measures, however, the need to control and improve quality in clinical laboratories has concordantly grown due to possibly increasing numbers of types of various tests. Furthermore, the parameters that have to be checked in QC measures have additionally grown with the increasing understanding of the tests due to various scientific researches (1,2). The proficiency testing/external quality assessment programs, pre/post-analytical and analytical quality specifications and internal quality measures are established-but periodically and dynamically updated- and currently in use. International/national organisations such as the Clinical and Laboratory Standards Institute (CLSI) publish and update documents to provide continuous improvement and reliability on laboratory results by establishing strict monitoring standards for QC (2,3,4,5,6). In addition, clinical laboratories that are willing to be internationally recognised try to gain international and independent approvement by accreditation certificates such as ISO 15189. Recently, in laboratory profession, global "acceptibility" has become a very important trend, since the cruciality of this point was observed in the last pandemic of Coronavirus disease-2019. Furthermore, this point actually gives a perspective of "legal responsibility" regarding the laboratory results (7).

The process control in clinical microbiology laboratories has step-by-step checkpoint data from pre- to post-analytic phases. In internationally-adapted guidelines of Turkish Ministry of Health, these data as quality measures of specimen rejection ratio, missing specimen ratio, contamination in urinary and/or blood cultures (UCs, BCs) unsuitability in internal and/or external control executions were clearly defined. In addition, measures of positivity ratio in total BCs, false positivity ratio in total BCs, time period from BC positivity to first notification to the clinic, BC ratio sampled as two or more sets, BC ratio as sampled only one bottle, compatibility ratio of gram staining result and last identification in BCs were stated (4,5,6). The aim of this study was to monitor the current condition and variations of stated measures in our clinical microbiology laboratory in 2017-2020.

Material and Methods

Ethical approval: Approved by the Ethical Board of Balıkesir University Faculty of Medicine (date: 11 Nov 2020/desicion number: 2020/203).

Materials and methods: Microbiological specimens of both inpatients and outpatients admitted to Balıkesir Atatürk City Hospital, which were obtained and sent to clinical laboratories (immunoserology, tuberculosis, bacteriology/mycology and virology) in 2017-2020, were included. The data of specimens and ratios according to the criteria of the quality of the guidelines of Turkish Ministry of Health were retrospectively investigated (4,5,6). The data were obtained by hospital sofware system and hospital quality management department. There is a software system that monitorize the sample step-by-step and the data divided to services and different laboratories. Internal medicine services (IMSs) include forensic medicine, family medicine, pediatrics, adult and pediatric psychiatry, dermatology and venereal diseases, infectious disesases, chest diseases and pulmonology, physical therapy and rehabilitation, internal medicine, cardiology, neurology, nuclear medicine, radiation

oncology, radiodiagnostics, sports medicine, underwater and hyperbaric medicine, medical genetics and medical ecology and hydroclimatology. Surgical services (SSs) include emergency medicine (ER), neurosurgery, general surgery, pediatric surgery, ophthalmology, gynecology and obstetrics, cardiac and thoracic surgery, ear-nose-throat surgery, orthopedics and traumatology, urology and plastic, reconstructive and aesthetic surgery departments. Intensive care units (ICUs) include pediatric, neonatal, surgical, cardiovascular, chest diseases and pulmonology, internal medicine, anesthesiology and reanimation and general ICUs.

The QC of all media and BC vials was performed once a month and QC of gram staining was performed once a week. In the case of a new party of any of these materials, all QC procedures according to manufacturers' recommendations were additionally performed.

Statistical Analysis

We statistically analyzed the research data using the SPSS 22.0 (SPSS INC, Chicago, IL, USA) program. Categorical variables are denoted as numbers and percentages, and we performed a chi-square test the compare the data between the independent groups. A p-value of <0.05 was considered statistically significant.

Results

In a 4-year period (2017-2020), a total of 2.181.162 tests were requested and 1.862.038 (85.4%) specimens were sent to the clinical microbiology laboratories. Specimen rejection analysis regarding services and reasons, UC and BC contaminations and various BC quality parameters are presented in Tables 1, 2, 3.

Over 80% of specimen rejections are caused because of inappropriate specimen and/or container, insufficient specimen, missing specimen and/or test requests. The majority (90.7%) of the rejected specimens were sourced from outpatient units and IMSs. However, such rejections were particularly rare in SSs and ICUs. There was statistically significant difference between polyclinics and IMSs compared with SSs and ICUs (p<0.001). The nearly half of specimen rejections (47.7%) were observed in samples that were sent to bacteriology/mycology and virology laboratories.

12.4% of all UCs were reported as contamination and outpatient services had the highest rate (68.8% of all urinary contaminations; 11.9% of all UCs from outpatient services), which was predominantly sourced by pediatrics and ER (52.2% of all urinary contaminations; 6.5% of all UCs). Regarding services, 20.2% of all UCs from inpatient services were contaminated, which's majority was again from pediatrics (10.5% of all urinary contaminations). The lowest UC contamination was from infectious diseases and urology inpatient services (1.8% of all UC contaminations). There was not any significant difference in contamination rates between services (p=0.182) and in addition, among years, UC contamination rates did not show any significant alteration (p=0.846).

22.6% of all BCs gave positive signal with a contamination rate of 5.6%, and false positivity of 1.1%. The alterations contamination rates regarding years was not significant (p=0,630). Majority of contaminations were from ICUs (72.8% of all BC contaminations, 6.7% of all BCs from ICUs). All BCs of outpatient services were obtained from ERs with a rate of 1.9% among all BC contaminations. Pediatric ICUs had the highest contamination rates (45.0% of ICU contaminations, 32.8% of all BC contaminations, 1.8% of all BCs), followed by surgical ICUs (26.1% of ICU contaminations, 18.9% of all BC contaminations, 1.1% of all BCs). The lowest BC contamination was from infectious diseases and cardiovascular surgery services (2.9% of all BC contaminations). On the other hand, all services did not significantly differ in BC contaminations (p=0.630). Failure in the first notification of positivity to the clinic was ⩽0.1%, with the Gram staining-final identification agreement as 94.3%. One vial BCs was 3.8% of BCs, which were mostly neonatal cases (>90%).

Table 1. Specimen rejection analysis regarding reasons

Specimen rejection analysis	Immunoserology	Tuberculosis	Bacteriology/mycology/ virology	Total	In total samples (%)
Improper barcoding	30	8	56	94	0.005
Missing sample and/or test request	75	54	144	273	0.015
Inappropriate specimen	45	208	268	521	0.028
Insufficient specimen	60	128	128	316	0.017
Inappropriate containers	270	8	156	434	0.023
Inappropriate transport/storage conditions	15	16	8	39	0.002
Other (intra- and post-analytical phases)	45	12	128	185	0.009
Total	540	434	888	1862	0.1

Table 2. Specimen rejection analysis regarding services

Specimen rejection analysis	Immunoserology		Tuberculosis		Bacteriology/mycology/virology		Total[1]	
	n	%	n	%	n	%	n	%
Polyclinics (outpatient services)	432	0.07	66	0.2	573	0.2	1071	0.2[a]
Internal medicine services	46	0.09	356	0.5	216	0.07	618	0.2[b]
Surgical services	31	0.6	12	0.3	40	0.05	83	0.08[c]
Intensive care units	31	0.5	0	-	59	0.04	90	0.05[d]
Total	540	0.08	434	0.4	888	0.1	1862	0.1

[a]Among outpatient, [b]Among internal medicine patients, [c]Among surgical patients, [d]Among intensive care unit patients, [1]There was a statistically significant difference between polyclinics and internal medicine services vs. surgical services and intensive care units (p<0.001)

Table 3. Contamination rates regarding urine and blood culture samples

	Years	2017		2018		2019		2020		Total[1,2]	
	Services	n	%	n	%	n	%	n	%	n	%
Urine culture (UC)	Intensive care units (ICU)	53	5.3	170	10.0	247	14.3	313	14.1	783	11.8[a]
	Inpatient services	174	19.5	359	18.5	377	21.0	408	21.0	1318	20.2[b]
	Outpatient services	1229	14.4	888	9.1	1250	11.3	1192	13.5	4559	11.9[c]
	Total	1456	13.2	1417	9.9	1874	12.3	1913	14.3	6660	12.4
	Years	2017		2018		2019		2020		Total[1,2]	
	Services	n	%	n	%	n	%	n	%	n	%
Blood culture (BC)	Intensive care units	97	4.2	389	6.8	392	6.9	415	8.3	1293	6.7[a]
	Inpatient services	59	3.1	180	4.6	125	3.6	84	3.2	448	3.8[b]
	Outpatient services	13	5.6	4	2.7	7	5.5	11	7.5	35	5.3[c]
	Total	169	3.4	573	5.9	524	5.6	510	6.6	1776	5.6

[a]Among ICU patients, [b]Among inpatients, [c]Among outpatients, [1]There was not statistically significance in differences of UC (p=0.846) and BC (p=0.630) contamination rates regarding years. [2]There was not statistically significance in differences of UC (p=0.182) and BC (p=0.630) contamination rates regarding services

Discussion

In the last decades, advances of new technologies that the caused massive automation of laboratory processes have created to an increasing trend in test demands, and accordingly rising amounts of test workload with increasingly sophisticated tests. As a result, clinical laboratories perform billions of test reports, that require maintenance of quality on not only analytical processes, but also all steps starting from test order to result interpretation. Quality indicators (QIs) are beneficial tools to enable laboratories to monitor and quantify the quality of a selected test by comparing with a pre-defined criteria in order to optimize laboratory perfomance. QI is an objective measure tool, which was defined via many scientific researches and manufacturers' investigations. Continuous monitoring, observing errors, systematic and consistent data recording and correction reports are the main goals to improve performance and patient safety. Various studies indicated the numbers of QIs, on the other hand, authorities such as CLSI, ministries of health and ISO published different but concordant guides to achieve the same goals: safety of patients, effectiveness, equity, patient-centeredness, timeliness and efficiency (1,2). In Türkiye, Turkish Ministry of Health along with board organisations declared such guides, especially in the last decade, which strongly recommend the steps stated above (4,5,6). Recently, Sciacovelli et al. (8) published update on quality specifications of the QIs, focusing on every phase of laboratory errors, which shows the levels of ranges of "qualifications".

Specimen rejection and missing specimen ratios are two of the major QIs for microbiology laboratories. In our study, a rate of 0.1% was observed in overall, with a particular rejection predominance because of pre-analytical problems (90.1%). Inappropriate specimen and/or containers and insufficient specimen held the majority, indicating mostly sampling issues prior to transport to laboratories. These results are actually compatible with many studies, since researches generally state a pre-analytical predominance in laboratory errors (8,9,10). However, regarding each individual indicators, all but one pre-analytical QIs of

our laboratory showed "medium" quality, with "improper barcoding" demonstrating "low" quality. Although these pre-analytical errors are thought to be unrelated to the laboratory, laboratory/diagnostic errors are actually accepted as in five phases including pre-pre-analytic, pre-analytic, analytic, post-analytic and post-post-analytic steps. The pre-pre-analytic phase consists of test selection and request, patient identification, sampling and transport to laboratory. This phase was reported as the most "error-tic" step, since several studies reported that over 70% of laboratory errors were sourced from this period (9,10,11). On the other hand, intra- and post-analytic phases had high quality, indicating intralaboratory perfomance was at an optimum level, in our study. Analytic phase is accepted as the least susceptible to errors (9,10). However, clinical biochemistry and microbiology laboratories differ at this point, since microbiology laboratories require relatively more manual/hand-made operations. This might elevate the numbers of errors in microbiology, but in the last decade, with the aggressive interventions in standardization of microbiology laboratories by such as publishing national microbiology standards and continuous lectures organized by public health reference laboratories, significant experience has been gained by microbiology professionals (12). We believe "well-quality" for analytic phase was a result of this, but unfortunately, we could not obtain any data to prove this hypothesis, since our facility was established in 2017. On the other hand, it was clear that bacteriology/mycology/virology laboratories, which have relatively more manual/hand-made operations than others, had the highest numbers of errors in intra- and post-analytical phases. This picture might be a clue to correctness of the hypothesis stated above. Post-post-analytic phase actually depends on interpretation of clinicans (9). In our laboratory, there is a continuous commucation line with the clinicans, and during reporting there are explanation boxes that states the "meaning(s)" of the result. We believe that this "well-quality" is caused by these applications.

Heavy workload is generally a disruptive issue against achieving quality goals. ERs are "victims" of such a condition, since in some studies it is obviously observed that majority of the errors are sourced from there. In the analysis of our study regarding services, outpatient units showed the highest number of laboratory errors (57.5% of all errors). In addition, as previously stated, specimen rejection rates were significantly higher in polyclinics (outpatient units) and IMSs than SSs and ICUs ($p<0.001$). Among outpatients, 40.3% of errors were from ERs, which coincides 23.2% of all errors. This is actually a huge amount, but common it is (13). The second problematic area was IMSs, particularly pediatrics. IMSs had 33.2% of all errors, whereas pediatrics had 21.4% (64.4% of errors in IMSs). It must be stated that in our data pediatric ER was included to ER category, so in assessment of pediatrics as a whole ER+ICU+in/outpatient services, pediatrics seems to have the majority of all errors among all services. We believe these results obviously showed that "the need for quick manipulation" causes pre/pre-pre analytical problems significantly. A non-problematic process such as blood sampling might be seriously problematic when it is applied to minors, like the implementations in the ERs. Thus, as previously reported (13), ERs and pediatric units cover nearly half of the errors (44.6% of all errors). The surprising result of our data was the ICUs (even pediatric ICUs were included in this category), since they took generally second line in previous studies (13). It must be noted that errors in ICU category were mainly sourced by pediatric ones (78.9% of ICU errors), which was totally compatible with our assessments above.

Bloodstream infections (BSIs) are serious causes of mortality and morbidity, that require immediate and accurate interpretation (14,15,16). The skin preparation with an appropriate disinfectant has a crucial role to significantly reduce contamination. There are various disinfectant solutions in use of such purpose, like alcoholic iodine, aqueous povidone-iodine, alcoholic chlorhexidine and other alcoholic antiseptics. Their superiority to each other of these solutions was also a topic of reseach, that did not indicate a consensus. However, it was strongly recommended to use sterile disposable devices and application of antiseptics also to the tops of BC vials. Independent from what kind of disinfectant used, proper training and experience (e.g.; dedicated BC collection teams) were particularly notified by researchers, which was found to have a strong reducer effect on BC contamination rates (15,16). 0% contamination is impossible and is not desired (indicates that there is an interpretative issue), while The American Society of Microbiology recommends a BC contamination rate to be ⩽3% (14,17). However, reports from Türkiye showed a dark picture, since many studies stated their BC contamination findings were above this rate. A 10-year BSIs study from a tertiary center reported a rate of 6.4%, while another center shared it as 6.5% (14,18). Similar results were stated from different centers even in wider studies (4.9-6.8%) (19,20,21). Unfortunately but similarly, in our study, BC contamination was found as 5.6%. There was not any significant reduce in contamination rates regarding years ($p=0.630$), despite our all continuous trainings in order to achieve proper sampling. In addition, there was not any significant difference in BC contamination rates between services ($p=0.630$) (possibly due to their patient load), however, most of the contaminations were caused from ICUs, particularly pediatric/neonatal ICUs (72.8% of all BC contaminations,

6.7% of all BCs from ICUs). We believe this situation is because of the lack of proper catheter care and disinfection, since blood sampling from indwelling catheters is seriously common in ICUs. High level of contaminations particularly in pediatric/neonatal ICUs, are actually an indicator of this hypothesis, since healthcare staff usually do not prefer to make further invasive interventions to minors, while a catheter is in use. Higher *Candida parapsilosis* complex isolation rates from these ICUs (unpublished data) is another clue indicating this claim, since this organism is a direct sign of catheter care (22,23).

Positivity ratio in total BCs, false positivity ratio in total BCs, period from BC positivity to first notification to the clinic, BC ratio sampled as two or more sets, BC ratio as sampled only one bottle and compatibility ratio of gram staining result and last identification in BCs are other parameters that are in routine monitoring. 22.6% of all BCs gave positive signals with a contamination rate of 5.6%, and false positivity of 1.1%. This false positivity rate is actually slightly higher than ideal (≤1%), but in our retropective analysis we found a period of malfunction of our BC device, which covers nearly 60% of our false positivities. False positivity can even as high as 20-50%, but this data includes contaminations too. False positivities without any growth of microorganisms are generally caused due to high level of leukocytes, over-filled vials or improper incubation conditions (such as overheat). In such cases vials should be re-inserted for routine incubation, with a spesific warning not to leave the vials out of the devices more than 1h (15). "First notification to the clinic" is another criteria with a huge importance, since early treatment has a crucial role in prognosis of patients (24). First notifications of our laboratory are made by direct contact with the clinic and/or hospital software that sends a panic SMS to the responsible physician. We were unable to discriminate the ways of notifications, however, our notification failures were extremely rare (≤0.1%), which were mostly because of fault SMS notifications. Obtaining two seperate sets (four vials; set: one aerobic, one anaerobic vial) is a crucial point in order to achieve optimal isolation rates of bacteremia/fungemia agent (except neonatal cases) (25). Our laboratory follows this rule very strictly (one vial 3.8%, mostly neonatal cases), since except particular rare cases, BCs without at least two vials are in rejection zone. However, in our sectional prospective observation, it was noticed that some of the clinics do not strictly follow "one set from catheter, one set from peripheral" rule in diagnosis of catheter-assosciated infections, which laboratory itself could not discriminate. We could not make any comment on the ratio of this, but it is clear that there is a need of training in sampling procedures. In routine procedures, gram staining has a crucial role in the first notification of positivity. It also guides the laboratory for positive vial to be cultivated onto additional media (25).

Compatibility of gram staining result in BCs and last identification of the causative organism is an indicator of the quality of gram staining and training of the laboratory staff. The gram staining-final identification agreement was found as 94.3%. The most incompatibility was observed with Gram-positive *cocci* that were reported as yeasts, followed by Gram-negative cocobasilli that were reported as Gram-positive *bacilli*. In 5 cases, polymicrobial infections were reported as monomicrobial cases, and in one fungemia case the organism was reported as Gram-positive *cocci*. In 8 cases no organism was detected in gram staining, while yeast and Gram-negative *bacilli* were isolated in cultivation. It was very clear that there is a lack of training and experience among laboratory staff in evaluation of gram staining. A similar but higher concordance was found by other centers (26). Some researchers claimed beter results with automated gram staining evaluation (27), however we believe this rate can be elevated by just simple training interventions without any automated system. Of note, gram staining and positivities were, of course, reported to services, so that there is a possibility that they have started an antimicrobial regimen due to these preliminary data. However, in our investigation, it was obvious that our infectious disease department approach especially to coagulase negative *staphylococci* in a huge suspicion, since "one vial Gram-positive *cocci* positivity" resulted in antimicrobial treatment with only <1%. Thus, we believe these faults caused only minor issues clinically, but maybe major issues financially.

Urinary tract infections (UTIs) are one of the most common infections in both pediatric and adult populations. The definition of UTIs consists of a wide spectrum of infections from asymptomatic cases to serious infections that may cause mortal sepsis. Gram-negative bacteria, mainly the order *Enterobacterales,* are the majority of causatives, since *Escherichia coli* causes almost 80% of UTIs (28). Catheter-associated UTIs are the most frequently encountered nosocomial infections, with an elevating risk of infection concordant with the duration of catheterization (28,29). UCs generally have the largest piece of workload in microbiology laboratories, that can be contaminated by periurethral, epidermal, perianal, and vaginal microbiota, which is a serious financial cost and delayer of diagnosis. Contamination rates differ fom center to center, that can be even below 1% to over 40%. Sampling procedure especially in outpatient services strictly related with contamination rates, alongside with pre-cultivation processes such as refrigeration (29). Studies indicated that pediatric cases, especially under 24 months of age,

have the highest contamination rates, probably due to "clean-catch" and/or "bag-catch" methodology to obtain sample (30). Furthermore, female gender, pregnancy and obesity were found to be significantly related with contamination in primary care (31). In total, our UC contamination rate was 12.4%, which can be defined as high-medium performance regarding quality (32). There was not any significant alteration in contamination rates regarding both years (p=0.846) and services (p=0.182). On the other hand, majority of the contaminations were sourced from outpatient services (68.8% of all urinary contaminations; 11.9% of all UCs), especially pediatrics and ER (52.2% of all urinary contaminations; 6.5% of all UCs). These results are actually expected, since sampling from pediatric populations is thorny and more susceptible to contamination as stated above. In addition, like in BCs, "the need for rapid sampling" and "under-elective conditions" may cause higher contaminations in ERs. Interestingly, inpatient services showed higher amounts of contamination than ICUs, that was possibly because of pediatric cases, again (10.5% of all urinary contaminations). It must be noted that 53.1% of pediatric UC orders were done as "clean-catch" or "bag-catch" in our facility. This rate is actually higher in reality, since some physicians mistakenly order UCs as in routine, but the samplings were done as "clean-catch" or "bag-catch". Accordingly, the methodology of sampling seems to be the main source of contaminations. We believe our facility struggles about the same issues with other centers worldwide, thus, a programe should be organised on spesific training of parents in obtaining proper urine samples in case of any order of culture.

Conclusion

Here we presented QI results of our clinical microbiology laboratory, and even though they are partially satisfactory, it seems some urgent actions has to be taken in particular issues. Although our rejection and quality rates are below highest thresholds of quality criteria, a need of training and organization in especially outpatient units is obviously required. Similar impropriety was observed in UC contaminations with the same units. BC contaminations in ICUs are thought to be sourced from inappropriate indwelling catheter care, which is a common problem in many facilities and yet requires an emerging intervention in our hospital.

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Ethics

Ethics Committee Approval: Approved by the Ethical Board of Balıkesir University Faculty of Medicine (date: 11 Nov 2020/desicion number: 2020/203).

Informed Consent: Retrospective study.

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Authorship Contributions

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