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"Professional Regulation, Technology and the Division of Labor: A Historical
Analysis of X'Ray, Ultrasound and Clinical Pathology"

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Professional Regulation, Technology, and the Division of Labor in
Health Care: A Historical Analysis of Trends in
Diagnostic Radiology, Ultrasound, and Clinical Pathology

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Comments Welcome.

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Abstract

This paper explores the role of technology, market forces and professional regulation in shaping the division of labor in health care. The focus is on the production of complex diagnostic services in radiology, ultrasonography, and clinical pathology. Historical trends in the division of labor in these areas are examined and compared at three levels: 1) between medicine and lay experts and administrators; 2) within medicine between specialists and between specialists and generalists; and 3) between medicine and subordinate technical support personnel. Experiences vary significantly. Possible implications of findings for the future are discussed.

Since the late nineteenth century, medicine has been transformed from a cottage industry into a large and complex enterprise. In the process, major changes have occurred in the division of labor and the organization of production. One hundred years ago, technology was largely limited to the contents of the doctor's black bag. There was little use of technical support personnel. Most medical care was provided directly by autonomous general practitioners in solo practice. Patients were treated in their homes or in doctors and paid for services directly out of pocket on a fee-for-service basis.

Since the turn of the century, medicine itself has become increasingly specialized. More and more physicians have limited their practices to particular clinical or technical areas. There has also been a growing delegation of technical tasks to subordinate personnel and increased use of lay (non-medical) technical experts. Finally, production of many health care services has become centralized in hospitals and clinics, as has payment for services with the spread of third party payment since World War II.

Despite growing specialization in medicine and centralization of the production of and payment for services, until very recently physicians both individually and collectively have retained a high degree of professional autonomy. This has occurred through the emergence of a bifurcated system of control. Under this system as it existed until the late 1970s, hospitals have provided a growing share of inputs- nursing staff, technical support personnel and capital equipment. But self-employed, autonomous physicians have

retained control over the coordination of clinical decision making subject only to the review of their peers.

This system basically still remains in place. But during the past decade, in the face of mounting cost pressures there has been a growing trend towards reduced physician autonomy and increased centralized control over clinical decision making. More and more physicians have become employees of organizations like HMOs and increasingly provider organizations and third party payers are seeking to monitor physician performance. This paper seeks to provide a better historical basis for examining the implications of recent trends for the division of labor.

Along with broad social and political forces, previous studies have identified technological change, market forces, and professional regulation as important factors in explaining trends in the division of labor in health care (cf. Starr 1984). However, discussions of the role of these various types of factors in the literature has usually been at a general level or have focused on one area of medicine. There has been relatively little in depth comparative analysis of possible interactions between factors.

This paper seeks to explore in detail historical trends in the division of labor in three rapidly growing, technology oriented areas of medicine: diagnostic radiology, diagnostic ultrasound, and clinical pathology. Analysis focuses on the interactions between technological changes, professional regulation and market forces at a micro level, drawing both on economic models and the sociology literature on professionalism.

Diagnostic radiology, ultrasound, and clinical pathology were selected for study because while sharing many common features, the division of labor has evolved in significantly different ways within these areas. The starting point for analysis in each case is the emergence of well defined new area of work. In order to keep the study manageable, 1980 was selected as an end point. Although there is some discussion of subsequent events, no attempt is made to encompass the rapid changes of the past decade.

There are many possible ways to categorize the division of labor, such as gender, type of tasks performed, etc. The approach adopted for the purposes of this analysis is to focus on occupational divisions. Changes in the division of labor are examined at three levels: 1) between medicine and lay experts and administrators; 2) within medicine between specialists and between specialists and generalists; and 3) between medicine and subordinate technical support personnel.

Section I briefly discusses economic theories of the division labor and professional regulation and the sociological literature on professionalism. Section II presents the results of historical case studies of trends in the division of labor in the three areas selected for study. Section III compares and contrasts these experiences. The paper concludes with a discussion of the possible implications of findings for the future.

I. Theoretical Framework:

Standard economic models suggest that the division of labor is likely to increase in response to 1) the existence of economies of

scale from specialization and 2) market size (the effective demand for services in relevant market areas). Thus, new technologies may lead to a greater division of labor if they increase potential gains from specialization, for example from performing repetitive tasks in producing laboratory tests. At the same time, an increase in market size may also lead to greater specialization if it increases opportunities for realizing economies of scale (e.g. increasing concentration of population in large urban areas and reduced transportation costs may boost the total demand for tests). Conversely, smaller market size suggests a worker is more likely to be a jack-of-all-trades (the rural physician). Finally, the division of labor may reflect changes in factor costs (e.g. the relative costs of skilled and unskilled personnel and capital equipment).

In addition to technological and market forces, the division of labor may also be affected by institutional arrangements. In the health care industry, historically perhaps the single most important institutional feature has been professional regulation, broadly defined here to encompass both public and private systems for controlling the use of occupational titles and the division of labor between occupations. Not only physicians, but also a wide range of other health care occupations are subject to occupational licensure and/or voluntary certification and to personnel standards based on these systems (e.g. hospital accreditation standards).

Traditional "public interest" models of economic regulation suggest that professional regulation may be introduced to increase

economic efficiency in the face of problems with imperfect information. Focusing on physicians, Arrow (1963) and others have suggested two types of issues are involved: First, it is often difficult for consumers to evaluate their need for health care services; Second, consumers lack the expertise to evaluate the quality and appropriateness of services received.

Arrow (1963) and others (cf. Dranove and White 1987) argue that in medicine, the first problem leads to the use of physicians by patients not just to provide services, but to act as their agents. The second problem leads to professional regulation as a means of controlling abuses of the doctor/patient relationship. In this context, major features of professionalism-- agent autonomy, certification, peer review (Arrow 1963), institutions for professional socialization (cf. Freidson 1977), and even restrictions on total entry may all be seen as methods of addressing agency problems. (Arrow 1963, (Leland 1980). Conversely, agency models suggest that if underlying informational problems regarding the evaluation of services, so should the degree of professional regulation.

By extension, White and Marmor (1982) argue that efficiency considerations may also lead to professional regulation of subordinate support personnel. Physicians and hospitals are presumably more knowledgeable than consumers in hiring personnel and do so on an ongoing basis. But informational problems still exist in evaluating qualifications and performance. White and Marmor suggest that the bifurcated system of control in hospitals

creates incentives to address these problems through professional regulation, rather than through hierarchical systems of administrative control such as those employed in manufacturing firms.

Efficiency considerations are not the only possible reason that professional regulation may be introduced. "Economic" models of regulation suggest that rent seeking activities by occupations may also shape regulatory institutions, potentially to the detriment of those they supposedly serve (Stigler 1971, Peltzman 1976). For example, physicians or members of a subordinate health occupation may try to increase entry restrictions for their own benefit at the expense consumers.

"Economic" models predict that success of such efforts will depend on 1) the total magnitude of losses and gains anticipated by occupations and the purchasers of their services as a result of regulation, 2) the distribution of these losses and gains with groups (i.e. the extent to which there are concentrated gains for individual actors from supporting or opposing regulation) and 3) the costs of political action to groups. Economic models in particular predict that regulatory process is most likely to be "captured" by a occupations if 1) purchasers of an occupations services (and members of rival occupations) are poorly organized, 2) the impact of regulation on them is diffused, and 3) members of the occupations itself are well organized and anticipate concentrated gains.

Economic models of regulation do not rule out market failure

considerations as motives for regulation. But they suggest that the process by which systems of regulation evolve may be quite complex,

Turning to the sociological literature on professions, early studies focus on categorizing occupations in terms of "ideal types" (**). In this literature, the existing division of labor is usually taken as given and there is little attempt to analyze the functional role of professional institutions. However, more recent studies such as Halpern's (1989) of pediatrics have sought to examine role of professional regulation in shaping the division of labor over time and possible interactions with technological and market forces in this process.

In this context, several general organizational features of professional regulation in the health care industry are relevant to this research. First, public and private systems of regulation tend to be closely linked. Second, as Halpern (1989) observes, they have tended to evolve in a complementary fashion, new institutions building on old ones, rather than replacing them. Thus, the system of medical licensure developed in the late 19th and early 20th century provides the foundation for modern systems for credentialing specialists in specific areas of medicine. Third, systems of regulation have tended to develop in a hierarchical fashion. Superordinate occupations, particularly physicians, have historically played a major role in establishing and operating voluntary systems of regulation for subordinate personnel, in the process helping to shape the types of tasks

delegated to these personnel.

II. Historical Case Studies:

As noted, while diagnostic radiology, ultrasonography and clinical pathology share many common historical features, there are marked differences in the development of the division of labor. This section summarizes historical trends in the division of labor in each area at a descriptive level. Possible explanations of these trends are explored in the comparative analysis which follows.

o Radiology:

Diagnostic radiology encompasses a variety of imaging techniques, including X-rays, computerized tomography, magnetic resonance imaging and, to a degree, ultrasound. X-ray is the oldest of these techniques and the focus of discussion here, where a discussion of ultrasound follows. Sometimes clinicians ordering X-rays "read" them themselves. But historically, the service provided has been not simply an image, but a clinical interpretation of this image by a radiologist.

X-rays were first discovered in 1895. While they almost immediately they won acceptance as a clinical tool, at first poor equipment, safety problems, and the need for considerable skill to interpret them limited their application. But by the early 1920s, these problems had been largely overcome and their the use in routine clinical practice began to rapidly expand.

No figures are available on X-ray volume until after World War

II. However, the number of physicians listing radiology as a specialty gives an indication of the pattern of expansion. In 1913, only a few hundred physicians appear to have been specializing in radiology, most of them on a part time basis (Brecher and Brecher 1969 p. 109). In 1931 the AMA Medical Directory listed 1005 physicians specializing in radiology,. By 1938, this number had increased to 2191, with more than 75 % estimated to be working full time (Brecher and Brecher 1969 p. 211-12). As of 1987, the total number of physicians specializing in radiology was 26,000 (AMA 1987). Mettler (1987) estimates the total number of diagnostic X-rays grew from 109 million in 1964 to 136 million in 1970 to 180 million in 1980.

Production of X-rays has taken place in two main settings: hospitals and doctor's offices. No data exist on relative volume until recently. However, by the 1920s, most hospitals had X-ray departments serving their inpatients and also some outpatients. As of 1980 the total share of X-rays produced in hospitals was 73 %. For outpatients alone, who accounted for slightly under 60% of all X-rays, more than half were produced in hospitals (Mettler 1987).

In hospitals, from the beginning production was typically centralized in a single unit serving all areas of the hospital. This arrangement created obvious inconveniences because the presence of patients was required to perform examinations. This meant transporting them, sometimes significant distances, which would not have been necessary, at least to the same degree, if services had been provided in a decentralized fashion on hospital

floors. For outpatients, using hospital X-ray departments meant a separate trip to the hospital unless their doctor's office was located in the hospital.

Three major trends stand out in the division of labor in radiology: 1) physician dominance over the field; 2) the emergence of radiology as a technical specialty; and 3) growing delegation of technical tasks to subordinate technical. Paralleling these developments has been the growth of professional institutions for physicians and technical personnel in the field.

In the early years of radiology, physicians faced some competition from lay practitioners. Some had little training. But others, for example those with degrees in physics, had claims to superior technical expertise in the technical side of production. Nevertheless, by the 1920s Medicine had clearly come to dominate the field. Today, while technical experts in areas like physics are routinely employed in many X-ray facilities, it is always in a subordinate position.

Possible factors contributing to the domination of the field by medicine include 1) direct involvement with patients in performing examinations and 2) the need for specialized knowledge to interpret X-rays. There was, for example, the potential need for medical judgement in positioning patients. In any case, as Reiser (1978) observes, despite an association with "objective" "scientific" medicine, X-rays required not only technical skill, but also a significant element of art and clinical judgement to interpret them. A lay practitioner attempting to provide this

service could have been held in violation of medical licensure laws and any case would have had to approximate a medical education.

The emergence of radiology as a technical specialty and the emergence new professional institutions are closely linked. Beginning in 1900, a series of professional associations were established. These organizations provided members not only with a opportunity to exchange information, but also a loose form of certification. Formal recognition from organized medicine came more slowly. The official position of the AMA was that radiology was simply an adjunct of other areas of medical practice. Not until 1925, were radiologists able to prevail on the AMA to permanently establish a separate study section (Brecher and Brecher 1969).

This bridge crossed, radiology was one of the first medical specialties (1934) to establish a system of board certification under the auspices of the AMA. This provided the basis for establishing a unified set of voluntary standards for post-graduate training and certification for radiologists. And overtime, this framework has provided a basis for recognizing new areas in the field such nuclear medicine.

Following the general pattern within American medicine, however, no legal controls have been established over the practice of radiology by physicians. In fact, at the time board certification was established, state licensure for radiologists was explicitly rejected by radiology professional groups. At least in part this appears to have been because of concerns that this type

of regulation might serve as vehicle for competing claims of groups of physicians outside the mainstream of radiology (). But hostility of the rank and file of American medicine to attempts to directly restrict their scope of practice, already manifested in response to the American College of Surgeons bid for specialty licensure before World War I (Stevens 1971), probably was also a factor.

Significantly, while most radiologists are now certified, there is still a large group claiming to specialize in the field who are not (about a quarter in 1981) (AMA 1984). And some non-specialists continue to produce X-rays in their offices.

Paralleling the emergence of professional institutions for radiologists, increasing use of technical support personnel was accompanied by the establishment of a voluntary registry for these personnel in 1920. This registry provided a framework for certifying personnel and standardizing training. Set up under the aegis of radiology professional groups, the primary requirement of its original code of ethics was that technician only work under the supervision of a qualified professional (ARRT 1972). Subordinate personnel organized their own professional group during the same period and over time have sought a growing voice in the registry to push up standards. In the face of opposition from radiologists to these efforts, there has been a growing trend to turn to state licensure as an alternative means of effecting standards. As of 1985, radiology support personnel were licensed in 12 states (Akey 1987).

At least on the surface, the emergence of specialized technical occupations in radiology seems to flow from the emergence of radiology itself as a technical specialty. This, however, begs the question of why radiology itself developed as a technical specialty, rather than an adjunct of clinical specialties, as envisioned by the AMA.

One explanation is that this pattern was dictated by the need for specialized expertise in interpreting X-rays, as well as sometimes the need for medical judgement in performing them. Claims to such expertise were not only recognized by other medical specialty groups, particularly the powerful American College of Surgeons, but reenforced through such means as the College's hospital accreditation standards (). In this context, centralized X-ray departments may be seen as way of realizing economies of scale associated with centralizing this medical expertise.

However, technological factors also seem important. Early X-ray equipment was not very costly. But the shielding necessary to protect patients and operators was, sharply pushing up the necessary capital investment. For instance, when St. Louis City Hospital opened a new X-ray department in 1924, the cost of equipping it alone was estimated at \$100,000 (Sante 1924). High set up costs created significant economies of scale, making centralized facilities economically attractive despite the inconvenience of having to move patients around the hospital.

These two explanations are not mutually exclusive. Both hinge

on the existence of economies of scale which could reenforce each other. The main issue is their relative importance, where it is difficult to disentangle them by looking at radiology alone.

The very success of radiologists in establishing themselves as a technical specialty paradoxically exposed them to a major attack on their autonomy by hospitals beginning in the 1930s. Basically, hospitals sought to subordinate hospital based radiologists to lay administrators and turn them into employees. Their primary motive appears to have been to capture a greater share of the revenues from X-rays, which were becoming a profitable area.

By in large these efforts failed, although not without a bitter conflict. Radiologists success in fending them off was partly a result of their ability to use professional sanctions against radiologist who broke rank. However, a second key factor appears to have been economic- a failure of hospitals to offer adequate compensation to attract physicians. Here, a important factor may have been institutional constraints. More investigation is needed, but salaries in non-profit hospitals typically were low, while the types of alternative compensation arrangements common today were not available.

One feature of radiology, in common with clinical pathology, which has made it unusual compared to other areas of medicine is that objective quantitative measures exist of some aspects of performance. In particular, it is possible to measure patient (and operator) exposure to radiation. Exposures to significant unnecessary levels of radiation have been widely documented ().

Potentially, this type of quantitative measure of performance could have been incorporated into professional standards. And the extent performance was lower for non-specialists, it could have served as a means of limiting competition. In practice, this has not happened. In part, reluctance may be explained by a desire not to incur the ire of the rank and file of medicine. However, perhaps more importantly, radiologists appear to have been reluctant to expose themselves to this type of monitoring.

One consequence of this reluctance to directly address quantifiable quality problems has been to add impetus to efforts to introduce external public regulation of quality by non-professional bodies. The Radiation Control for Health and Safety Act of 1968 is one example of such legislation, more recently followed by the Consumer-Patient Radiation Health and Safety Act of 1981. An interesting dimension of the latter act is that includes provisions tying in with efforts by technical personnel to promote state licensure.

o Ultrasound:

Ultrasound, like X-rays, is basically an imaging technology. The basic product produced is a test result which takes considerable expertise to evaluate and interpretation is generally part of the service provided. As ultrasound is a much more recent innovation than X-rays, its history is accordingly briefer. Development began in the late 1940s. But clinical applications did not occur on a large scale until the 1970s, when it became possible to produce multidimensional images. Combined with the fact that to

date, there are no significant known safety risks, this has made ultrasound the technique of choice in areas such fetal exams, while it is widely used in cardiology and in abdominal applications.

No volume figures on ultrasound are available. But one indication of their overall level of clinical usage is that in 1982, when the American Hospital Association first started collecting data on this area, 73% of all short-term hospitals reported providing ultra-sound services. For hospitals over 150 beds, this share was over 96% (AHA 1983).

Along with hospitals, ultrasound images are also produced in doctor's offices. No volume break downs are available as a basis for evaluating relative shares. One qualitative differences which does stand out compared to radiology, however, is that within hospitals, ultrasound equipment appears to often be decentralized. Sometimes units are located in radiology departments. But there are also often dedicated units located in clinical departments such cardiology and obstetrics.

Looking at trends in the division of labor, again medicine is the dominant group, while large scale delegation of technical tasks to subordinate personnel has occurred. However, within medicine, rather than being the province of a single specialty, the division of labor has been highly controversial. Radiologists have sought to claim the technology as an imaging technique. Clinical specialties, however, have rejected these claims, arguing it is more appropriately treated as an adjunct to their practices.

One consequence of these controversies is that no unified

system of credentialing has emerged for physicians in ultrasound. An umbrella professional group exists whose membership includes lay technical personnel as well as physicians. Established in 1951, this group has sought to address such broad issues as the overall safety of ultrasound (). But no unified system of voluntary credentialing has been established within medicine. Instead, radiology and clinical specialties such as obstetrics each require competence in the area, but it makes up only a small part of their examinations for board certification.

Interestingly, this pattern of fragmentation has not extended to technical support personnel. An umbrella professional group was established in 1969. This group lead the way in negotiating with the AMA to gain recognition for "sonography" as an occupation (1974) and to set up an accreditation program (1979). It also established a registry in 1975 certifying competence in basic sonography and in various clinical specialty areas ().

One notable feature of this voluntary system of credentialing is that while medical specialty groups joined with sonographers in setting in drawing up accreditation standards, from the start they have dominated the board of their registry. Their relatively high degree of autonomy in part reflect a general trend in this direction for subordinate personnel. But the lack of unity in the medical profession also seems a factor. Licensure of sonographers has not been an issue.

One explanation of the high degree of fragmentation within medicine regarding ultrasound is lack of consensus over questions

of expertise. Part of the issue is experience in interpreting images *per se*, but generally debate has focused on questions of underlying training. Radiologists concede that where single organ systems are involved, as in echocardiology, they may not have special claims. But where multiple organ systems are involved, for instance in fetal monitoring, they argue their expertise is superior to that of clinical specialties oriented towards one organ system (Birnholtz 1985). That groups such as obstetrics have not accepted this view is self-evident.

But fragmentation may also be traced to technological factors. In particular, the kind of economies of scale associated with radiology due to the high fixed costs associated with installing shielding for X-ray equipment are absent. This removes an economic barrier to the use of freestanding units by competing specialists.

In ultrasound there are no well defined quantitative measures of performance. Hence there has been no question of incorporating such measures into systems of professional regulation. Nor has there has not been any attempt to introduce external public regulation of quality of the type seen in radiology. To date, there has been no question of specially subordinating of medical specialists in ultrasound to lay administrators.

o Clinical Pathology:

Unlike radiology and ultrasound, no single innovation is associated with the emergence of clinical pathology. It embraces a wide range of different types of diagnostic tests and has

developed incrementally. Major areas of clinical pathology include histology (laboratory examination of tissue samples), cytology, hematology (examination of blood materials), clinical chemistry, and clinical microbiology. The focus here is on the last two areas.

A common feature of clinical pathology is that tests entail detailed laboratory analysis of specimens of body materials, in contrast to anatomical pathology, which entails visual examinations. Particularly in the case of clinical chemistry and microbiology, 1) patients usually do not have to be present for tests- it is sufficient to send a specimen to a lab, 2) tests are generally performed by technical support personnel and 3) no clinical interpretation of test results is usually provided to clinicians ordering them.

Laboratory tests began to become a routine part of clinical practice in the period around World War I and like X-rays, their increasing use was closely associated with the rise "scientific" medicine. By the 1920s, clinical laboratories were becoming a standard feature of American hospitals. Growth in test volume has been especially rapid since the 1960s, when efforts began to automate laboratories. To date, automation has occurred primarily in clinical chemistry and hematology, but major changes now appear pending in microbiology as well.

Historically, clinical laboratory tests in clinical chemistry and microbiology have been produced in three main locations: hospitals, doctor's offices and independent commercial

laboratories. Typically, hospital laboratories have been centralized with volume depending on total hospital size. Doctor's office laboratories have tended to be quite small. The size of independent laboratories has varied. Some are quite small, but others have quite high volumes. Organizational structure has also varied and has been changing over time. In the past most were freestanding. More recently, their ownership has increasingly become concentrated in the hands of large corporate chains.

Current test volume has been estimated to be as high as 3 billion tests a year (Wagner 1988). In recent testimony, the Inspector General of the Department of Health and Human Services has estimated that there are 6,600 hospital labs, 4,500 independent labs and approximately 98,000 doctor's office labs. The volume of labs in the last group tends to be low, where it is estimated that only 25,000 doctor's office labs do more than 5,000 tests per year (Kusserow 1988). However, it has also been estimated that volume in office labs has recently been expanding at a rate as high as 16% per year, where this increase at least in part appears linked to the availability of new small scale automated equipment (Fischer 1988).

At least one important measure of performance, test accuracy, can be qualitatively measured for clinical laboratories. Studies indicate a positive association between volume and accuracy (). There is also evidence of decreasing marginal costs in laboratories (). This suggests laboratories may be able to achieve economies of scale with respect not only to cost, but also quality as volume

increases.

Major features in the division of labor of in the clinical chemistry and microbiology areas are: 1) lay competition with physicians in the supervision of the production of laboratory tests, primarily as directors of independent laboratories, but also in hospitals; 2) the emergence of clinical pathology as a specialty within medicine, where pathologists experienced (and successfully resisted) an attack on their autonomy by hospitals similar to that in radiology; and 3) delegation of technical tasks to subordinate personnel. As in other fields, these patterns have been paralleled by the development of new professional institutions, some within medicine, but others outside of it.

Lay laboratory directors have included not only graduates of academic programs in chemistry and microbiology, but also subordinate technical personnel. Historically, the use of lay directors has been greatest outside hospitals in independent labs. Hospital labs have generally been the province of clinical pathologists, who, like radiologists, emerged as a specialty group in the period around World War I. Labs themselves have been staffed with technical support personnel. These personnel have performed the technical tasks involved in producing test. Especially in smaller hospitals, they have also had significant responsibility for overall supervision of the day to day activities of laboratories, where pathologists have often managed more than one hospital lab.

Clinical pathologists became organized as a group in 1921. In

1929, under the auspices of this group, a registry for technical personnel was established in 1929. The establishment of this registry was followed by the founding of a professional group for technical personnel in 1933. The subsequent history has been one of conflict over control of the registry and personnel standards, as well as provisions by the registry forbidding personnel to work for lay laboratories. Since the 1960s, the focus of these conflicts has been expanded through efforts by technical personnel not only to directly challenge voluntary standards, but to introduce occupational licensure laws at the state level (White 1979).

Within medicine, there has been little dispute over clinical pathologists claims to the laboratory area. Rather, powerful groups, particularly the American College of Surgeons, have sought to reenforce these claims. For example, the College included obtaining the services of a pathologist as a laboratory director, even if only a part time basis, as one of its requirements for hospital accreditation.

These efforts help to explain why even though lay technical experts with laboratory specific training may have had greater claims to expertise, they were not employed as laboratory directors in hospitals. In particular, the College of Surgeons primary motive in requiring a hospital association with a pathologist appears to have been to assure watchdog activities such as autopsies and examinations of tissue removed in surgery would be carried out. However, these services were rarely income producers.

White (1979) suggests guaranteeing pathologist control of clinical labs, which were generally profitable, was an important concern as a means of cross-subsidization.

Concerns about maintaining pathologists' independence may also have played a role in gaining medical groups' support in pathologists struggles with hospitals over their autonomy in the 1930s. Again, however, the question may be raised whether the decisive factor was professional concerns or the issue of compensation within the context of the constraints existing on non-profit hospitals.

Outside hospitals, the continuing role of commercial laboratories seems linked to two quite different factors. Both hinging on an unwillingness of clinicians to boycott them completely. One ongoing factor appears to be related to financial and service considerations. Commercial labs had more incentive to tailor their services to the needs of physicians in outpatient practice. Also, physicians did not need to share billings with hospitals. Against this, however, was the need to weigh quality considerations, where the same basic arguments exist regarding doctor's office labs.

Ironically, a second argument for using commercial labs is improved quality. Specifically, large, high volume independent labs with specialized expertise potentially offer superior performance. In particular, this likely to be the case where volume is low because a hospital is small, or because a test is infrequently ordered.

The issue of test accuracy has repeatedly attracted the attention of regulators. While clinical pathologists have long operated a voluntary proficiency testing program, there has been little attempt to rigorously integrate this type of performance measure into existing systems of professional regulation within medicine. This reluctance, coupled with ongoing evidence of problems, has helped to open the way for a variety of efforts to regulate quality directly through external public regulation at the federal, state and local level. Subordinate personnel and lay technical experts have often played a role in these efforts. And not infrequently, one outcome has been personnel standards reflecting claims by these groups regarding the appropriate division of labor competing with those put forward by pathologists.

III. Comparative Analysis:

While not all of the issues raised fit neatly, (e.g. the role of external public quality regulation), the occupational distribution of labor provides a useful framework for comparing and contrasting experiences described in historical case studies.

o Medicine and Lay Experts:

Lay technical experts have existed with claims to superior expertise regarding technical aspects of testing in all three areas studied. At administrative level, however, they only emerged as competitors to physicians in the clinical laboratory area; in radiology and ultrasound, their role remained primarily consultative.

Professional regulation clearly played an important role in

restricting the use of technical experts, for example as directors of clinical laboratories in hospitals. But differences in professional regulation alone do not explain differences in trends in clinical pathology and the other areas studied. Rather, the most important factors in explaining differences appears to be technological- i.e. the requirement that the patient be present, the potential need for medical judgement in conducting tests, and the difficulty of interpreting findings without specialized knowledge.

o **Medicine and Lay Administrators:**

Efforts by hospitals beginning in the 1930s to extend administrative control over hospital based radiologists and pathologists and employ them on an salaried basis are consistent with agency models. The case for employing physicians as autonomous agents in these models rests on difficulties in evaluating performance. The emergence of pathology and radiology as "doctors' doctors" performing relatively standardized technical activities on a repeat basis for presumably knowledgeable fellow physicians suggests a potentially significant reduction in informational problems.

The extent to which these types of agency considerations motivated hospitals is, however, unclear. Physicians themselves placed considerable emphasis on the importance of preserving autonomy to protect the interest of patients. But as discussed, financial considerations may be more important in explaining hospitals' failure to extend control.

o **Within Medicine:**

In all three areas studied the division of labor within medicine appears closely linked to the degree to which technological and market forces created incentives to centralize production at the hospital level. Thus in radiology and pathology, where incentives to centralize were strong, technical specialties emerged. And in radiology, this occurred despite the initial opposition of organized medicine. In the case of ultrasound, radiology sought to claim it as a imaging technology. Nevertheless, it has largely become an adjunct of clinical specialties in the face of much weaker incentives to centralize.

This relatively fluid division of labor of course directly reflects the voluntary nature of credentialing at the specialty level within medicine in the context of a system of relatively free choice by consumers. An obvious alternative was to introduce specialty licensure legally restricting the division of labor. The question of specialty licensure never arose in clinical pathology or ultrasound, but in radiology this option was explicitly rejected. In part this appears to have reflected concerns that such regulation might have served as vehicle for competing claims of groups outside organized radiology. But almost certainly likely opposition from medicine's rank and file was also a factor.

Turning to the division of labor between specialists and general practitioners, this issue arises most clearly in clinical pathology and radiology. In both cases, centralization of facilities served early on to largely eliminate non-specialist

competition in hospitals. But competition remained outside the hospital, where controversy has focused on doctor's offices and independent clinical laboratories.

Specialists have often complained about quality problems in doctor's offices and independent labs. However, despite the availability of objective techniques to monitor important aspects of performance and potentially reduce competition, they have been reluctant to use such techniques as a regulatory tool.

Two factors appear important in explaining this reluctance. First, opposition from the rank and file of the medical profession. Second, quality problems extended to specialist managed facilities as well, where there was strong resistance within specialties to any type of centralized effort to link credentialing directly to performance monitoring.

The existence of quality problems is not unique to clinical pathology and radiology. Nor is the reluctance to use professional regulation to attempt to directly address quality problems, and especially to link credentialing to performance monitoring. What is unusual is the extent to which quality issues in these areas have lead to external public regulation.

As discussed, public regulation has been introduced to attempt to regulate quality in both fields at the federal level, while many states and even some local governments regulate clinical laboratories and x-ray equipment. What explains this unusual level of external regulation? A common feature which separates radiology and clinical pathology from other areas of medicine is

the ability to monitor important aspects of performance noted above- radiation exposure in the case of X-rays and the accuracy of tests in the case of clinical pathology.

Interestingly, in each case it is has been precisely these aspects of performance which have been the focus of regulatory efforts. This suggests that the ability to quantify quality problems, rather than their existence per se or a reluctance to address them through professional regulation, has been a key factor in the introduction of external regulation.

Paradoxically, actual regulations are largely concerned with personnel standards. One reason for this is the high cost of routinely collecting (and evaluating) meaningful quantitative data. But another important factor is the constituency for this legislation. Much of the support for laws has come from lay technical experts and subordinate technical personnel. And one of the key features of legislation has been to recognize competing claims by these groups which have been rejected by physicians, for example regarding staff qualifications.

o Subordinate Personnel:

In all areas, large scale delegation of technical tasks to subordinate personnel has occurred without any significant delegation of clinical functions. Across the board, the right to interpret diagnostic tests has been reserved to physicians. While conflict has been growing over the division of labor, it has revolved almost entirely around the qualifications necessary to perform technical tasks.

The uniformly sharp delineation between technical and clinical tasks limits the usefulness of comparative analysis in exploring forces behind it. And in all cases, it is certainly possible to conceive of alternative ways of structuring production in which subordinate personnel played at least some clinical role. The reasons why this did not happen remain a puzzle based on the analysis here, however.

Regarding the division of labor in technical tasks, pressure for higher entry standards by subordinate personnel in radiology and pathology basically fit the type of scenario described by White and Marmor (1982). Increasing use of subordinate personnel is accompanied by the creation of new hierarchical professional institutions. Faced with highly segmented occupational structures and no opportunities for promotion, personnel seek to promote their occupations through higher voluntary standards. When blocked by physicians and hospitals, they turn to public regulation as an alternative vehicle. Interestingly, this last pattern has yet to develop in ultrasound. In part this may be because the occupation is still quite new. But it may also reflect the fact that in the absence of any clear division of labor within medicine, personnel have so far been able to more successfully pursue their goals through voluntary regulation.

IV. Discussion:

It is evident from the previous discussion that the division of labor has been quite fluid within medicine in all three areas studied. Within a framework of voluntary specialty regulation,

technology and market forces have played a major role in shaping the distribution of tasks among physicians, as evidenced by the contrasting cases of radiology and ultrasound. It is also evident that even where there have been acknowledged quality problems, specialty groups have been reluctant to make use of quantitative assessments of performance as a means of extending control. This has helped to set the stage for external public regulation of quality in radiology and pathology.

Professional regulation has, however, been an important factor in limiting competition with physicians by lay technical experts, especially as clinical laboratory directors. Personnel regulation also appears to have been a factor in blocking efforts by hospital administrators to subordinate pathologists and radiologists, although preliminary investigation suggests compensation issues may have played a key role as well.

Turning to subordinate personnel, the delegation of technical tasks has been quite responsive to technological and market forces. However, in all of the areas studied, the interpretation of the results of diagnostic tests has uniformly remained the prerogative of physicians, where comparative analysis sheds little light on why.

The effect of creating new systems of voluntary regulation for subordinate personnel has been both to facilitate their use by medical professionals and to create a organization basis for these groups to challenge medicine's control over the division of labor. While the hierarchical nature of these voluntary systems has served

as a check on challenges by subordinate groups, public regulation has provided an alternative vehicle for their claims, particularly in the context of problems with the quality of services in pathology and radiology.

What lessons do these findings suggest for the future? The analysis in this paper has focused entirely on micro changes within the context of the traditional bifurcated system of control in medicine in which physicians have acted as patients' autonomous, self-regulating agents. As suggested in the introduction to this paper, significant changes are currently taking place in this system. In the discussion which follows, the approach is consider possible implications of this research at two levels: 1) with respect to the traditional system of organization in health care through the early 1980s; and 2) with respect emerging trends.

In the context of the traditional system, perhaps the most striking finding of this research is that the division of labor within medicine could change dramatically in response to technological innovations tending to increases or decrease the level centralization in the production of diagnostic tests or other medical services. One case in point is the current trend towards decentralization of laboratory testing as the result of the introduction of new automated equipment, which has apparently contributed to a rapid growth in testing in doctors' offices.

A second implication within the context of the existing system is that to the extent delegation of new tasks to lay experts and subordinate technical personnel continues, competing claims

regarding the appropriate qualifications of personnel and the division of labor are likely to multiply. If past experience in radiology and pathology is any guide, the significance of such claims will depend a good deal on the degree to which traditional systems of professional successfully address quality issues in which some objective measure of performance is possible.

As suggested earlier, failure to address such quality issues has contributed to the introduction of external systems of quality regulation which have served as vehicles for competing claims of competing groups. While historically, objective measures of performance have been lacking in most areas of medicine, successful refinement of new techniques for monitoring physician performance could dramatically change this situation.

To date, leadership in developing such monitoring techniques has come primarily from public bodies and private third party payers, rather than from organized medicine. Moreover, there has been little attempt to integrate the use of emerging techniques into existing systems of professional regulation. Within the context of the traditional system of organization within health care, this suggests that if such techniques are adopted on a large scale, the impact on the division of labor of competing claims by lay experts and subordinate personnel could significantly increase.

A key question, however, is the extent to which the traditional bifurcated system of control in health care is likely to remain intact. As far as the effects of new monitoring techniques goes, experiences in radiology and clinical pathology in

the 1930s suggest that the impact could be modest. However, the relevance of these experiences is questionable. Major differences exist on several fronts. Not just a few specialties, but the entire medical profession is involved. At the same time, purchaser interests are far more concentrated than they were in the past, while cost pressures have created a powerful motivation for change. Finally, a much greater range of options exist for paying physicians than did in the 1930s.

A number of commentators have suggested that the combined effect of cost pressures and improved performance monitoring could be a rapid centralization of managerial authority along corporate lines and a sharp reduction in physician autonomy (cf. White, Salmon and Feinglass 1989). It is beyond the scope of this paper to speculate in any detail about the possible impact of such changes on the division of labor. However, two observations seem warranted. First, even if control becomes more centralized, professional regulation could still remain an important feature of the industry. Second, while some types of rigidities in the division of labor associated with professional regulation might decline (e.g. rigidities associated with the use of lay experts), it is possible that other types might increase. For example, lines of demarcation between specialties could become increasingly bureaucratized in the face of greater administrative controls. By way of illustration, one need only think about the possible implications of treatment protocols that specify the type of personnel which should be used to perform specific activities.

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