Horizontal and Vertical Integration in Hospital Laboratories and the Laboratory Information System

Bruce A. Friedman, MD,* and Will Mitchell, PhD†

The decade of the 1990s will be a period of intense pressure for pathologists who are directors of hospital clinical laboratories. Hospital administrators, third party payers, and clinicians will continue to demand increased test quality, more rapid test turn around time, and decreased test cost. These demands will result in an even more competitive environment than exists today for hospital laboratories. Formal strategic planning will become increasingly essential for successful laboratories in order for them to adapt to this rapidly changing and highly competitive laboratory testing market. Strategic means that something of value is provided by laboratories to clients that their competitors are unable to provide.

The purpose of this article is to provide a theoretical management model that emphasizes horizontal and vertical integration to assist pathologists in developing a formal strategy to increase the efficiency and quality of clinical laboratory operations. Emphasis is placed on the means by which the laboratory information system (LIS) facilitates horizontal and vertical integration. Practical examples are used throughout the article to illustrate how this theoretical model can be used to understand laboratory information flow and solve strategic problems. Because a specialized vocabulary is used throughout the article, a glossary of terms is also provided.

* Professor of Pathology, Department of Pathology, University of Michigan Medical School, Ann Arbor, Michigan
† Assistant Professor of Corporate Strategy, Department of Corporate Strategy, University of Michigan School of Business Administration, Ann Arbor, Michigan

Clinics in Laboratory Medicine—Vol. 10, No. 3, September 1990
CONTROL AND INTEGRATION IN CLINICAL LABORATORIES

An understanding of vertical and horizontal integration and their quasi-integration variants is fundamental to the development of a competitive strategy in hospital clinical laboratories. These basic organizational concepts, in turn, are based on the need to establish control over critical laboratory inputs and outputs. The pathologist, like all competent managers, will seek greater control of mission-critical system inputs and outputs to define and regulate "what ought to be," that is, to establish the basic direction of the organization and increase the quality and efficiency of the laboratory operations.

A pathologist does not need to use organizational methods such as integration to control all of the diverse laboratory inputs and outputs. Considering the input of a product or service, the pathologist should seek organizational control of its supplier only if an alternative for the product or service cannot be readily found, if it is used frequently, or if there is uncertainty about its future supply. Williamson refers to such a critical system input as a transaction-specific resource. For products that are readily available from several suppliers or are used infrequently, the threat of purchasing the product elsewhere is usually sufficient to exercise market control over the supplier. For example, high-quality glass test tubes are readily obtainable from multiple vendors, so there is little need to control a test tube vendor to ensure the success of the laboratories. However, if a supplier's actions could have a significant impact on laboratory operations, the pathologist will benefit from organizational control of that supplier.

The importance of controlling critical resources will come as no surprise to the pathologist. To cite only one common example, the pathologist frequently will seek control of blood drawing services in the hospital to regulate laboratory system inputs (i.e., the flow and quality of incoming blood specimens). One method for exercising such control is for the laboratories to employ all hospital phlebotomists directly, an example of backward vertical integration. Such employment will improve communication with the phlebotomists and allow synchronization of blood specimen inputs with the processing requirements of the laboratories. Such synchronization and communication may be more difficult if the phlebotomy team is under the administrative control of nursing administration, because nurses have their own set of job-related goals and objectives, which may not totally overlap with those of pathology.

All pathologists learn, in time, that they will be held accountable, either directly or indirectly, for any problems or inefficiencies that occur from the time that a laboratory test is ordered by a clinician until the test results are generated and reported directly to that clinician. In practical terms, this accountability translates into a need for the pathologist to control and coordinate, whenever possible, all processes involved in
producing test results. The term quality assurance, in contrast to quality control, is now commonly used in laboratory medicine to convey this broad sweep of responsibility and encompass both pre-analytic and post-analytic activities, including specimen collection and test result reporting.\textsuperscript{1} Achieving such broad control will help pathologists to reduce the frustration of being blamed for the mistakes and inefficiencies of others and will also provide the management opportunity to improve laboratory operations.

Vertical integration is not the sole means for achieving control of laboratory inputs and outputs. Other methods at the disposal of the pathologist include aligning the incentives of the supplier of a good or service with those of the laboratories by setting penalties for poor service or agreeing to arbitration with the supplier to resolve disputes.\textsuperscript{13} The application of penalties and arbitration invariably occur after the fact, however, so that the pathologist must still attempt to correct the harmful effects of mistakes that have already occurred. Therefore, a before-the-fact control method is preferable. Frequently, this control will take the form of vertical integration; that is, control by the laboratory of its own inputs or distribution of its own outputs. Other hospital organizational units may also pursue a similar control-oriented strategy, resulting in political conflicts. Such conflicts are inevitable in organizations, and the political process then comes into play to adjudicate such disputes through the use of political power.

AN ORGANIZATIONAL MODEL OF INTEGRATION IN THE LABORATORIES

A model of laboratory integration is given in Figure 1. The individual laboratories define the central position in laboratory operations because of their role in generating test results. The centrality of the various clinical laboratories in Figure 1 should not be interpreted to mean that they are identical to each other. The strongest link among laboratories such as histology, blood bank, and clinical chemistry is that they are usually under the control of pathology and produce test results. The individual laboratories may use different technical processes to produce such test results or, in the case of the blood bank, may generate tests results primarily as a means for providing compatible blood for patients.

Prior to the deployment of a LIS in a hospital, the individual clinical laboratories tend to act semi-autonomously. For example, they often develop their own sets of test requisitions, collect their own specimens, and create their own hardcopy reports. In addition, technologists in each laboratory may respond independently to telephone requests for test results. There is usually no perceived need to standardize the information product emanating from the different laboratories.

The LIS introduces major changes into such an environment. Test
order-entry becomes a specialized function performed by laboratory personnel in a centralized specimen-intake unit or in patient care units. The function of reporting results is transferred entirely to the LIS. The LIS produces daily cumulative hardcopy reports and also provides other computer-mediated reporting applications such as direct on-line user access to the electronic data base through terminals in patient care units or remote stat printing. Laboratory information system personnel are also increasingly bringing "help" functions on-line by providing users electronic access to the laboratory procedure manual.
The easiest way to understand this transition from a lab-centric manual laboratory system to a LIS-centric automated system is to picture the clinical laboratories as information-generating units and the LIS as the means for supporting specimen collection, accepting test orders, and processing and communicating the test results generated within the laboratories to the physician who ordered the test. Rule-based decision support software also will be installed routinely on LISs in the near future. Information is the core product of the laboratories rather than some tangible good. The contribution of the LIS is so integral to the mission and information product of pathology that we consider the creation of the core product of the clinical laboratories as a joint laboratory and LIS endeavor. This arrangement is the basis for the schematic representation of the LIS wrapping around the laboratories, as shown in Figure 1.

LABORATORY INFORMATION SYSTEM AS THE HORIZONTAL INTEGRATOR OF CLINICAL LABORATORIES

Horizontal integration is the process of merging the activities of two or more organizations producing similar goods or services. To be defined as horizontal integration, the merged activities of one of the organizations should be substitutive of those of the other, or the demand for one of the merged organization’s outputs should be affected by the price and quality of the other. Consider, for example, the consolidation of all the clinical laboratories within a single hospital under the control of pathology. This example would be most relevant in larger hospitals in which medical specialists other than pathologists may have established control over some of the core laboratories, or special function laboratories with a limited test menu (“hobby” laboratories) may have evolved. Although the test results produced by any one individual laboratory cannot actually substitute for those of other, clinicians’ experience with one laboratory will definitely affect their perceptions about the entire system. An intrahospital laboratory consolidation initiative thus qualifies as horizontal integration.

Another instance of horizontal integration, interhospital in this case, involves the consolidation of laboratory functions when two hospitals, often a larger one and a smaller one, combine in a formal business partnership and combine laboratory functions as well as other hospital activities. From the perspective of the strategic goals of the hospitals as a whole, such an arrangement may also include elements of vertical integration if the executive officers in the larger facility pursue the venture as a means for ensuring more upstream patient referrals. The venture may also provide downstream opportunities for physicians in the larger hospital to transfer convalescent patients who require less intensive care.
Another form of horizontal integration occurs when the laboratories in a large hospital assume both the testing and managerial functions of the laboratories in a smaller hospital in the absence of any combination of the parent hospitals. Frequently, the formal contract and the development of administrative routines that span the two sets of laboratories will lead to horizontal quasi-integration; that is, the parent hospitals will act as if the laboratories in the smaller facility had been merged with those in the larger hospital. However, such a relationship can be defined as true horizontal integration only if the smaller hospital's laboratories are bound effectively to the laboratories in the larger hospital; that is, true control is established. If the smaller hospital can easily convert to in-house laboratory testing or refer specimens to an outside reference laboratory, the relationship is merely contractual and therefore not horizontal integration.

Horizontal integration should be distinguished from a situation in which a hospital laboratory contracts with an outside reference laboratory for the performance of esoteric tests. Test results from the reference laboratory are then delivered to pathology, most often in hardcopy format, and entered into the LIS data base. This extramural contractual performance of esoteric tests is differentiated from horizontal integration on the basis that the hospital laboratory exercises little control over the reference laboratory other than the threat of taking its business elsewhere.

The managers of reference laboratories fully understand the market potential of performing the bulk of the routine testing for hospitals. They are therefore moving rapidly to implement electronic data interchange (EDI) of test results with hospitals. The prime advantage of transmitting tests results to hospitals in a standard format, including detailed individual patient demographic information, is that the test results can then be easily integrated into the existing hospital clinical data base. Electronic data interchange of test results thus threatens one of the two most important competitive advantages currently held by pathology over outside vendors of laboratory services: the control of the hospital long-term archive of patient test results.

In terms of a strategic response to competitive pressure from reference laboratories, the other major competitive advantage currently enjoyed by hospital pathologists is the ability to provide extremely rapid turnaround time for test results to clinicians. The LIS provides the means to deliver test results rapidly to clinicians, either in their private offices or in the hospital. It is interesting to note that pathologists have never viewed benignly, and as a competitive opportunity, the seemingly insatiable appetite of clinicians for more rapid test result turnaround time. Rather, they tend to regard stat test ordering by physicians as a chronic irritant. The obvious reason for such an approach to the "problem" has been the pathologists' quest for system efficiency, at least from the labo-
ratory point of view, with a dominant emphasis on the batch processing of specimens. Stat processing of specimens does not readily lend itself to batch processing.

The LIS facilitates horizontal integration of the various intramural and extramural clinical laboratories by serving as both the back-end and the front-end for most laboratory operations. In other words, the LIS produces horizontal integration of the laboratories by integrating them vertically. The clinician, as a client of the various laboratories, understands that each laboratory is a separate physical entity, but perceives the information output of the laboratories primarily as a merged (i.e., horizontally integrated) pool of test results managed by the LIS. The LIS also meets the substitutive test for horizontal integration, after its deployment, by assuming the burden of upstream and downstream activities previously carried out by individual laboratories.

BACKWARD VERTICAL INTEGRATION AND LABORATORY INFORMATION SYSTEMS

In many cases, the deployment of a LIS makes it possible for the pathologist to control critical system inputs through backward (i.e., upstream) vertical integration. As shown in Figure 1, upstream inputs can be categorized as either process or product. One of the most important process inputs for the clinical laboratories is the collection and transportation of blood specimens by phlebotomists. The LIS facilitates blood collection by generating lists for the phlebotomy team with the names of all patients with ordered tests, in the most convenient blood-drawing order, accompanied by preprinted test tube labels.

Another example of backward vertical integration in the laboratories that is supported by the LIS, this time in the product category, is drawing blood from donors in the hospital blood bank as an alternative to total reliance on the regional blood supplier for blood inventory. (Our consideration of blood products as tangible product inputs to the laboratory system is consistent with common usage by blood banking professionals, even though regional blood suppliers themselves often refer to their professional activities as the service of drawing blood from a donor rather than providing a product.)

The decision to draw blood from donors locally in hospitals and thus pursue backward vertical integration can result in political repercussions and retaliation from the regional blood supplier. However, the decision to draw blood from donors in a hospital also may have important strategic control advantages for the blood bank in terms of ensuring a more dependable source of blood, and perhaps in some cost savings. Greater upstream control is sought in this instance by the pathologist because the
goals of the regional blood supplier may not overlap sufficiently with those of the hospital blood bank. For example, the regional blood supplier may seek to increase profits at the expense of ensuring what the hospital pathologist may perceive to be an adequate regional blood supply. Profits for the regional supplier are increased by maintaining a lean region-wide inventory of the highly perishable blood products, thus reducing the costs associated with outdated blood. The hospital, on the other hand, will generally advocate that the regional supplier maintain a sufficiently large region-wide inventory to cushion the impact of the inevitable periodic blood shortages.

Other examples of backward vertical integration for the clinical laboratories include the manufacture of test reagents and hospital development of LIS software. These strategies are not common, because external suppliers often can achieve cost-effective economies of scale and scope and because production of some laboratory inputs requires specialized knowledge not held by pathology personnel. A more common example of backward vertical integration is the adaptation of microcomputer shelf software to the information processing needs of the clinical laboratories. This technique is analogous to the adaptation of general purpose analytical test instruments to the specialized testing requirements of the clinical laboratories.

TRUE VERTICAL INTEGRATION VERSUS VERTICAL QUASI-INTEGRATION

Before discussing the relationship of the LIS to forward vertical integration, it is necessary to distinguish between forward vertical integration and forward vertical quasi-integration. At one end of the forward integration spectrum, the laboratories exercise complete ownership and control over the system for distributing the information product to the clinical laboratories and to the end-users. The scope of system here goes beyond the LIS and includes other components such as the hardcopy report distribution system. At the other and non-vertically integrated extreme of the spectrum, the LIS serves primarily as an information satellite for the hospital mainframe computer, receiving all test orders from the mainframe and transmitting test results to the mainframe for reporting of results to the clinicians. The most extreme example at the non-vertically integrated end of the definitional spectrum occurs when all laboratory software runs as a module installed on the mainframe. In such a situation, pathology relinquishes much of its ability to control ordering of tests and reporting of results.

If test orders are entered directly into the LIS, if clinicians sign onto
the LIS for electronic access to test results that are not copied elsewhere, and if hardcopy laboratory reports are generated by the LIS, a semblance of true forward integration is achieved. (This would be a mid-range example.) We equivocate here between the notion of true forward vertical integration and forward vertical quasi-integration with regard to our mid-range example, because the laboratories generally do not achieve true ownership of either the LIS, which usually is paid for by the hospital, or the hardcopy report distribution system in the hospital. Therefore, the concept of forward vertical quasi-integration is generally more applicable to the clinical laboratories and the LIS than is pure forward vertical integration.

This concept of forward quasi-integration also can be applied to the relationship between the clinical laboratory and the end-users of test results, primarily hospital clinicians. Because the laboratories do not control the clinicians who order and use test results, there can be no true forward vertical integration of the laboratories to the clinicians. Nevertheless, the deployment of a LIS does establish a form of forward quasi-integration into the hospital patient care units and private physician offices.

The degree of control exercised by the laboratories over clinicians and other end-users such as nurses consists of the quasi-monopoly awarded to pathology to perform tests within a hospital. However, every pathologist rapidly comes to understand that the quasi-monopoly held by pathology is relatively tenuous and continues in force only at the sufferance of hospital clinicians and hospital administrators and only as long as both groups continue to be satisfied with the laboratory's performance. The LIS can actually help to perpetuate the quasi-monopoly awarded to pathology to the extent that it enhances the quality of laboratory services provided to users. The second element of control maintained by the clinical laboratories consists of the natural tendency to try to avoid the switching costs and organizational disruptions that would be experienced if the methods of generating, distributing, and consulting on test results in the hospital are changed.

ORDER-ENTRY, RESULT-REPORTING, AND LABORATORY INFORMATION SYSTEMS

We have made the following points thus far in our discussion of forward vertical integration: (1) the clinical laboratories are forward quasi-integrated rather than forward integrated, because the laboratories do not own the LIS and cannot control the clinicians' test-ordering patterns, (2) this forward vertical quasi-integration is primarily mediated
by the LIS through front-end value-added features such as results reporting, (3) front-end features provided by the LIS enhance the quasi-monopoly of pathology and inhibit competition by increasing the value of the information product of pathology to clinicians and increasing the cost of switching to another system.

It is not necessarily intuitive to consider the ordering of laboratory tests as a front-end application rather than a back-end system input. For the purposes of our model, however, we describe all communication channels between the LIS and end-users of laboratory services as front-end applications. The laboratories have a relationship with the supplier and therefore an upstream relationship with the clinician. In contrast, back-end components for laboratory operations relate mainly to specimen, reagents, and testing equipment inputs to the clinician. Although physicians have a downstream relationship to the laboratories, they have a simultaneous upstream relationship to the hospital when they admit patients to the hospital; that is, they act as suppliers of patients to the hospital.

The concept of front-end electronic communication channels between clinicians and pathologists will be increasingly useful when electronic mail becomes an important means for consultations between the two groups. Notification to clinicians about urgent matters such as "panic" laboratory values, triggered by decision-support rules constantly scanning the laboratory data base, will also be mediated through hospital electronic mail. In other words, increasingly sophisticated LIS technology will continue to enhance the value-added features supplied through these front-end communication channels.

Each of the front-end LIS applications of entering orders, reporting results, and storing long-term results has a different strategic value for the pathologist and the clinician. Least important, in terms of added value for both groups, is electronic order-entry directly from patient care units, assuming the laboratory’s manual test-ordering system is satisfactory. No efficiencies are gained by the laboratories in expediting test ordering electronically because test performance must always await the arrival of the specimen in the laboratories. Allowing electronic ordering of tests from patient care units also shifts the responsibility for test ordering from pathology personnel to patient unit personnel, an undesirable net loss for the laboratories in terms of forward integration and control.

The most strategically important component of LIS-mediated forward integration is results reporting, both in hardcopy and electronic formats, because it increases the efficiency of clinicians by enhancing test turn around time and providing better organization of test results for clinicians. An older LIS may automate intralaboratory operations and thus satisfy pathology personnel by increasing their efficiency; however, it may not optimize front-end applications from the perspective of the
hospital clinicians. By maintaining an older LIS, the pathologist may fall prey to the competency trap\(^5\) and undermine the political support among the hospital clinicians for pathology's quasi-monopoly on laboratory testing.

The strategic value of maintaining a long-term laboratory test archive is particularly important for the clinical laboratories in a tertiary care teaching hospital with a large ambulatory care patient load, rapid turnover of house officers, complex patient needs, and perhaps an inefficient paper medical record system. In such an environment, a high premium is placed by clinicians on long-term electronic access to previous test results. Providing such a service for clinicians enhances the efficiency of medical care delivery and increases the switching costs of abandoning the stand-alone LIS.

We have emphasized the need for the clinical laboratories to increase the efficiency and effectiveness of clinicians and satisfy them and that the LIS can help to achieve this goal. It is important to recognize that LIS obsolescence can be a barrier to increased effectiveness. Therefore, pathologists must incorporate LIS replacement planning into their formal strategic objectives. In the past, a common approach to investment in LIS hardware and software has been to purchase a turnkey LIS and then depreciate it over a period of 5 or more years without a software or hardware upgrade. The pursuit of such a strategy makes it inevitable that the LIS will function suboptimally in the latter years of its depreciation cycle.

This situation has now changed, at least from the software point of view, because successful LIS software vendors support an active research and development program and continuously provide hospital clients with software upgrades and new versions of software. We favor a shorter phased hardware upgrade cycle to maintain peak system performance as the number of system users grows and as the software functions increase. Unfortunately, it may be difficult to wean hospital financial personnel from their traditional capital depreciation cycles.

Incremental upgrades in hardware and software will provide better service to clinicians and decrease the likelihood that the hospital administration will seek a change in the laboratory testing and information processing system. In part, the hospital administration may be reluctant to switch because of the money already spent on the LIS. More important, though, is the comparison of future costs to future service improvements. If the current LIS is providing state-of-the-market service, the incremental advantage of investing in an entirely new system such as a mainframe LIS module or a contract with an external reference laboratory is much less. If the LIS is upgraded regularly, the costs of reorganizing the laboratory information processing system imposed on the administration are likely to exceed the benefits that would be obtained by supporting current LIS operations.
INTEGRATION AND ROLE OF LABORATORY INFORMATION SYSTEMS IN MARKET SEGMENTATION

A major goal of forward vertical quasi-integration in the clinical laboratories is to establish some degree of influence over the clinicians and other health care professionals in the hospital in which the laboratories are based. This goal is achieved, in part, by providing front-end value-added features that help bond current hospital clients to the laboratories. Hospital laboratories that desire to remain competitive should also seek to modify or enhance their information product to appeal to new market segments. New market segments for some larger hospital laboratories include reference laboratory business for smaller hospitals in the same geographic region, or esoteric testing and tissue diagnosis for those commercial reference laboratories that prefer to perform high-volume batch-oriented tests. Another rapidly emerging, and potentially important, set of clients for the information product of the laboratories are the hospital administrators.

Hospital administrators are already indirect laboratory clients in the sense that the LIS captures charges for laboratory test performance that are passed to the hospital mainframe computer. Such information is critical for those administrators charged with responsibility for the financial well-being of the hospital. Administrators are also indirect clients of the laboratories in the sense that they must support the medical practice needs of hospital clinicians. However, administrators are also becoming direct clients of the laboratories because third party payers, government agencies, and accrediting agencies are demanding retrospective, and even real time reports, on laboratory test utilization. One example is the requirement of the Joint Commission on Accreditation of Healthcare Organizations that hospitals monitor the transfusion of all blood and blood components.

It is strategically very important for pathologists to cultivate hospital administrators as a new market segment for the information product of the clinical laboratories. This approach could be described as forward vertical quasi-integration into the executive suite of the hospital. Once again, the LIS plays a pivotal role in the development of the strategy. Newer LISs come equipped with data base management software that is used to create recurring or ad hoc reports on test utilization. Examples include test utilization by diagnosis-related group (DRG) or test ordering patterns by clinicians.

SUMMARY

An understanding of horizontal and vertical integration and their quasi-integration variants is important for pathologists to formulate a
competitive strategy for hospital clinical laboratories. These basic organizational concepts, in turn, are based on the need to establish control over critical laboratory inputs and outputs. The pathologist seeks greater control of mission-critical system inputs and outputs to increase the quality and efficiency of the laboratory operations. The LIS produces horizontal integration of the various hospital laboratories by integrating them vertically. Forward vertical quasi-integration of the laboratories is mediated primarily by the LIS through front-end valued-added features such as reporting of results and creating a long-term on-line test result archive. These features increase the value of the information product of pathology for clinicians and increase the cost of switching to another system. The LIS can also serve as a means for customizing the information product of the laboratories to appeal to new market segments such as hospital administrators.

GLOSSARY

Back-end functions: Synonymous with backward or upstream activities.
Backward (upstream) vertical integration: Internal production of physical inputs or internal provision of services that might otherwise be purchased from independent suppliers.\(^{10}\)
Core product: The physical good or non-physical service that an organization defines as its primary output.
Economies of scale: Reduction in average fixed cost achieved by using the same production equipment and systems to produce more units of the same type of output.\(^{10}\)
Economies of scope: Reduction in average fixed cost achieved by using the same production equipment and systems to produce more units of different types of output.\(^{11}\)
Electronic data interchange (EDI): Computer-to-computer transmission of business data in a standard format. A business management strategy for exchanging information without the use of paper, mail, facsimile, or teletype.
Forward (downstream) vertical integration: Provision of the distribution operations by the producer of a good.\(^{10}\)
Front-end functions: Synonymous with forward or downstream activities.
Horizontal integration: Combining two or more organizations that produce the goods or services that have a high cross-elasticity of demand; that is, the products are substitutes for each other or the price or quality of one will affect the demand for another.
Horizontal quasi-integration: Achieving control or significant influence over the provider of similar products without undertaking formal ownership of the provider.
Integration: Unification or combination into a whole.
Market segments: Groups of buyers, each group having a similar set of demands for product characteristics, price, distribution channels, and service.\textsuperscript{6}
Monopoly: Sole supplier of a physical good or service.\textsuperscript{10}
Product: A thing made, implying a physical good or nonphysical service. See core product.
Quasi-: Seemingly, but not actually.
Quasi-monopoly: Sole effective supplier of a physical good or service because access to existing alternate suppliers is blocked by contracts, habits, switching costs, or other barriers.
Sunk cost: A past cost that is unavoidable because it cannot be changed no matter what action is taken.\textsuperscript{7}
Switching cost: Resources that must be used to change suppliers. Examples include the cost of new supporting products such as software or time and money in training new employees to deal with a new supplier.\textsuperscript{8}
Transaction-specific resource: Special-purpose technology.\textsuperscript{13}
Vertical integration: Production by an organization of its own inputs (backward or upstream integration) or distribution of its own outputs (forward or downstream integration).\textsuperscript{6}
Vertical quasi-integration: Achieving control or significant influence over the provider of inputs or distributor of outputs without undertaking formal ownership of the supplier or distributor.\textsuperscript{2} The definition can be extended to achieving control over the user of outputs. A variant definition applies to situations in which a firm owns physical assets used by its suppliers or customers.\textsuperscript{9}

REFERENCES


Address reprint requests to:

Bruce A. Friedman, MD
Department of Pathology
University of Michigan Medical School
1301 Catherine Road
Ann Arbor, MI 48109-0602