old GAS (+) ARI subjects, 92.8% had cough, 76.2% rhinorrhea and 37.2% conjunctivitis; 80% had > 2 of 3 symptoms noted above. Among 40 GAS (+) ARI subjects, a virus was co-detected in 34 (85%), among which Rhinovirus/Enterovirus were predominant 22/34 (55%). Of the 130 (28%) ARI subjects with sore throat, more tested positive for viruses (107/130, 82.3%) than for GAS (9/130, 6.9%). All GAS (+) HC (13/205, 6.3% overall) were < 3 year olds.

Conclusion. PCR detected GAS in 6.3% HC < 5 years old and 8.7% ARI subjects < 18 years old; mostly in 3- to 15-year-old ARI subjects. Most GAS (+) ARI children had cough, rhinorrhea or conjunctivitis and/or virus co-detection suggesting GAS carriage. Our data demonstrate that GAS may be detected in patients with a low clinical suspicion for acute GAS pharyngitis. These findings highlight the need to review patient selection and exercise caution in implementing highly sensitive GAS PCR assays especially in such clinical settings.

	ARI	<3 yrs	3–15 yrs	16–17 yrs	Total	HC	<3 yrs	3–4 yrs	Total
GAS(+)		13 (4.6%)	25 (14.9%)	2 (28.6%)	40 (8.7%)		13 (6.2%)	0 (0%)	13 (6.3%)
GAS(-)		270 (95.4%)	143 (85.1%)	5 (71.4%)	418 (91.3%)		182 (93.3%)	10 (100%)	192 (93.7%)
Total (N=)		283	168	7	458		195	10	205

Disclosures. **All authors:** No reported disclosures.

2186. Differentiation of Severe Fever with Thrombocytopenia Syndrome from Scrub Typhus

Hyoung Sul, MD[1]; Na Ra Yun, MD, PhD[1]; Dong-Min Kim, MD Degree[2]; Jieun Kim, MD, MSc[3]; Jian Hur, MD, PhD[4]; Sook In Jung, MD, PhD[5]; Seong-yeol Ryu, MD, PhD[6]; Ji Yeon Lee, MD, PhD[7]; Kyungmin Huh, MD[8]; Yee Gyung Kwak, MD, PhD[9]; Young Keun Kim, MD, PhD[10]; Hye Won Jeong, MD, PhD[11]; Jung Yeon Heo, MD, PhD[12]; Dong Sik Jung, MD, PhD[13]; In-Gyu Bae, MD, PhD[14]; Su-Jin Lee, MD, PhD[15]; Sun Hee Lee, MD, PhD[16]; Sun Hee Park, MD, PhD[17]; Joon-Sup Yeom, MD, PhD[18]; Hyungdon Lee, MD, PhD[19]; [1]Chosun University Hospital, Gwanjugwangyeoksi, Kwangju-jikhalsi, Republic of Korea; [2]Chosun University Hospital, Gwang ju, Kwangju-jikhalsi, Republic of Korea; [3]Department of Laboratory Medicine, Soonchunhyang University Seoul Hospital, Soonchunhyang University College of Medicine, Seoul, Seoul-t'ukpyolsi, Republic of Korea; [4]Yeungnam University Hospital, Daejongwanyeoksi, Taegu-jikhalsi, Republic of Korea; [5]Chonnam National University Hospital, Gwanjugwangyeoksi, Kwangju-jikhalsi, Republic of Korea; [6]Department of Internal Medicine, Keimyung University Dongsan Medical Center, Daegu, Korea, Daejongwanyeoksi, Taegu-jikhalsi, Republic of Korea; [7]Keimyung University Hospital, Daegugwangyeoksi, Taegu-jikhalsi, Republic of Korea; [8]Samsung Medical Center, Seoul, Seoul-t'ukpyolsi, Republic of Korea; [9]Inje University Ilsan Paik Hospital, Goyang, Kyonggi-do, Republic of Korea, [10]Yonsei University Wonju College of Medicine, Wonju, Kangwon-do, Republic of Korea, [11]Chungbuk University Hospital, Cheongju, Ch'ungch'ong-bukto, Republic of Korea, [12]Ajou University Hospital, Suwon, Kyonggi-do, Republic of Korea, [13]Dong-A University Hospital, Busangwangyeoksi, Pusan-jikhalsi, Republic of Korea, [14]Gyeongsang University Hospital, Jinju, Kyongsang-namdo, Republic of Korea, [15]Pusan National University Yangsan Hospital, Yangsan, Kyongsang-namdo, Republic of Korea, [16]Pusan National University Hospital, Yangsan, Kyongsang-namdo, Republic of Korea, [17]Division of Infectious Diseases, Department of Internal Medicine, College of Medicine, The Catholic University of Korea, Seoul, Korea, Daejon, Taejon-jikhalsi, Republic of Korea, [18]Department of Internal Medicine, Yonsei University College of Medicine, Seoul, Seoul-t'ukpyolsi, Republic of Korea, [19]Hallym university Chuncheon Sacred Heart Hospital, Chuncheon, Kangwon-do, Republic of Korea

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Background. SFTS and scrub typhus have similar clinical features and difficult to differentiate. Thus, a study to develop a scoring system to differentiate between two diseases in a clinical setting before the confirmation of laboratory results was reported by Kim et al. However, the statistical power could be low because of low numbers of cases (21 SFTS, 91 scrub typhus), our study analyzed by increasing the number of cases to overcome these limitations.

Methods. We retrospectively collected data from 183 SFTS and 178 scrub typhus patients who visited the 21 hospitals in South Korea between October, 2013 and November, 2017. The study protocol was approved by the IRB of each institution. SFTS was diagnosed through detection of SFTS viral RNA using RT–PCR. Scrub typhus was diagnosed either detection of 56-kDa antigen of *O. tsutsugamushi* using nested PCR or ≥ 4 fold rise in IgM or IgG titer using indirect IFA. Statistical analyses were performed by using SPSS and Medcalc.

Results. To differentiate SFTS from scrub typhus, we applied the scoring system proposed by Kim et al. After multivariable logistic regression, altered mental status, leukopenia, prolonged aPTT, and normal CRP(≤ 1.0 mg/dL) were significantly associated with SFTS compared with scrub typhus. Each variable was scored by 1 point, with a total score of 0–4 points, the optimal cutoff value was > 1 for the ROC curve. A score > 1 had 92% sensitivity, 96% specificity for diagnosis of SFTS, with a ROC AUC of 0.974. Because the sensitivity was less than 95%, we changed the normal CRP criteria to ≤ 3.0 mg/dL. The modified scoring system had 97% sensitivity, 96% specificity for diagnosis of SFTS, with an AUC of 0.983, and it showed a statistically higher accuracy than original scoring system (P = 0.0487). In this study, four factors for predicting SFTS were newly developed: leukopenia, prolonged aPTT, normal CRP (≤3.0 mg/dL), and elevated CK (>1,000 IU/L). Our study scoring system had 97% sensitivity, 98% specificity for diagnosis of SFTS, with an AUC of 0.992, and it showed a statistically higher accuracy than original scoring system (P = 0.0308).

Conclusion. In conclusion, we can easily differentiate SFTS from scrub typhus by using our scoring system of leukopenia, prolonged aPTT, normal CRP, and elevated CK in the endemic area.

Variable	SFTS (n=183) No. (%) or Mean (SD)	Scrub typhus (n=178) No. (%) or Mean (SD)	P value
Season (months)			<.001
Spring-Summer (March-August)	102 (56)	0	
Autumn-Winter (September-Feburary)	81 (44)	178 (100)	
Geographic distribution (residential area)			<.001
Metropolitan area	12 (7)	55 (31)	
Province	171 (93)	121 (69)	
Geographic distribution (infected area)			.010
Metropolitan area	8 (4)	16 (12)	
Province	172 (96)	113 (88)	
Age, mean (SD), year	66 (14)	69 (13)	.044
Male sex	95 (52)	68 (38)	.010
Underlying disease			
Previously healthy	85 (46)	67 (39)	.141
Diabetes	37 (20)	39 (23)	.477
Hypertension	71 (39)	62 (37)	.715
Cerebrovascular disease	12 (7)	15 (10)	.313
Congestive heart failure	3 (2)	6 (4)	.321
Asthma	1 (1)	0 (0)	> .99
COPD	3 (2)	3 (2)	> .99
Solid tumor	5 (3)	8 (5)	.304
Chronic liver disease	8 (5)	5 (3)	.366
Chronic kidney disease	3 (2)	3 (2)	> .99
Immunosuppressive condition	0	0	
Symptom duration before hospital visit, mean (SD), day	4.5 (3.3)	7.2 (4.0)	<.001
Clinical characteristics			
Fever	169 (93)	161 (93)	.905
Chillness	115 (65)	143 (90)	<.001
Myalgia	86 (47)	121 (74)	<.001
Arthralgia	10 (6)	77 (54)	<.001
Fatigue	48 (27)	133 (91)	<.001
Ophthalmalgia	1 (1)	37 (26)	<.001
Back pain	17 (10)	35 (25)	<.001
Sore throat	7 (4)	44 (32)	<.001
Thirst	15 (9)	111 (75)	<.001
Cough	26 (15)	50 (33)	<.001
Dyspnea	34 (20)	32 (22)	.557
GI symptoms			
Anorexia	67 (38)	105 (71)	<.001
Nausea	68 (39)	66 (45)	.762
Vomiting	34 (19)	33 (21)	.765
Diarrhea	60 (34)	29 (18)	<.001
Dyspepsia	12 (7)	49 (34)	<.001
Abdominal pain	39 (22)	39 (25)	.514
Hemorrhagic symptoms	28 (15)	9 (5)	.002
Hemoptysis	4 (2)	4(3)	.735
Hematemesis/melena	5 (3)	3 (2)	> .99
Purpura	6 (4)	3 (2)	.736
CNS symptoms			
Headache	55 (31)	103 (63)	<.001
Neck stiffness	13 (8)	13(11)	.265
Altered mental status	69 (39)	27 (16)	<.001
Skin rash	28 (16)	142 (83)	<.001
Conjunctival injection	12 (7)	20 (15)	.026
lymphadenopathy	18 (10)	24 (18)	.066
Tick or chigger bite wound	54 (31)	154 (92)	<.001
Typical escher	22 (17)	154 (100)	<.001
Laboratory findings			
Leukopenia (WBC count<4000/μL)	164 (90)	25 (15)	<.001
Leukocytosis (WBC count>10,000/μL)	4 (2)	57 (34)	<.001
WBC count, mean (SD), WBCs/μL	2457 (2670)	8454 (4944)	<.001
Thrombocytopenia (PLT count <150X10^3/μL)	173 (95)	114 (68)	<.001
Thrombocytopenia (PLT count <100X10^3/μL)	137 (75)	43 (26)	<.001
Thrombocytopenia (PLT count <50X10^3/μL)	53 (29)	9 (5)	<.001
Platelet count, mean (SD), X10^3/μL	77 (43)	185 (577)	.016
Anemia (Hb<11g/dL)	14 (8)	23 (14)	.066
Hemoglobin, mean (SD), g/dL	13.5 (1.8)	13.8 (11.4)	.800
Prolonged PT (INR>1.3)	8 (5)	10 (6)	.790
INR, mean (SD)	1.1 (0.2)	2.0 (8.1)	.164
Prolonged aPTT (>40seconds)	87 (55)	6 (4)	<.001
aPTT, mean (SD), seconds	49 (44)	33 (14)	<.001
Normal CRP level(≤3.0mg/dL)	146 (88)	9 (6)	<.001
Normal CRP level(≤1.0mg/dL)	110 (66)	2 (1)	<.001
CRP, mean (SD), mg/dL	2.0 (5.3)	11.2 (9.5)	<.001
Renal dysfunction (Cr>1.30)	33 (22)	34 (27)	.292
Creatinine, mean (SD), mg/dL	1.2 (1.0)	1.7 (5.9)	.309
Abnormal LFT (AST or ALT>40IU/L)	141 (78)	154 (92)	<.001
AST, mean(SD), IU/L	226 (418)	118 (111)	.001
ALT, mean(SD), IU/L	87 (119)	87 (80)	.988
Alkaline phosphatase, mean(SD), IU/L	90 (94)	125 (106)	.007
Total bilirubin, mean(SD), mg/dL	0.6 (0.6)	0.9 (0.5)	<.001
Rhabdomyolysis feature (CK>1000IU/L)	58 (45)	5 (3)	<.001
Creatine kinase, mean(SD), IU/L	1886 (4747)	227 (558)	<.001
Lactate dehydrogenase, mean(SD), IU/L	1086 (1825)	849 (258)	.144
Complications			
Meningoencephalitis	12 (7)	21 (13)	.056
Seizure	9 (5)	0	.004
Arrhythmia	10 (6)	3 (2)	.070
Pneumonia	5 (3)	15 (9)	.011
Hemophagocytic lymphohistiocytosis	4 (2)	0	.143
Clinical course			
ICU admission	73 (40)	15 (9)	<.001
Mechanical ventilation	32 (23)	7 (4)	<.001
In-hospital death	40 (22)	4 (2)	<.001

<Table 1. Clinical characteristics and outcomes of Severe fever with thrombocytopenia syndrome and Scrub typhus>

Univariable Logistic regression analysis	Odds ratio (95% CI)	P value
Season	0.00	0.996
Geographic distribution(residential area)	6.477 (3.326-12.613)	<0.001
Geographic distribution(infected area)	3.044 (1.261-7.349)	0.013
Age	0.984 (0.968-1.000)	0.046
Male sex	0.578 (0.380-0.879)	0.010
Chillness	0.204(0.112-0.373)	<0.001
Myalgia	0.311(0.197-0.491)	<0.001
Arthralgia	0.051(0.025-0.106)	<0.001
Fatigue	0.039 (0.020-0.073)	<0.001
Ophthalmalgia	0.021 (0.003-0.159)	<0.001
Back pain	0.333 (0.178-0.625)	0.001
Sore throat	0.093 (0.040-0.214)	<0.001
Thirst	0.032 (0.017-0.062)	<0.001
Cough	0356 (0.208-0.610)	<0.001
Anorexia	0.258 (0.162-0.410)	<0.001
Diarrhea	2.447 (1.472-4.067)	0.001
Dyspepsia	0.147 (0.075-0.291)	<0.001
Hemorrhagic symptoms	3.212 (1.468-7.028)	0.003
Headache	0.260 (0.166-0.408)	<0.001
Altered mental status	3.376 (2.028-5.621)	<0.001
Skin rash	0.040 (0.023-0.070)	<0.001
Conjunctival injection	0.431 (0.203-0.917)	0.029
Tick or chigger bite wound	0.040 (0.021-0.075)	<0.001
Leukopenia (WBC count<4000/μL)	52.116 (27.315-99.434)	<0.001
Leukocytosis (WBC count>10,000/μL)	0.044 (0.015-0.124)	<0.001
Thrombocytopenia (PLT count <150X10^3/μL)	8.195 (4.009-16.751)	<0.001
Thrombocytopenia (PLT count <100X10^3/μL)	8.658 (5.350-14.009)	<0.001
Thrombocytopenia (PLT count <50X10^3/μL)	7.203 (3.424-15.151)	<0.001
Prolonged aPTT (>40seconds)	32.729 (13.659-78.420)	<0.001
Normal CRP (≤3.0mg/dL)	107.067 (47.101-243.379)	<0.001
Normal CRP (≤1.0mg/dL)	136.518 (32.590-571.861)	<0.001
Abnormal LFT (AST or ALT>40IU/L)	0.305 (0.156-0.595)	<0.001
Alkaline phosphatase	0.996 (0.994-0.999)	0.012
Total bilirubin	0.228 (0.118-0.440)	<0.001
Elevated CK (CK>1000IU/L)	23.200 (8.905-60.441)	<0.001

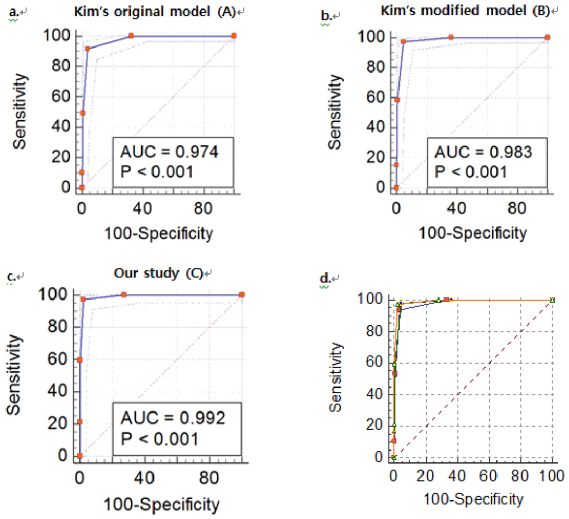
<Table 2. Univariable logistic regression analysis of predictive parameters for severe fever with thrombocytopenia syndrome>

Abbreviations: CI=confidential intervals; WBC=White blood cell; aPTT=activated partial thromboplastin time; CRP=C-reactive protein; LFT=Liver function test; AST= aspartate aminotransferas; ALT= Alanine aminotransferase; CK=Creatine kinase

Multivariable logistic regression analysis	Odds ratio (95% CI)	*P* value	AUC (95% CI)	*P* value	Sensitivity (95% CI)	Specificity (95% CI)
Altered mental status	5.681 (1.369-23.571)	0.017	0.974 (0.949-0.989)	<0.001	91.9 (86.3-95.7)	96.3 (91.6-98.8)
Leukopenia (WBC count<4000/μL)	75.879 (14.418-399.323)	<0.001				
Prolonged aPTT (>40seconds)	80.133 (14.369-446.877)	<0.001				
Normal CRP (≤1.0mg/dL)	166.855 (23.482-1185.613)	<0.001				
Altered mental status	15.385 (2.216-106.828)	0.006	0.983 (0.960-0.995)	<0.001	97.3 (93.2-99.3)	95.6 (90.6-98.4)
Leukopenia (WBC count<4000/μL)	92.573 (14.971-572.430)	<0.001				
Prolonged aPTT (>40seconds)	65.010 (10.510-402.105)	<0.001				
Normal CRP (≤3.0mg/dL)	184.937 (35.731-957.207)	<0.001				
Leukopenia (WBC count<4000/μL)	145.404 (12.686-1666.604)	<0.001	0.992 (0.971-0.999)	<0.001	97.3 (92.4-99.4)	97.8 (93.6-99.5)
Prolonged aPTT (>40seconds)	250.124 (18.403-3399.536)	<0.001				
Normal CRP (≤3.0mg/dL)	172.021 (26.289-1125.629)	<0.001				
Elevated CK (>1000IU/L)	192.616 (8.307-4466.445)	0.001				

<Table 3. Multivariable logistic regression analysis of predictive parameters for severe fever with thrombocytopenia syndrome and Diagnostic performance of clinical scoring in differentiating severe fever with thrombocytopenia syndrome>

Abbreviations: CI=confidential intervals; WBC=White blood cell; aPTT=activated partial thromboplastin time; CRP=C-reactive protein; CK=creatine kinase



<Figure 1. Receiver operating characteristic(ROC) curves of the multivariable logistic regression models (a. model A: Altered mental status, Leukopenia, Prolonged aPTT, Normal CRP (≤1.0mg/dL), b. model B: Altered mental status, Leukopenia, Prolonged aPTT, Normal CRP (≤3.0mg/dL), c. model C: Leukopenia, Prolonged aPTT, Normal CRP (≤3.0mg/dL), Elevated CK (>1000IU/L), d. square: model A, circle: model B, triangle: model C) for Severe fever with thrombocytopenia syndrome predictive model>

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2187. Prediction of Patient Outcome During Febrile Neutropenia Despite Anti-infective Treatment Using Machine Learning Algorithms

Carolin Jakob, MSc[1]; Annika Classen, Dr[1];
Melanie Stecher, MSc Public Health[2]; Sandra Fuhrmann, BSc[1]; Bernd Franke[1];
Frieder Fuchs, Dr[1]; Sarah Walker, Dr[1]; Oliver Cornely, Prof[1];
Jörg Janne Vehreschild, Prof[1]
[1]University of Cologne, Faculty of Medicine and University Hospital Cologne, Köln, Nordrhein-Westfalen, Germany; [2]University of Cologne, Faculty of Medicine and University Hospital Cologne, Department I for Internal Medicine, Cologne, Nordrhein-Westfalen, Germany

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Background. Clinical management of prolonged febrile neutropenia despite broad-spectrum empirical antibacterial treatment is a clinical challenge, as standard empirical treatment has failed and a broad spectrum of differential diagnoses has to be considered. Growing prevalence of multi-resistant bacteria and fungi has made a balanced choice of effective anti-infective treatment more difficult. A reliable prediction of complications could indicate options for treatment optimization.

Methods. We implemented a supervised machine learning approach to predict death or admission to intensive care unit within 28 days in cancer patients with prolonged febrile neutropenia (neutrophils < 500/mm^3 and body temperature ≥ 38°C longer than 3 days). We analyzed highly granular retrospective medical data of the Cologne Cohort of Neutropenic Patients (CoCoNut) between 2008 and 2014. Random forest and 10-fold cross-validation were used for classification. The neutropenic episodes from 2014 were used for evaluation of prediction.

Results. In total, 927 episodes of prolonged febrile neutropenia (median age 52 years, interquartile range 42–62; 562/927 [61%] male; 390/927 [42%] acute myeloid leukemia; 297/927 [32%] lymphoma) with 211/927 (23%) adverse outcomes were processed. We computed 226 features including patient characteristics, medication, clinical signs, as well as laboratory results describing changes of state and interactions of medical parameters. Feature selection revealed 65 features with an area under the receiver operating characteristic curve (AUC) of 0.75. In the validation data set the optimized model had a sensitivity/specificity of 36% and 99% (AUC: 0.68; misclassification error: 0.12) and positive/negative predictive values of 89% and 88%, respectively. The most important features were albumin, age, and procalcitonin.

Conclusion. Structured granular medical data and machine learning approaches are an innovative tool that can be used in a retrospective setting for prediction of adverse outcomes in patients with prolonged febrile neutropenia. This study is the first important step toward clinical decision support based on predictive models in high-risk cancer patients.

Disclosures. **All authors:** No reported disclosures.

2188. Provider Education and Rapid Antigen Detection Test Use in Private and Academic Pediatric Clinics

Steven Dahl, MD[1]; Emily A. Hurley, MPH, PhD[1];
Brian R. Lee, MPH, PhD[1]; Jason Newland, MD, MEd, FPIDS[2];
Andrea Bradley-Ewing, MPA, MA[1]; Evelyn Donis De Miranda, BHS[3];
Kimberly A. Pina, MPH[3]; Alexander Mackenzie, BS[3]; Kathy Goggin, PhD[4];
Angela Myers, MD, MPH[5]; Angela Myers, MD, MPH[5]; [1]Children's Mercy Kansas City, Kansas City, Missouri; [2]Washington University School of Medicine, St. Louis, Missouri; [3]Children's Mercy, Kansas City, Missouri; [4]University of Missouri - Kansas City, Kansas City, Missouri; [5]Children's Mercy Kansas City, UMKC, Kansas City, Missouri

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Background. Rapid antigen detection testing (RADT) is needed to differentiate Group A Streptococcal (GAS) pharyngitis from viral pharyngitis. Guidelines do not recommend RADT in patients with viral symptoms or in children <3 years old without GAS exposure. Reduction in unnecessary RADT use may impact inappropriate antibiotic use by decreasing prescriptions in children likely colonized with GAS. We examined the impact of guideline concordant education of appropriate RADT and antibiotic use in pharyngitis on providers' (physician and APRN) use of RADT in an academic and private pediatric primary care clinic.

Methods. Retrospective chart review of 1,085 healthy children, age 1–5 years old, seen in clinics between September 2015 and March 2019 (355 pre- and 730 post-education; 211 academic and 874 private). Education occurred in 3/2017. Cases selected had either complaint of sore throat, RADT, or diagnosis of GAS pharyngitis or pharyngitis. Data collected included the presence of viral symptoms (e.g., cough, rhinorrhea), RADT/GAS culture results, diagnosis, and prescribed antibiotics. RADT was deemed unnecessary for all children < 3 years old without GAS exposure, in patients with ≥ 2 viral symptoms, or in patients ≥ 3 years old without pharyngitis.

Results. Overall, RADT use decreased from pre to post intervention (72.1% vs. 23.4% of patients, $P \leq 0.0001$). Unnecessary RADT use decreased overall (50.4% vs. 16.2%, $P \leq 0.0001$), in all clinics (private: 56.2% vs. 16.0%, $P \leq 0.0001$; academic: 38.1% vs. 17.4%, $P = 0.0012$), and with all providers (physician: 41.6% vs. 18.3%, $P \leq 0.0001$; APRN: 58.8% vs. 14.1%, $P \leq 0.0001$). Unnecessary RADT use decreased for children <3 years old (28.1% vs. 7.4%, $P \leq 0.0001$) and ≥2 viral symptoms (65.7% vs. 16.5%, $P \leq 0.0001$).

Conclusion. Unnecessary RADT use decreased in the post-education period overall (34%), in children <3 years old (21%), and in patients with ≥ 2 viral symptoms (49%). Reductions were also seen in both academic (21%) and private (40%) clinics as well as with both physicians (23%) and ARPNs (45%). Limitations include lack of a control group and sample size variance by the clinic. We observed positive trends in RADT reduction following provider education in private and academic settings; however, further research including control and optimal sample size is needed to confirm any direct impact.