The College of American Pathologists and National Society for Histotechnology Workload Study

Shane K. Kohl, MD; Sue E. Lewis, BS, HTL(ASCP)QIHC; Janet Tunnicliffe, MLT, ART; Robert L. Lott, HTL(ASCP); Lena T. Spencer, MA, HTL(ASCP)QIHC; Freida L. Carson, PhD, HT(ASCP); Rhona J. Souers, MS; Robert H. Knapp, MD†; Saeid Movahedi-Lankarani, MD; Thomas S. Haas, DO; Richard W. Brown, MD

• Limited data exist in regard to productivity and staffing in the anatomic pathology laboratory. In 2004, the National Society for Histotechnology (NSH) conducted a pilot study to examine productivity and staffing in the histology laboratory. After review of the data, The College of American Pathologists (CAP)/NSH Histotechnology Committee concluded that a larger survey was required to further address and expand on the pilot study findings. In 2007, a total of 2674 surveys were sent out to North American laboratories. From the responses, comparisons of laboratory demographics and productivity were examined by institution type and workload volume. Productivity was measured as the number of paraffin-embedded tissue blocks processed per full-time equivalent per year. This manuscript presents and discusses the data collected from the CAP/NSH Workload Study.

(*Arch Pathol Lab Med.* 2011;135:728–736)

In 2004 the National Society for Histotechnology (NSH) conducted a pilot study to gather data on specific technical and clerical tasks routinely performed in anatomic pathology laboratories and the amount of time needed to complete such tasks.[1] These data became the standard for setting a benchmark on productivity in the anatomic pathology laboratory. In the last several years there have been considerable changes in the technical processes used in the anatomic pathology laboratory, which are perceived to have a significant impact on the day-to-day workflow. These changes come from improved safety standards, implementation of Lean work processes, automation of manual tasks, and increasingly complex testing methods.

Although many published studies have defined and measured productivity in laboratory medicine, these studies have almost exclusively focused on assessment of productivity in the clinical laboratories. Very little data exist in the medical literature that address productivity in anatomic pathology laboratories in a manner that includes all facets of the technical work, leading up to pathologist's review and the rendering of a diagnosis.[2–7] In addition, there is no nationally recognized authority or consensus among practicing professionals on a definition of histology workload recording components. Administrators working within an increasingly complex regulatory environment must also meet internal and external budgetary goals for laboratory staff and support personnel. This article will propose a workload recording system based upon sound technical practices combined with proven staffing methods that contribute to a high-quality work product. The system components will address many previously submitted administrative questions regarding optimal staffing levels within the anatomic pathology laboratories, including the gross specimen examination room and the histology and immunohistochemistry laboratories.

This article provides data points based upon common clinical practices combined with proven staffing methods that are known to contribute to a high-quality work product. Application of these data points to current and projected work volumes has the potential to assist administrators in projecting optimal staffing levels within the anatomic pathology laboratories, including the gross specimen examination room and the histology and immunohistochemistry laboratories.

In 2002, the NSH created the Histopathology Productivity Task Force in response to numerous queries concerning staffing levels and skill mix. Clearly, both bench-level staff and management representatives sought an authoritative system to assist in defining and designing a productive laboratory work environment. The task force included experienced technical managers and staff personnel who were charged with developing a pilot study. The survey group identified 16 laboratories previously screened to include small, medium, and large surgical

Accepted for publication September 29, 2010.

†Deceased.

From The Pathology Center, Nebraska Methodist Hospital, Omaha (Dr Kohl); the Department of Pathology, University of Iowa Hospital and Clinics, Iowa City (Ms Lewis); the Department of Pathology, Royal Columbian Hospital, New Westminster, British Columbia, Canada (Ms Tunnicliffe); Lab First, Pathology, Trinity Medical Center, Birmingham, Alabama (Mr Lott); the Department of Pathology, Norton Healthcare, Louisville, Kentucky (Ms Spencer); Retired, Dallas, Texas (Dr Carson); Biostatistics, College of American Pathologists, Northfield, Illinois (Ms Souers); Pathology Laboratory, PC, Grandville, Missouri (Dr Knapp); the Department of Pathology, Abbott Northwestern Hospital, Minneapolis, Minnesota (Dr Movahedi-Lankarani); the Department of Pathology, Mercy Health System, Janesville, Wisconsin (Dr Haas); and the Department of Pathology, Memorial Hermann Southwest Hospital, Houston, Texas (Dr Brown).

The authors have no relevant financial interest in the products or companies described in this article.

Reprints: Shane K. Kohl, MD, The Pathology Center, Nebraska Methodist Hospital, 8303 Dodge St, Omaha, NE 68114 (e-mail: shane.kohl@nmhs.org).

pathology caseloads. The study was designed to address the following concerns:

1. Determining optimal managerial and technical staffing needs.
2. Determining tasks completed by a full-time equivalent (FTE) staff in routine technical practice areas of anatomic pathology.
3. Using the data obtained to report upon standard work practices and the time needed to perform the tasks.
4. Proposing a consistent and standardized workload recording method that could be used as a template to determine workload and staffing needs in any anatomic pathology laboratory.

The Workload Task Force concluded that the data collected supported the need for a staffing level of 11 FTEs, consisting of technical and nontechnical personnel, to produce 28 800 surgical cases per year or 649 slides per day. However, both the data collection and the resulting staffing recommendations were valid for only this data set. The amount of data collected was clearly not sufficient to make broad assumptions about staffing levels for laboratories whose work practices did not coincide with the institutions used in this original study. Therefore, the task force recommended that this study be used as a foundation to conduct a larger survey by using more extensive demographic data collection, which could then be used to better define customary work skills, tasks, and time to compute appropriate staffing levels.

In response to this challenge, the joint College of American Pathologists (CAP)/NSH Committee decided to conduct a new survey to correlate tasks and time with the number of anatomic laboratory personnel required. The goal of this survey was to define a standard for productivity in the anatomic pathology laboratory by defining a unit of work. This was done in 2007 by collecting demographic and statistical information from participating laboratories. The findings from the CAP/NSH 2007 study, which targeted a broader representation of anatomic pathology laboratories in North America, will be presented here.

Many of the terms used in this article and their definitions can be found in Table 1.

MATERIALS AND METHODS

This study was conducted by mailing out a 13-page survey to North American laboratories enrolled in the CAP anatomic education/competency programs. A total of 2674 surveys were sent out on January 18, 2007, with completed responses returned by February 20, 2007. The survey questionnaire was divided into 2 general sections: practice setting and time accounting.

The practice setting section addressed specific demographic questions regarding the participant laboratory. Sample questions asked for information about the type of laboratory (independent or hospital based), workload (defined as the number of paraffin blocks produced annually), staffing characteristics (defined as certification, years of experience), and laboratory hours of operation.

Data from the individually timed technical tasks were difficult to evaluate. For example, some respondents failed to specify the exact units of measurements (minutes versus seconds). These same laboratories did not specify whether the timed events represented a single event, average of several events, or a summation of all 10 events. Many attempts to refine and apply logical interpretations to the data reported were not successful. These inconsistencies, combined with other unexplained outliers reported in this data set, led to the decision to eliminate this entire data subset from consideration. The aim is to minimize the effects of random variability while maintaining statistical rigor when evaluating all the contributing factors leading to recommendations about workload recording and staffing levels. The authors uphold using the data reported to draw conclusions about best practices within a quality system.[8]

Participant Characteristics

Thirty-two percent (n = 855) of the surveys sent out to North American laboratories were completed and returned.

Statistical Analysis

Data received from the participant surveys were sorted by institution type (independent versus hospital laboratory), and then further stratified into 3 groups by reported numbers of tissue blocks processed per year (small, 0–12 500; medium, 12 501–53 000; and large, >53 000).

The block and slide volumes, staffing personnel, tissue-block ratios, and time accounting percentages were tested for individual association with institution type by using the Kruskal-Wallis test. These practice characteristics were also tested for association with the 3-level institution caseload variable by using the Wilcoxon rank sum test. All tests were run at the $P < .05$ significance level.

The productivity measure of blocks per FTE was analyzed and required a log transformation for the regression-based analyses, owing to a severely skewed distribution. Individual associations between productivity and the demographic and practice variables were investigated using Wilcoxon rank sum tests for discrete-valued independent variables and regression analysis for the continuous independent variables. Variables with significant associations ($P < .10$) were introduced into a multivariate regression model. All variables remaining were significantly associated at the $P < .05$ significance level. All analyses were run with SAS 9.2 (Cary, North Carolina).

RESULTS

Laboratory Demographics

There were 631 institutions (83.1%) representing hospital laboratories and 128 (16.9%) representing independent laboratories. Most participating laboratories (50.5%) processed between 12 501 and 53 000 blocks per year (medium workload), while 25.4% and 24.1% fell into the small (0–12 500 blocks per year) and large (>53 000 blocks per year) categories, respectively (Table 2). Most laboratories (n = 397; 49.7%) reported that their hours of operation were fewer than 12 h/d from Monday through Friday. Institutions that operated Monday through Friday and Saturday or Sunday made up 39.5% of the total respondents (n = 316). Very few institutions (n = 86; 10.8%) operated for more than 12 hours from Monday through Friday (Table 2).

The authors were surprised to find that 8.2% of the participants reported absence of quality assurance activities for review of the stained slides before release of the slides to a pathologist. Table 2 shows results of other questions regarding practice setting.

Laboratory Work Volumes

Overall, independent laboratories processed significantly ($P < .001$) more tissue blocks, hematoxylin-eosin (H&E)–stained slides, histochemical stains, and immunohistochemical-stained slides, as compared with hospital laboratories (Table 3). There was no significant difference in the number of unstained slides produced between hospital and independent laboratories ($P = .29$). As expected, larger laboratories also processed significantly

Table 1. College of American Pathologists/National Society for Histotechnology 2007 Survey Definitions	
Full-time equivalent (FTE)	An employee who works 2080 h/y
Certified technician/technologist	A person who has successfully passed the appropriate certifying examination administered by either the American Society for Clinical Pathology, Board of Registry examination (HT/HTL), or the Canadian Society of Laboratory Medical Science (RT/MLT)
Noncertified technician/technologist	A person who has on-the-job experience working within a histopathology laboratory but has not successfully completed a certifying examination
Manager	A person who has administrative responsibilities for the anatomic pathology laboratory, which may include any combination of financial, human resources, technical, and operational oversight for the laboratories; this person may or may not perform technical duties within the laboratory
Productivity	The amount of input (labor) required to produce a unit of work (output)
Proficiency	The abilities, skills, and knowledge needed to perform job duties and responsibilities
Quality control	A system of routine operational techniques and activities implemented within a quality system[8]
Quality assurance	The planned and systematic activities implemented within a quality system[8]
Work processes	Throughout all procedures, the constant verification between specimen, paperwork, blocks, and slides, which is an essential quality assurance activity for which all laboratory personnel are responsible
Accessioning	The receipt and verification of specimens and their related requisitions for testing procedures, the subsequent order entry into the laboratory information system, and the assignment of a unique identifier that is associated with all related specimen materials
Grossing, or gross examination	The macroscopic examination of surgical specimens and the related order requisition to include specimen identification, clinical history, specimen description, number and location of blocks generated
Tissue block	Tissue from 1 cassette, embedded into 1 block of paraffin and uniquely identified
Embedding	The process of orientation and placement of a tissue specimen from 1 cassette into a paraffin-filled mold
Microtomy	The use of the microtome to cut thin sections of a tissue specimen, which are floated onto a water bath, and then mounted onto 1 glass slide
Staining	The procedure that defines the steps required to remove paraffin from the mounted section, and the application of dye solutions to differentially color tissue components
Hematoxylin-eosin (H&E) stain	One glass slide containing a minimum of 1 paraffin tissue section stained with H&E stain
Special stain	One glass slide containing a minimum of 1 paraffin tissue section stained with any histochemical technique other than H&E
Immunohistochemistry	One glass slide containing a minimum of 1 paraffin tissue section stained with an immunohistochemical technique
Coverslipping	The manual or automated process for the application of a glass or plastic coverslip that is permanently affixed to the surface of the stained tissue slide
Slide sorting/labeling/distribution	The application of a systematic work process in which stained slides are identified by a unique identifier, labeled, sorted, and then distributed by an internally defined protocol
Slide/block filing and retrieval	The application of a systematic work process in which stained slides and blocks are identified by a unique identifier, sorted and stored using an internally defined protocol, which allows for efficient recovery for ancillary review or testing
Certified task	Histology tasks requiring the use of certified personnel that include grossing, specimen processing, embedding, microtomy, routine and special staining, and frozen section preparation[5]
Noncertified task	Histology tasks not requiring the use of certified personnel that include accessioning, transporting specimens, filing, transcribing reports, and running automated instruments[5]

more slides in every category when compared with smaller laboratories.

Staffing and Staffing Ratios

Independent laboratories employed significantly ($P < .001$) more technical staff, which included both certified and noncertified staff, as compared with hospital laboratories (Table 4). Overall, a median of 6 nonmanagerial/managerial FTEs was found among all responding institutions. Independent laboratories demonstrated statistically significant ($P < .001$) higher ratios (median, 8 nonmanagerial/managerial FTEs) as compared with hospital laboratories (median, 5 nonmanagerial/managerial FTEs). Larger laboratories also demonstrated a statistically significant ($P < .001$) higher nonmanagerial/managerial FTE ratio (median, 12 nonmanagerial/managerial FTEs) when compared with medium (median, 5 nonmanagerial/managerial FTEs) and smaller (median, 3 nonmanagerial/managerial FTEs) institutions (Table 4).

Time Accounting for Specific Tasks Performed Within the Laboratory (Percentage of Total Hours Worked)

When examining the responses from all laboratories, most work hours were spent performing microtomy (25.0%). In contrast, the least amount of work hours were spent in the areas of slide/block filing (5.9%) and slide sorting (9.1%). There was no significant difference in the percentage of hours reported for performing most of the tasks when comparing hospital versus independent laboratories (Table 5). The 3 exceptions occurred in the

Table 2. Institutional Characteristics of Laboratories Participating in College of American Pathologists/ National Society for Histotechnology 2007 Survey

Characteristic	No. (%) of Institutions
Institution type	
Hospital laboratory	631 (83.1)
Independent laboratory	128 (16.9)
Institution caseload	
Small (0–12 500 blocks/y)	204 (25.4)
Medium (12 501–53 000 blocks/y)	406 (50.5)
Large (>53 000 blocks/y)	194 (24.1)
Practice hours	
Monday–Friday plus Saturday or Sunday	316 (39.5)
Monday–Friday (>12 h/d)	86 (10.8)
Monday–Friday (≤12 h/d)	397 (49.7)
Laboratory supporting residents or fellows	
Yes	161 (20.0)
No	643 (80.0)
Laboratory receiving specimens grossed at other sites	
Yes	142 (17.9)
No	652 (82.1)
Laboratory sorts slides by pathologist or subspecialty	
Yes	475 (59.6)
No	322 (40.4)
Laboratory matches slides with the blocks before releasing to pathologist	
Yes	477 (59.3)
No	327 (40.7)
Laboratory places cases in numerical order	
Yes	646 (80.2)
No	159 (19.8)
Laboratory restricts the number/type of cases in a tray	
Yes	367 (45.8)
No	434 (54.2)
Laboratory reconciles work-list problem before releasing slides	
Yes	757 (94.6)
No	43 (5.4)
Laboratory performs quality control of stained slides before releasing	
Yes	737 (91.8)
No	66 (8.2)

amount of time spent embedding (hospital laboratory, 11.1%; independent laboratory, 11.5%; $P = .03$), staining (hospital laboratory, 11.1%; independent laboratory, 8.3%; $P = .003$), and slide/block filing (hospital laboratory, 5.9%; independent laboratory, 4.3%; $P < .001$). Larger laboratories spent significantly more work hours performing gross specimen examination ($P < .001$) and microtomy ($P < .001$). Predictably, they spent significantly fewer hours staining ($P < .001$) and slide/block filing ($P < .001$). Medium and larger laboratories also spent significantly fewer work hours in accessioning ($P = .02$) and slide sorting ($P < .001$) (Table 5).

Productivity (Blocks per FTE per Year)

All data collected were examined by using multiple algorithms to define a standard unit of work. The authors believe that this definition will set the single point of reference for any laboratory that intends to build a practice plan for adequate staffing. Administrators and other managers could reference this unit of work to project and implement staffing plans. Data review for all laboratories (n = 792) produced a median of 6433 blocks per FTE per year. No significant statistical difference in productivity was seen between hospital versus independent laboratories (hospital, 6259 blocks per FTE per year; independent, 7511 blocks per FTE per year; $P = .09$); however, institutions processing more blocks per year showed significantly higher productivity ($P < .001$) (Table 6).

When aligning productivity to laboratory tasks, laboratories whose stained slides were sorted by using various in-house defined criteria, such as by pathologist or by subspecialty, demonstrated significantly higher productivity (7180 blocks per FTE per year) when compared with laboratories that did not use this method (5625 blocks per FTE per year; $P < .001$). For the related work tasks in which laboratories match slides to blocks before the slides are released to a pathologist, a statistically significant decrease in productivity was observed (6191 blocks per FTE per year) as compared with laboratories that did not complete this quality assurance activity (6925 blocks per FTE per year; $P = .02$). Laboratories in which the pathologists grossed all specimens showed a statistically significant ($P < .001$) variation in productivity (5000 blocks per FTE per year) as compared with laboratories in which grossing was performed by nonpathologist personnel (7058 blocks per FTE per year). No major differences in productivity were identified when comparing other laboratory tasks against productivity (Table 7). However, those laboratories in which 1 or more histologists reportedly performed gross specimen examination showed a trend toward less productivity (6163 blocks per FTE per year) than that of laboratories in which this examination was not performed (6324 blocks per FTE per year).

Tissue Block and Glass Slide Ratios

The data showed an average of 1.8 total slides cut per block (Table 8). There was no significant difference between hospital and independent laboratories in their total numbers of H&E slides, histochemical stains, immunohistochemical stains, unstained slides, or total number of slides produced per tissue block.

COMMENT

The tissue block is the central connecting work product common to all areas of practice within anatomic pathology, from gross specimen examination to stained-slide production. Therefore, workload and recording within the anatomic pathology laboratory are best measured by using the total number of tissue blocks processed per year as the unit of work. With this in mind, anatomic pathology laboratory staffing requirements and measures used to attain optimal productivity are best determined by using a simple formula: defining the number of paraffin blocks processed per nonmanagement full-time equivalent per year (blocks per FTE per year). This formula for histology laboratory productivity has also been described by other authors.[5,6,7] In our survey, the median productivity of all responding institutions (n = 792) was 6433 blocks per FTE per year. In 2006, Buesa[5] reported results from a survey on the productivity of 163 US laboratories and found that a

Table 3. Workload Volumes of Laboratories Participating in College of American Pathologists/National Society for Histotechnology 2007 Survey

		n	5th Percentile	Median	95th Percentile	*P* Value
Tissue blocks	All	804	3619	24 946	158 427	
	Institution type					<.001
	Hospital laboratory	618	3673	22 301	117 189	
	Independent laboratory	125	2064	54 114	342 000	
	Institution caseload					<.001
	Small (0–12 500 blocks/y)	204	260	7374	12 092	
	Medium (12 501–53 000 blocks/y)	406	13 202	25 551	49 950	
	Large (>53,000 blocks/y)	194	55 618	89 658	280 000	
H&E slides	All	799	5500	39 472	261 221	
	Institution type					<.001
	Hospital laboratory	612	5780	34 769	185 510	
	Independent laboratory	125	4811	83 450	700 000	
	Institution caseload					<.001
	Small (0–12 500 blocks/y)	200	303	11 046	28 882	
	Medium (12 501–53 000 blocks/y)	397	15 031	39 268	87 600	
	Large (>53,000 blocks/year)	194	67 784	134 548	687 049	
Special stains	All	783	173	2400	14 830	
	Institution type					<.001
	Hospital laboratory	602	173	2189	12 479	
	Independent laboratory	122	100	4568	30 002	
	Institution caseload					<.001
	Small (0–12 500 blocks/y)	194	0	774	4821	
	Medium (12 501–53 000 blocks/y)	392	430	2239	8528	
	Large (>53 000 blocks/y)	191	1500	7565	35 931	
IHC slides	All	678	0	2383	33 501	
	Institution type					<.001
	Hospital laboratory	511	0	1950	20 000	
	Independent laboratory	117	0	5666	55 608	
	Institution caseload					<.001
	Small (0–12 500 blocks/y)	149	0	142	12 275	
	Medium (12 501–53 000 blocks/y)	345	0	1950	11 520	
	Large (>53 000 blocks/y)	178	0	11 167	48 019	
Unstained slides	All	663	0	1085	28 852	
	Institution type					.29
	Hospital laboratory	514	0	1062	24 192	
	Independent laboratory	104	0	1250	78 022	
	Institution caseload					<.001
	Small (0–12 500 blocks/y)	169	0	234	7563	
	Medium (12 501–53 000 blocks/y)	327	0	1056	15 000	
	Large (>53 000 blocks/y)	163	0	5000	50 441	

Abbreviations: H&E, hematoxylin-eosin; IHC, immunohistochemistry.

histologist could process 8600 blocks to stained glass slides per year. Further, the author reported that histologists responsible for only embedding and sectioning tasks could process an average of 13 800 blocks per year. Other related studies reported similar findings, including that of Valenstein and colleagues[7] who, in 2005, reported a median of 6908 blocks processed per histology nonmanagement FTE in 116 histology laboratories.

In this current survey, no statistically significant ($P = .91$) difference in productivity was demonstrated between independent and hospital-based institutions, although a trend toward greater productivity in independent laboratories was seen (median: hospital, 6259 blocks per FTE per year; independent, 7511 blocks per FTE per year). Institutions that processed higher block counts (>53 000 blocks per year) were found to have significantly higher productivity (9167 blocks per FTE per year) than medium (7727 blocks per FTE per year) and small (3169 blocks per FTE per year) institutions. These findings contrast with those of Valenstein et al,[7] who reported no significant increase in productivity with increased workload in the histology laboratory. However, Buesa[5] reports that the workload per histologist in laboratories with higher volumes (>50 000 surgical specimens per year) was greater than that for histologists working in smaller institutions.

One explanation for the higher productivity per higher block counts is likely related to the specific tasks performed by histologists in institutions with smaller workloads. Histologists in these smaller institutions often report performing additional responsibilities outside of the routinely assigned technical laboratory tasks. In a survey examining tasks within 480 histology laboratories, Buesa[5] reports that histologists who performed both noncertified (eg, accessioning, transporting specimens, filing, transcribing reports, running automated instruments) and certified (eg, grossing, embedding, slide labeling, microtomy, staining, coverslipping) tasks demonstrated a decrease in productivity of up to 60% as compared with histologists who performed only routine technical tasks. Therefore, the greater productivity in larger institutions is most likely related to the fact that a

Table 4. Staffing Volumes of Laboratories Participating in College of American Pathologists/National Society for Histotechnology 2007 Survey

		n	5th Percentile	Median	95th Percentile	*P* Value
Certified technicians	All	767	1	2	13	
	Institution type					<.001
	Hospital laboratory	581	1	2	10	
	Independent laboratory	126	1	4	21	
	Institution caseload					<.001
	Small (0–12 500 blocks/y)	176	0	1	4	
	Medium (12 501–53 000 blocks/y)	383	1	2	5	
	Large (>53 000 blocks/y)	194	2	6	23	
Noncertified technicians	All	646	0	1	6	
	Institution type					<.001
	Hospital laboratory	483	0	1	5	
	Independent laboratory	113	0	2	15	
	Institution caseload					<.001
	Small (0–12 500 blocks/y)	142	0	1	3	
	Medium (12 501–53 000 blocks/y)	330	0	1	4	
	Large (>53 000 blocks/y)	162	0	2	9	
Other technical staff	All	502	0	1	6	
	Institution type					<.001
	Hospital laboratory	356	0	1	5	
	Independent laboratory	107	0	2	14	
	Institution caseload					<.001
	Small (0–12 500 blocks/y)	99	0	0	2	
	Medium (12 501–53 000 blocks/y)	239	0	1	4	
	Large (>53 000 blocks/y)	155	0	2	13	
Total technical staff	All	812	1	4	21	
	Institution type					<.001
	Hospital laboratory	623	1	4	16	
	Independent laboratory	127	2	7	35	
	Institution caseload					<.001
	Small (0–12 500 blocks/y)	201	1	2	5	
	Medium (12 501–53 000 blocks/y)	402	2	4	10	
	Large (>53 000 blocks/y)	194	5	11	37	
Manager	All	521	0	1	1	
	Institution type					<.001
	Hospital laboratory	369	0	1	1	
	Independent laboratory	113	0	1	2	
	Institution caseload					<.001
	Small (0–12 500 blocks/y)	94	0	1	2	
	Medium (12 501–53 000 blocks/y)	248	0	1	1	
	Large (>53 000 blocks/y)	168	0	1	2	
Total techs/manager	All	392	2	6	28	
	Institution type					<.001
	Hospital laboratory	261	2	5	22	
	Independent laboratory	105	3	8	32	
	Institution caseload					<.001
	Small (0–12 500 blocks/y)	49	1	3	9	
	Medium (12 501–53 000 blocks/y)	179	3	5	13	
	Large (>53 000 blocks/y)	158	5	12	37	

Abbreviation: techs, histotechnologists.

higher number of certified, trained histologist FTEs are dedicated to routine histology tasks such as embedding and microtomy. Larger institutions are more likely to have a more diverse skill mix, including additional nontechnical support staff such as laboratory assistants, pathologists' assistants, morgue assistants, and clerical personnel, who, in turn, are responsible for specific technical tasks including specimen accessioning, gross specimen examination, frozen section preparation, specimen transport, clerical functions (slide/block sorting or filing), answering the phone, and autopsy services. In addition to the defined tasks and responsibilities of the histologist, greater productivity gains are most likely related to the reported increased use of automation in larger institutions, such as bar code readers, cassette and slide labelers, automated stainers, and coverslippers. Buesa[6] reports that using a combination of automated instruments, such as stainers and coverslippers, in addition to assigning appropriate tasks to laboratory assistants, can increase productivity by a factor of 2.4.

When looking at productivity and specific laboratory functions, laboratories that sorted slides by pathologist/subspecialty and reconciled work-list problems before releasing slides demonstrated an increased productivity (7180 compared with 5625 blocks per FTE per year). Laboratories in which pathologists reportedly performed all of the gross specimen examination were found to process statistically significantly fewer blocks per FTE per

Table 5. Time Accounting (Percentage of Total Hours by Category) of Laboratories Participating in College of American Pathologists/National Society for Histotechnology 2007 Survey

		n	5th Percentile	Median	95th Percentile	*P* Value
Accessioning	All institutions	809	3.6	14.8	34.8	
	Institution type					.13
	Hospital laboratory	616	4.6	15.0	34.8	
	Independent laboratory	127	0.0	14.3	34.8	
	Institution size					.02
	Small (0–12 500 blocks/y)	198	2.6	14.3	50.0	
	Medium (12 501–53 000 blocks/y)	401	4.7	15.7	33.3	
	Large (>53 000 blocks/y)	191	0.0	14.3	29.1	
Grossing	All institutions	809	0.0	17.6	33.3	
	Institution type					.07
	Hospital laboratory	616	0.0	17.6	33.3	
	Independent laboratory	127	0.0	18.2	35.1	
	Institution size					<.001
	Small (0–12 500 blocks/y)	198	0.0	14.3	33.3	
	Medium (12 501–53 000 blocks/y)	401	0.0	17.6	31.6	
	Large (>53 000 blocks/y)	191	0.0	20.7	36.9	
Embedding	All institutions	809	3.3	11.1	21.1	
	Institution type					.03
	Hospital laboratory	616	2.7	11.1	21.1	
	Independent laboratory	127	3.8	11.5	23.5	
	Institution size					.05
	Small (0–12 500 blocks/y)	198	0.0	11.1	25.0	
	Medium (12 501–53 000 blocks/y)	401	4.2	11.1	20.0	
	Large (>53 000 blocks/y)	191	6.5	11.4	21.2	
Microtomy	All institutions	809	8.7	25.0	46.2	
	Institution type					.37
	Hospital laboratory	616	8.7	25.0	46.4	
	Independent laboratory	127	6.5	26.0	45.8	
	Institution size					<.001
	Small (0–12 500 blocks/y)	198	0.0	20.0	46.5	
	Medium (12 501–53 000 blocks/y)	401	10.3	25.0	45.3	
	Large (>53 000 blocks/y)	191	13.5	30.1	46.3	
Staining (H&E only)	All institutions	809	0.0	10.8	23.1	
	Institution type					.003
	Hospital laboratory	616	0.0	11.1	22.2	
	Independent laboratory	127	1.5	8.3	25.0	
	Institution size					<.001
	Small (0–12 500 blocks/y)	198	0.0	12.5	25.0	
	Medium (12 501–53 000 blocks/y)	401	0.0	11.5	21.4	
	Large (>53 000 blocks/y)	191	0.0	7.9	19.0	
Slide sorting	All institutions	809	2.6	9.1	20.0	
	Institution type					.86
	Hospital laboratory	616	2.6	9.1	20.0	
	Independent laboratory	127	3.7	8.9	19.2	
	Institution size					<.001
	Small (0–12 500 blocks/y)	198	0.0	10.0	26.9	
	Medium (12 501–53 000 blocks/y)	401	2.9	8.3	16.7	
	Large (>53 000 blocks/y)	191	3.7	9.1	17.2	
Slide/block filing	All institutions	809	1.0	5.9	16.7	
	Institution type					<.001
	Hospital laboratory	616	0.7	5.9	16.7	
	Independent laboratory	127	1.4	4.3	16.7	
	Institution size					<.001
	Small (0–12 500 blocks/y)	198	0.0	8.3	25.0	
	Medium (12 501–53 000 blocks/y)	401	1.9	5.6	14.3	
	Large (>53 000 blocks/y)	191	1.4	4.4	11.8	

Abbreviation: H&E, hematoxylin-eosin.

year (5000 compared with 7058 blocks per FTE per year). These findings are somewhat deceiving because experienced pathologists are more likely to submit fewer blocks per specimen than nonpathologist staff performing gross specimen examinations. Laboratories that matched slides to blocks before releasing the slides to the pathologist were significantly less productive (6191 compared with 6925 blocks per FTE per year). Consideration of value-added outcomes associated with systematic quality assurance/quality control (QA/QC) throughout the entire process is crucial in the prevention of critical errors. Such errors may include paraffin blocks that do not correspond

Table 6. Staffing Productivity (Blocks per Full-Time Equivalent per Year) by Type and Size of Laboratories Participating in College of American Pathologists/National Society for Histotechnology 2007 Survey

	n	5th Percentile	Median	95th Percentile	*P* Value
All institutions	792	1333	6433	13 762	
Institution type					.09
Hospital laboratory	607	1456	6259	13 019	
Independent laboratory	124	723	7511	16 000	
Institution size					<.001
Small caseload	197	200	3169	8441	
Medium caseload	401	2618	6727	12 650	
Large caseload	194	4690	9167	16 649	

to the labeled slide or incomplete/nonrepresentative tissue sections. Measures of staff productivity, while important to any organization's budgetary goals, must not outweigh patient safety.

Data show that 8.2% of responding laboratories reported that they did not perform quality assurance procedures before releasing the stained slides to the pathologist. Multiple publications recommend these activities as being essential to the production of a high-quality product. This screening step is necessary to verify that slides meet basic standards for diagnostic material. The CAP/NSH Histology Quality Improvement Program Committee agrees with a standard of best practice in quality control in which quality assurance procedures are not sacrificed in order to improve productivity. Examination of the stained slides before release to the pathologist is the histologist's last opportunity for identifying problems related to processing, embedding, microtomy, staining, and labeling. Intervention at this point allows the investigation and immediate resolution of any issues identified, thereby reducing the amount of nonproductive time required to identify, correct, and document errors retrospectively. Unrelated to productivity but directly connected to patient care, the review of slides and blocks can mitigate the risk of diagnostic errors by the pathologist, due to a mislabeled slide, inappropriate staining, or poor-quality tissue sections. Completion of daily quality control and the monitoring of H&E control slides can identify subtle

Table 7. Staffing Productivity (Blocks per Full-Time Equivalent [FTE] per Year) by Laboratory Functions of Laboratories Participating in College of American Pathologists/National Society for Histotechnology 2007 Survey

	n	5th Percentile	Median	95th Percentile	*P* Value
Sort slides by pathologist or subspecialty					<.001
Yes	463	1316	7180	14 565	
No	309	1422	5625	12 128	
Match slides with blocks before releasing to pathologist					.02
Yes	461	1318	6191	13 640	
No	318	1500	6925	13 762	
Place cases in numerical order					.16
Yes	626	1325	6327	14 201	
No	154	1800	6756	12 745	
Restrict the number/type of cases in a tray					.25
Yes	357	800	6843	14 201	
No	420	1777	6139	13 383	
Reconcile work-list problems before releasing slides					<.001
Yes	735	1389	6640	13 874	
No	40	849	5014	9672	
Perform slide/block QC					.29
Yes	718	1333	6502	13 874	
No	63	1483	5817	11 719	
Tech grossing					.90
≥1 tech	245	959	6481	12 943	
No techs	536	1483	6481	14 355	
Pathologist performs 100% of grossing procedures					<.001
Yes	205	1172	5 000	10 010	
No	484	1799	7058	14 500	
Blocks/FTE by practice hours					<.001
Monday–Friday plus Saturday or Sunday	306	1325	7321	13 565	
Monday–Friday (>12 h/d)	83	2375	7006	16 510	
Monday–Friday (≤12 h/d)	384	1318	5714	12 650	

Abbreviations: QC, quality control; tech, histotechnologist.

Table 8. Tissue Block Ratios of Laboratories Participating in College of American Pathologists/ National Society for Histotechnology 2007 Survey

	n	5th Percentile	Median	95th Percentile
H&E slides/tissue block	781	1.0	1.5	2.9
Special stains/ tissue block	767	0.0	0.1	0.4
IHC slides/tissue block	662	0.0	0.1	0.5
Unstained slides/ tissue block	649	0.0	0.0	0.7
Total slides/tissue block	786	1.1	1.8	4.1

Abbreviations: H&E, hematoxylin-eosin; IHC, immunohistochemistry.

trends in processing and staining issues that can be tracked and corrected in a timely, efficient manner and may prevent major catastrophes.

Most work time in the histology laboratory was spent in microtomy (median, 25.0%). These data support the view that a considerable amount of hands-on skilled labor is necessary to produce the essential unit of work product for anatomic pathology. The larger laboratories (>53 000 blocks per year) dedicated a significantly greater percentage of time in the areas of grossing and microtomy. This is most likely related to the overall increased work volume and complexity of the surgical specimens (ie, staging and large resection specimens).

Although independent laboratories report significantly higher volumes of tissue blocks and slides, no significant difference was found in the numbers of slides cut per block in any category (immunohistochemical stains, histochemical, unstained slides, and H&E) between hospital and independent laboratories. An average of 1.8 total slides cut per block was found, which correlates with the value previously reported by Buesa.[6]

Given the higher work volume (numbers of tissue blocks) found in independent laboratories, it is not surprising that they would require a significant increase in the number of FTEs across all categories. Overall, a median of 6 nonmanagerial/managerial FTEs was found among all responding institutions, which is lower than the 10.5 nonmanagerial/managerial FTEs reported by Valenstein et al.[7]

In summary, limited data have been available in the evaluation of productivity and staffing requirements in anatomic pathology laboratories. Our data report responses from more than 800 US and Canadian laboratories, which is a larger number than cited in previous studies examining productivity. The study design was based upon published, established work practices and the considerable combined years of technical experience from the NSH/CAP committee members and their consultants. The authors believe that productivity in the anatomic pathology laboratory is best measured by using tissue blocks processed per nonmanagerial FTE per year because it takes into consideration all of the steps and different variables involved in creating a glass slide from a tissue specimen. Although in our survey the median productivity of all responding institutions was 6433 blocks per FTE per year, there was great variability between individual laboratories, especially in laboratory workload volume, practice style, and individual staffing responsibilities. These variables and many others need to be taken into careful consideration before determining the expected productivity and staffing requirements for one's own laboratory. Determining an accurate value for productivity for all histology laboratories is extremely difficult owing to the numerous variables that have to be considered, and therefore, this may not be possible. One of the limitations in this study is that the data were self-reported. In addition, although the number of respondents was large, it cannot be assumed that the data are representative of all laboratories in the United States and Canada and their respective work practices. Also, only North American laboratories enrolled in the CAP anatomic education/competency programs received surveys, and therefore, again, the data may not be completely representative of all US and Canadian laboratories. Lastly, one other possible limitation is that the nonmanagerial FTE values reported above represent staff members who primarily perform histology-related tasks. Some institutions may use several FTEs, each with minor or support duties in the histology laboratory; this may have a significant impact on the overall productivity reported. Given these limitations, we hope that the above information may offer more insight and considerations in helping laboratories further address staffing requirements and productivity.

Financial support for the study was provided by the College of American Pathologists, Northfield, Illinois.

References

1. Lafriniere M, Lewis S, Sheppard B, Carson F. A report from the National Society for Histotechnology Productivity Task Force. *J Histotechnol*. 2004;27(4):293–295.

2. College of Medical Laboratory Technologists of Ontario. CMLTO 2006 Laboratory Manager's Survey—Anatomic Pathology. http://cmlto.com/communications/polls_and_surveys/pdf/managers.pps. Accessed April 5, 2009.

3. College of Medical Laboratory Technologists of Ontario. CMLTO 2006 Members' Survey—Anatomic Pathology. http://cmlto.com/communications/polls_and_surveys/pdf/members.pps. Accessed April 5 2009.

4. College of Medical Laboratory Technologists of Ontario. Practice Guidelines for Medical Laboratory Technologists Practicing in Histology: Histology Working Group of the CMLTO Quality Assurance Committee. http://cmlto.com/quality_assurance/MLT_practice_guidelines/learning/. Accessed April 5, 2009.

5. Buesa R. A puzzling, perplexing problem: histology staffing levels still a work in progress. *Adv Med Lab Prof*. 2006;18(20):22.

6. Buesa R. Removing the stumbling blocks: using statistics, learn how to optimize your workflow in histology. *Adv Med Lab Prof*. 2006;18(14):18.

7. Valenstein PN, Souers R, Wilkinson DS. Staffing benchmarks for clinical laboratories: a College of American Pathologists Q-Probes study of staffing at 151 institutions. *Arch Pathol Lab Med*. 2005;129(4):467–473.

8. Berte LM, Nevalaineen DE. Quality systems for the laboratory. *Am Soc Clin Pathol*. 2000:10.