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ARTICLE

# Impact of technical training on rapid antigen detection tests (RADT) in group A streptococcal tonsillopharyngitis

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**Abstract** Rapid antigen detection tests (RADT) are widely used for the rapid diagnosis of group A streptococcal (GAS) tonsillopharyngitis. In a prospective 3-year study, the reliability of two different RADT methods was compared, as performed by lab technicians versus physicians. Sensitivity and specificity, as well as positive and negative predictive values, were calculated. When performed by physicians, the results (44.4 %, 8.3 %, 26.7 % and 16.7 %) of a latex agglutination test (LAT) were unacceptably low. However, after switching to a lateral-flow immunoassay (LFIT) and implementing additional hands-on training, the performance improved dramatically (100 %, 92.6 %, 84.6 % and 100 %). In conclusion, technical errors, along with a lack of experience and expertise, negatively impact RADT accuracy.

## Introduction

Distinguishing between viral and bacterial tonsillopharyngitis is a frequent challenge in medical care [1]. However, doing so is critical, because it provides the basis for prescribing or withholding appropriate antibiotics [2, 3]. To achieve rapid diagnosis of group A streptococcal (GAS) tonsillopharyngitis, rapid antigen detection tests (RADT) are widely used in clinical practice [4–6]. A recent meta-analysis revealed broad variability in test quality, with test sensitivities between 65.6 % and 96.4 % and specificities between 68.7 % and 99.3 % [7]. Here, we prospectively evaluated RADT performance as compared to culture.

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## Materials and methods

Between 2008 and 2010, patients were tested for GAS tonsillopharyngitis both by RADT and by microbiological culture (Fig. 1). Conventional, non-flocked, dry swabs were used (i.e. one swab per patient). After immediate plating on sheep blood agar, RADT was performed with the same swab. In 2008, a latex agglutination test (LAT; Phadirect® Strep A Test, Bactus (now MKL Diagnostics) [8]) was used, and in 2009 and 2010, a lateral-flow immunoassay (LFIT) was used (QuickVue® In-Line Strept A test, Quidel [9]). During regular working hours, cultures and RADT were carried out by lab technicians, while outside regular hours, this was done by physicians at a laboratory located next to the patient facilities. Lab technicians, familiar with RADT diagnostics, trained physicians in LAT diagnostics in January 2008 and in LFIT diagnostics in January 2009. This teaching included both oral presentations and illustrative slides. In 2010, physicians received additional training that included hands-on training in conducting the LFIT. Test quality results were calculated for both RADT and culture and then compared by two-tailed Fisher's exact test. *p*-values were adjusted for multiple testing ($p_{corr}$) and were considered to be significant if <0.05.

## Results

In total, 974 tonsillopharyngeal smears were tested for GAS (Table 1). In 2008, the LAT sensitivity was low (55.4 %),

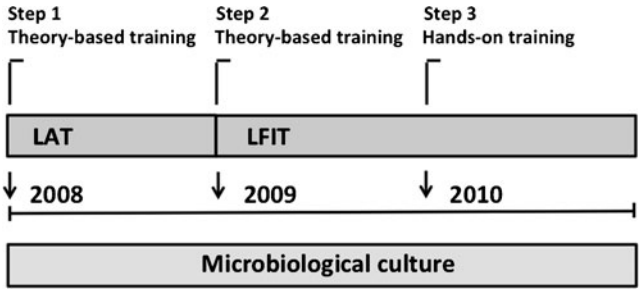


**Fig. 1** Illustration of the study design. *LAT*, latex agglutination test; *LFIT*, lateral-flow immunoassay test

independent of whether the test had been performed by lab technicians or physicians. The test specificity was excellent when performed by lab technicians (98.2 %), while it was poor when conducted by physicians (8.3 %, $p_{corr}$=0.007). After the switch to LIFT in 2009, the test sensitivity increased in both groups, with a test sensitivity of 93.0 % for lab technicians ($p_{corr}$=0.007) and 76.9 % for physicians ($p_{corr}$=0.748). The test specificity increased to 71.7 % when physicians performed the tests ($p_{corr}$=0.007). In 2010, LFIT performance further improved after hands-on training of the physicians (100 % sensitivity, 92.6 % specificity). Subsequent to this supplementary training, the test performance no longer differed between lab technicians and physicians.

## Discussion

Our findings show the LAT sensitivity to be much lower than previously reported. A partial explanation may be related to the swab type used because its small cotton head and wooden base may have resulted in reduced extraction efficacy and low bacterial inoculum. Yet, the swab type alone is unlikely to account for the low sensitivity, since sensitivity increased with the LFIT during the study period without there having been a change of swab types.

Instead, the improvement of LFIT specificity appears to indicate the advantage of an unambiguous test result reading. Agglutination may be more prone to subjective interpretation errors than the red band that appears on LFIT devices. This issue seems to be of particular concern with respect to personnel who have limited laboratory experience.

Further improvement was noted when physicians performed LFIT during the second year. We postulate that this was due to the hands-on training offered as a supplement to the more theoretical training offered beforehand.

In conclusion, the study findings illustrate significant differences in RADT performance depending upon testers, training and objective test reading. Furthermore, it should not be assumed that the performance levels stated by the manufacturers of RADT will hold true in actual practice.

**Table 1** Performance of different rapid antigen detection tests (RADT) in group A streptococcal (GAS) tonsillopharyngitis. (**a**) Number of tests performed for GAS culture and RADT in 2008 (latex agglutination test, LAT), 2009 (lateral-flow immunoassay test, LFIT) and 2010 (LFIT + practical training). The first figure in parentheses represents the number of tests performed by lab technicians; the second number represents those conducted by physicians. (**b**) Test performance of RADT with regard to sensitivity, specificity, and positive and negative predictive value as compared to culture results. The first figure in parentheses represents the performance of tests conducted by lab technicians; the second number represents those conducted by physicians

a

| | | 2008: LAT, *n*=360 | | 2009: LFIT, *n*=383 | | 2010: LFIT + training, *n*=231 | |
|---|---|---|---|---|---|---|---|
| | | GAS culture results (lab technicians/physicians) | | | | | |
| | | Positive, *n*=74 (20.6 %) | Negative, *n*=286 | Positive, *n*=70 (18.3 %) | Negative, *n*=313 | Positive, *n*=53 (22.9 %) | Negative, *n*=178 |
| RADT results | Positive | 41 (37/4) | 16 (5/11) | 63 (53/10) | 28 (15/13) | 52 (41/11) | 7 (5/2) |
| | Negative | 33 (28/5) | 270 (269/1) | 7 (4/3) | 285 (252/33) | 1 (1/0) | 171 (146/25) |

b

| RADT results (lab technicians/physicians) | 2008: LAT (*n*=339/21) | 2009: LFIT (*n*=324/59) | 2010: LFIT + training (*n*=193/38) |
|---|---|---|---|
| Test sensitivity (%) | 55.4 (56.9/44.4) | 90.0 (93.0/76.9) | 98.1 (97.6/100) |
| | *p*=0.50 (95 % Cl 0.37–1.67) | *p*=0.11 (95 % Cl 0.61–1.12) | *p*=1.00 (95 % Cl 0.98–1.07) |
| Test specificity (%) | 94.4 (98.2/8.3) | 90.2 (94.4/71.7) | 96.1 (96.7/92.6) |
| | *p*<0.0001 (95 % Cl 20.73–121.75) | *p*<0.0001 (95 % Cl 2.57–987) | *p*=0.29 (95 % Cl 0.46–10.95) |
| Positive predictive value (%) | 71.9 (88.1/26.7) | 69.2 (77.9/43.5) | 88.1 (89.1/84.6) |
| | *p*=0.77 (95 % Cl 0.50–2.77) | *p*=0.82 (95 % Cl 0.67–1.84) | *p*=0.77 (95 % Cl 0.50–2.77) |
| Negative predictive value (%) | 89.1 (90.6/16.7) | 97.6 (98.4/91.7) | 99.4 (99.3/100) |
| | *p*<0.0001 (95 % Cl 0.01–0.10) | *p*=0.0002 (95 % Cl 0.12–0.48) | *p*<0.0001 (95 % Cl 0.01–0.10) |

*LAT* latex agglutination test, *LFIT* lateral-flow immunoassay test, *GAS* group A streptococcus, *RADT* rapid antigen detection tests, *95 % CI* 95 % confidence interval

Rather, our study shows that accuracy is staff-dependent. Despite the simplicity of RADT, delegating performance of the test to personnel without specialized training is likely to lead to incorrect test results and, therefore, inappropriate antibiotic use.

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**Conflict of interest** The authors declare that there are no conflicts of interest.

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