

An Analysis of Factors That Influence the ASCUS/SIL Ratio of Pathologists

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Abstract

In pursuit of physician-specific performance data in cytology, we have been calculating the ASCUS/SIL (atypical squamous cells of undetermined significance/squamous intraepithelial lesion) ratio of cytopathologists (CPs) and providing confidential feedback every 6 months. At the same time, thin-layer technology was introduced as an alternative to conventional smears. Thus we analyzed factors that may influence the ASCUS/SIL ratio, particularly the effect of periodic feedback on outliers (defined by a professional benchmark). For 3 years, the mean ASCUS/SIL ratio for all CPs decreased significantly from 2.92 to 1.87. There was great variability in the mean ASCUS/SIL ratio among 12 CPs (range, 1.11-5.89). Of the 6 CPs who worked continuously during this time, 2 showed a statistically significant decrease in their ASCUS/SIL ratio, including the CP with the highest ratio; 1 showed a significant increase. The mean ASCUS/SIL ratio did not correlate well with years of CP experience or with individual annual case volume. The ASCUS/SIL ratio of some CPs can decrease significantly over time. Whether it was due to feedback or the introduction of thin-layer preparations could not be determined.

The most commonly made abnormal diagnosis on a Papanicolaou (Pap) test is “atypical squamous cells of undetermined significance” (ASCUS). The concept that some Pap smears may harbor atypical cells whose significance is uncertain was not invented by the Bethesda System (TBS), currently the de facto standard for reporting cervical/vaginal diagnoses in the United States. TBS did, however, more narrowly define the previously vague “atypical” Pap to exclude obviously benign cellular changes, as well as clear-cut intraepithelial lesions, thus limiting the category to “borderline” cases of undetermined significance.¹

The authors of TBS recognized the potential for overuse of the ASCUS diagnosis and suggested a benchmark, namely, that the ratio of ASCUS diagnoses to outright diagnoses of a squamous intraepithelial lesion (SIL), abbreviated as the ASCUS/SIL ratio, be no greater than 3:1.² The implication was that any laboratory and, hence, any cytopathologist with a higher ratio might be expressing uncertainty too frequently. Some authors have suggested that even this benchmark is too lenient,³ and others hope to eliminate ASCUS entirely.⁴ Clearly, there is no consensus on an ideal ASCUS/SIL ratio. In an effort to define common practice, a nationwide laboratory survey found that the median ASCUS/SIL ratio is 2.0 and that 80% of laboratories report ratios between 0.64 and 4.23.⁵ Because there is some consensus regarding its upper limits, monitoring the ASCUS/SIL ratio has been proposed as a quality improvement measure for laboratories,^{6,7} but so far there have been no studies of its use in evaluating the performance of individual cytopathologists (CPs).

In looking for quantitative, physician-specific performance data, particularly for the recertification process required by the Joint Commission on Accreditation of Healthcare Organizations and state medical boards, in 1997

we began to systematically calculate the ASCUS/SIL ratio for CPs at the Brigham and Women's Hospital (BWH), Boston, MA, and provide confidential feedback every 6 months. The underlying assumption was that this information, after identifying outliers, would give CPs an opportunity to bring their ASCUS/SIL ratio in alignment with the professional benchmark. The purpose of this study was to review the data obtained, analyze the impact of factors such as annual case volume and the years of experience of the CP on ASCUS/SIL ratios, and see whether there was improvement in the ratios of the outliers.

Materials and Methods

Data Acquisition and Retrieval

Data on the frequency of various cytologic diagnoses were obtained from the BWH Cytology System, one of the many components that make up the Brigham Integrated Computer System, a system of networked PCs. The operating system is an implementation of DateTree MUMPS (now InterSystems, Cambridge, MA). The Cytology System was designed and developed at BWH with the collaboration of one of us (E.S.C.) using the MUMPS (Massachusetts General Utility Multi-Programming System) programming language (now called M) (InterSystems).

The Cytology System captures events occurring from the accessioning to the final reporting of the specimen. All computer entries are audited, and audit information includes a time stamp, the identity of the user, and the information entered or changed. The system tracks each gynecologic Pap test by cytotechnologist and cytopathologist, if the case is referred for review. The provisional and/or final diagnoses are coded as one of 10 possible major diagnostic categories: (1) unsatisfactory; (2) within normal limits; (3) benign cellular changes; (4) endometrial cells, cytologically benign, in a postmenopausal woman; (5) ASCUS; (6) atypical glandular cells of undetermined significance (AGUS); (7) low-grade SIL; (8) SIL, difficult to grade; (9) high-grade SIL; and (10) carcinoma. Cases requiring CP review are not routinely reviewed by a supervisory cytotechnologist, but rather are passed directly to the CP by the cytotechnologist.

For any specified time frame, a case volume report can be generated that summarizes the number (with percentage) of cases diagnosed in each of the categories by individual CP and by the laboratory as a whole. This report also calculates an ASCUS/SIL ratio, obtained by dividing the sum of ASCUS and AGUS cases by the sum of low-grade SIL; SIL, difficult to grade; high-grade SIL; and carcinoma cases. Although this ratio includes AGUS cases, these were much less common than ASCUS cases (AGUS/ASCUS <3%). The

term *ASCUS/SIL ratio* used throughout this article, therefore, should be understood to include AGUS cases as well.

Case volume reports are generated every 6 months. Each CP receives a confidential memo listing, among other quality control measures, the ASCUS/SIL ratio and, for comparison, the ASCUS/SIL ratio for the entire laboratory.

Beginning in July 1998, a new Pap test, the ThinPrep (Cytec, Boxborough, MA) was introduced into the laboratory as an alternative to the conventional Pap smear. These cases were assigned a separate specimen type in the Cytology System, and the percentage of ThinPrep Paps and conventional smears was monitored on a monthly basis.

The overall case mix, ie, the number of cases from high-risk patients, did not change substantially during the years of this study.

Statistical Methods

The effect of the following factors on the ASCUS/SIL ratio was assessed: (1) the progress over time, during which CPs were given feedback on their ratios; (2) the increasing use of the ThinPrep Pap test during that time; (3) the years of experience of the CP; and (4) the annual case volume of each CP. The statistical analyses were based on data in **Table 1** and **Table 2**. Each of the time periods was a 6-month interval between July 1997 and June 2000.

First, to study the change in the ratios over time, we investigated the practice behavior of 6 of 12 CPs who were in the study throughout all time periods as well as pooled data from all 12 CPs. We compared the mean ratios per time period before and after July 1, 1998. A similar analysis was repeated using January 1, 1999, as a cutoff, with the consideration that it might have taken some time for a CP to react to the new Pap test and/or to feedback about the ASCUS/SIL ratio. For each CP and for the pooled data, a 2-sample Student *t* test was conducted to evaluate whether there was a statistically significant difference in the ASCUS/SIL ratio before and after the defined cutoff time. The correlation between the pooled ratio and the percentage of conversion to the ThinPrep was assessed using the Pearson correlation coefficient and the Spearman rho.⁸

To evaluate the effect of experience, we created a single ASCUS/SIL ratio for each of the 12 participating CPs **Table 3**. It was defined as the CP-specific ratio between the sum of all ASCUS values and the sum of all SIL values for all 6 time periods. We used the Pearson correlation coefficient and the Spearman rho⁸ to assess the correlation between the ASCUS/SIL ratio and the CP's experience practicing cytology as of July 1998. Owing to the high variability exhibited in both variables, we dichotomized the ratio at a cutoff point of 2.5, classifying it into a low (less than or equal to 2.5) or a high (greater than 2.5) group. The underlying mean years of experience then were compared for

Table 1
ASCUS/SIL Ratios for 12 Cytopathologists for Six Separate Periods*

Cytopathologist	Time Period					
	1	2	3	4	5	6
1	0	0	0	0	2.39 (239/100)	2.50 (200/80)
2	2.39 (440/184)	2.51 (430/171)	2.31 (335/145)	1.63 (385/236)	1.39 (262/189)	1.32 (226/171)
3	0	0	0	0	1.14 (50/44)	1.45 (84/58)
4	6.99 (496/71)	6.97 (551/79)	6.39 (556/87)	4.74(526/111)	4.76 (238/50)	5.26 (200/38)
5	2.78 (242/87)	2.81 (315/112)	2.13 (215/101)	1.85 (226/122)	3.46 (225/65)	2.02 (341/169)
6	3.18 (156/49)	0.67 (6/9)	2.51(248/99)	3.20 (227/71)	3.14 (226/72)	4.10 (82/20)
7	1.47 (88/60)	2.40 (36/15)	1.33 (24/18)	2.92 (76/26)	1.91 (122/64)	2.44 (144/59)
8	1.45 (133/92)	1.23 (97/79)	1.04 (120/115)	1.31 (101/77)	1.24 (72/58)	0.72 (100/139)
9	0.00 (3/0)	3.07 (83/27)	5.19 (140/27)	3.99 (339/85)	0	0
10	0	0	0	0	1.66 (214/129)	1.80 (187/104)
11	3.34 (207/62)	2.90 (261/90)	4.05 (166/41)	0	0	0
12	0	0	3.00 (81/27)	0	0	0
Laboratory total	2.92 (1,765/605)	3.06 (1,779/582)	2.86 (1,885/660)	2.58 (1,880/728)	2.14 (1,648/771)	1.87 (1,564/838)

ASCUS, atypical squamous cells of undetermined significance; SIL, squamous intraepithelial lesion.

* Each time period was a 6-month interval (see text for details).

Table 2
Years of Experience, Number of Papanicolaou Tests Reviewed by 12 Cytopathologists, and Percentage Conversion to ThinPrep Pap for Six Periods*

Cytopathologist	Experience (y)	Time Period					
		1	2	3	4	5	6
1	0	0	0	0	0	659	502
2	11	1,050	1,159	889	1,144	778	708
3	0	0	0	0	0	156	251
4	15	799	908	947	835	427	315
5	4	574	974	685	741	580	1077
6	3	290	25	459	364	350	139
7	1	248	117	54	205	315	353
8	21	517	462	548	430	284	496
9	5	3	173	212	568	0	0
10	0	0	0	0	0	923	593
11	3	444	651	378	0	0	0
12	0	0	0	136	0	0	0
ThinPrep/All Pap Tests (%)		0	0	27	54	78	84

* Each period was a 6-month interval (see text for details).

Table 3
Years of Experience, Average Case Volume, and Average ASCUS/SIL Ratio per Time Period

Cytopathologist	Experience (y)	Case Volume	ASCUS/SIL Ratio*
1	0	580	2.44
2	11	955	1.90
3	0	204	1.31
4	15	705	5.89
5	4	772	2.38
6	3	271	2.95
7	1	215	2.02
8	21	456	1.11
9	5	239	4.06
10	0	758	1.72
11	3	491	3.28
12	0	136	3.00

ASCUS, atypical squamous cells of undetermined significance; SIL, squamous intraepithelial lesion.

* Average ASCUS/SIL ratio for each of the 12 cytopathologists was calculated from the raw number of ASCUS and SIL cases in Table 1.

these 2 ratio groups using a 2-sample Student *t* test. The analysis was repeated with a ratio cutoff point of 3.0.

Finally, to evaluate the effect of annual case volume, we performed an overall analysis by computing for each CP the average case volume per time period, defined as the ratio between total case volume and the corresponding number of participating time periods. The overall analysis was similar to that described for assessing the effect of years of experience.

All statistical analyses were conducted using software S-Plus (S-Plus 5 for Unix Guide to Statistics, Data Analysis Products Division, Mathsoft, Seattle, WA, 1998).

Results

Twelve CPs reviewed Pap smears during this period, and 6 of them did so during the entire 3-year period from July 1997 through June 2000. The mean ASCUS/SIL ratio

for the laboratory (all CPs combined) decreased from 2.92 to 1.87. This decrease was statistically significant when mean ASCUS/SIL ratios were compared before and after January 1999 ($P = .01$). With July 1998 as a cutoff, the decrease was not significant ($P = .07$). When the analysis was restricted to the 6 CPs who worked continuously during all time periods, the mean ASCUS/SIL ratio decreased from 2.81 to 1.83. This decrease was statistically significant with January 1999 as a time cutoff ($P = .01$) and borderline significant with a time cutoff of July 1998.

When data were analyzed by individual CP, 4 showed a decrease in their ASCUS/SIL ratios, and 2 of these were statistically significant. With a time cutoff of July 1998, the mean ASCUS/SIL ratio for CP2 decreased from 2.45 to 1.66 ($P = .04$), and that for CP4 decreased from 6.98 to 5.29 ($P = .02$). The remaining 2 CPs showed an increase that was not statistically significant. When the cutoff for comparing ratios was set at January 1999, the decrease in ratios for CP2 and CP4 was still significant (both $P < .005$), but the increase in the ratio for CP6 became significant ($P = .05$). **Figure 1** illustrates the change in the ASCUS/SIL ratio for CPs 2 and 4 and for the laboratory as a whole. **Figure 2** shows the change in the ASCUS/SIL ratio of the 6 CPs who worked continuously during this period.

The ThinPrep method was introduced in July 1998, and the percentage of Pap smears prepared in this fashion rose steadily; by the end of the study period, it was 84% **Figure 3**. The decrease in the ASCUS/SIL ratio was highly correlated with the increase in the percentage of the ThinPrep Paps (Pearson correlation, -0.96 ; Spearman rho, -0.99).

The years of experience of the CPs ranged from 0 to 21 (mean, 5.2; SD, 6.9), and the ASCUS/SIL ratios ranged from 1.11 to 5.89 (mean, 2.67; SD, 1.40). The correlation coefficients were low (Pearson, 0.38; Spearman 0.33).

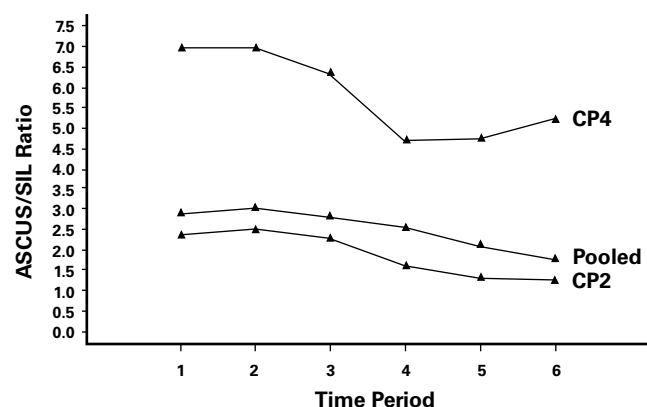


Figure 1 Plot of mean ASCUS/SIL (atypical squamous cells of undetermined significance/squamous intraepithelial lesion) ratios for 12 cytopathologists (pooled data) and 2 cytopathologists (CP2 and CP4) who showed a statistically significant decrease over time. Each period is 6 months.

When the experience data were dichotomized based on a ratio of 2.5, 7 CPs had a ratio less than 2.5, and 5 CPs had one greater than 2.5. In the low ratio group, the years of experience ranged from 0 to 21 (mean, 5.3; SD, 7.99). In the high ratio group, the years of experience ranged from 0 to 15 (mean, 5.2; SD, 5.76). The t test did not reveal a statistically significant difference in experience between these 2 groups.

In the overall analysis, the average case volume per time period ranged from 136 to 955 (mean, 481.8; SD, 272). This showed an essentially 0 correlation coefficient measure with the ASCUS/SIL ratio. In the low ratio group, the average volume ranged from 204 to 955 (mean, 562.9; SD, 288). In the high ratio group, the average volume ranged from 136 to 705 (mean, 368.4; SD, 271). The underlying means of the average volumes in these groups were not statistically different based on the t test.

Discussion

We found that during the 3 years that feedback was provided to CPs on their ASCUS/SIL ratio, the ratio decreased significantly when data were pooled from the 6 CPs who worked continuously during this time. Because this period of feedback overlapped with the conversion from smears to ThinPrep Paps in our laboratory, it is possible that the decrease in ratio can be attributed in part to the new Pap technology. Nevertheless, we think it likely that a significant component of this decrease is due to behavior modification based on feedback given twice a year.

The ASCUS/SIL ratio was not correlated with either the years of experience of the CP or with the annual Pap case-load. In other words, experienced CPs did not necessarily have a lower or higher ASCUS/SIL ratio than less experienced CPs. Similarly, CPs with a higher annual service

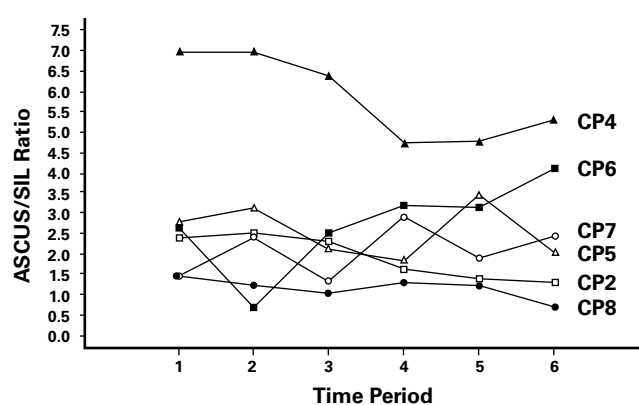


Figure 2 Plot of mean ASCUS/SIL (atypical squamous cells of undetermined significance/squamous intraepithelial lesion) ratios for 6 individual cytopathologists (CPs) who worked continuously during the study period. Each period is 6 months.

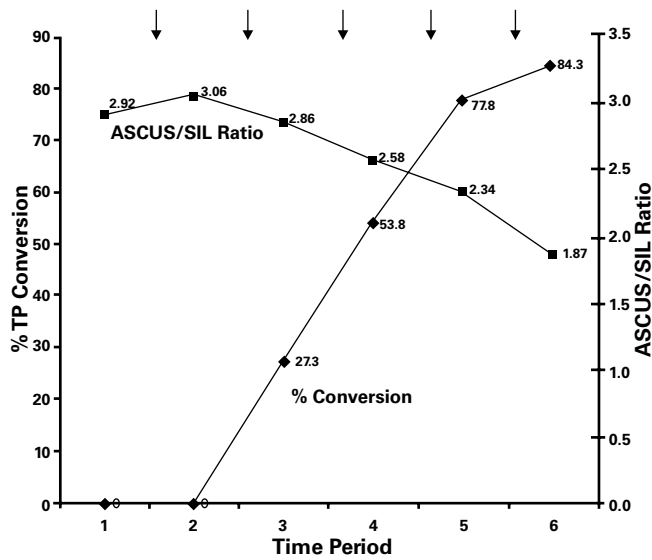


Figure 3 Plot of pooled mean ASCUS/SIL (atypical squamous cells of undetermined significance/squamous intraepithelial lesion) ratios for 12 cytopathologists and percentage conversion of Papanicolaou smears to the ThinPrep (TP) method. Although there is a significant correlation, this does not prove a causal relationship. The decrease in the ASCUS/SIL ratio may be the result of feedback provided to the cytopathologists after each time period. Timing of confidential feedback memos is indicated by arrows.

commitment to gynecologic cytology had neither a higher nor a lower ratio than those with a lower commitment. We did not attempt to correlate case load with the ASCUS/SIL ratio on a daily basis. It is possible that an especially heavy workday may increase or decrease the ASCUS/SIL ratio. But over time, the mean daily caseload was similar for all CPs and did not change significantly during this 3-year period (data not shown).

We are encouraged that 2 CPs showed a statistically significant decrease in their ASCUS/SIL ratios during the period of feedback, particularly the greatest outlier, whose ratio came closer to the national benchmark. Other CPs showed a decrease in their ratios and, although this did not reach statistical significance, it is possible that with a longer study period, these decreases also would be significant. On the basis of these results, we believe that confidential feedback on individual ASCUS/SIL ratios is a useful quality improvement tool, and we continue to use it as described herein. In addition, we have incorporated it into our cytopathology fellowship program by providing it to fellows after a period of supervised sign-out responsibility.

Not all CPs responded with a decrease in the ratio during those 3 years, however, and it is noteworthy that the ASCUS/SIL ratio of 1 CP increased significantly. This

argues that responses to feedback vary among individuals. Some may benefit from feedback alone; others may require active measures, such as a period of “double scoping,” if they are to lower their ratios to the recommended level.

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