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## Tuberculosis in medical students : is the disease an occupational hazard to students of medicine?

Roger R. Drew  
*University of Nebraska Medical Center*

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TUBERCULOSIS IN MEDICAL STUDENTS-  
IS THE DISEASE AN OCCUPATIONAL  
HAZARD TO STUDENTS OF MEDICINE?

Roger T. Drew

Senior Thesis  
Presented to the College of Medicine  
University of Nebraska  
Omaha, 1941

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## INTRODUCTION--PREFATORY REMARKS

The subject of this thesis was born from the realization that for two successive years a member of the Senior Class at the University of Nebraska College of Medicine has been forced to drop out of school for a year because of pleurisy with effusion. The fact that both of these men had seen service in a nearby hospital which maintains a large tuberculosis ward, were tuberculin negative prior to working at this hospital, became tuberculin positive while working there and broke down after having a service (as junior interne) on the tuberculosis ward--all these facts presented a train of events that appeared to have some direct connection. Of course there is no scientific basis for interpreting these facts as representing a clear case of cause and effect. Indeed, there has been no truly definite proof that the pleural effusions mentioned above were tuberculosis. The fact remains, however, that my interest was stimulated to the extent that a survey of the literature was undertaken in an attempt to determine how much of a hazard tuberculosis is to the medical student, and if so, what the most effective means of combatting the situation might be.

The purpose of the thesis, then, is to present

the results of this search of the literature and to weigh the matter pro and con--as to whether there is a real occupational hazard in this business of being a medical student, and finally to give the consensus of opinion as to the means of attacking the situation.

HISTORICAL ASPECT--EARLY REFERENCES TO AN  
APPARENT HEALTH HAZARD FOR MEDICAL STUDENTS

There are many early allusions in the literature to the possibility that tuberculosis might be considered a special hazard to students of medicine. Myers (1) recounts the following:--"The danger of those who care for tuberculosis patients contracting the disease has long been recognized, as evidenced by the following statement--Isocrates (436-338 B.C.) pleading for the inheritance of a consumptive who adopted him and whom he had nursed, exclaimed "I was in such a condition that all my friends, who came to see me, expressed their fear that I perish with him and pledged me to protect myself telling me that most of those who had nursed this disease had become its victims."

In the same article, Aristotle is quoted, "Why, when one comes near consumptives.....does one contract their disease while one does not contract dropsy, apoplexy, fever or many other ills? In approaching the consumptive one breaths this pernicious air. One takes the disease because there is in this air something disease producing."--Rather advanced ideas for Aristotle's time.

Valsalva, the anatomist (1666-1723) avoided

postmortem examinations when the cause of death was consumption. Morgagni, his pupil (1682-1771) continued the practice, avoiding them in order to protect his students as well as for personal reasons. Laennec, himself, infected his left index finger while performing a postmortem examination about 1800 and died of consumption in 1826. (10)

For more than a century the disease has been looked upon in Europe as one attacking professional workers with unusual frequency--especially those who cared for ill people--physicians and nurses. (2,4) In 1818, Armstrong of England wrote:--"When young men enter upon the study of medicine, they occasionally break up their general strength by the intensity of their application in the dissecting rooms, in the tainted air of the hospital, or in their own apartments and may actually become consumptive from this source." (3)

#### EARLY INVESTIGATIONS LEADING TO MODERN CASE FINDING TECHNIQUE

In spite of this apparent recognition of a professional hazard to the student of medicine, very little was done in the way of investigation as to the

severity of the problem, cause, or method of control until the decade commencing with 1920. During that space of time the seeds of the present elaborate and increasingly effective program were sown.

One of the pioneer workers in this country was Myers of Minnesota who recognized the fact that there was need of more attention to the chest conditions among students at the University of Minnesota and consequently established his chest clinic at the Student Health Service in 1920. No special technique was employed for finding tuberculosis--other than careful physical examination. Out of this clinic, however, grew one of the most thorough programs of case-finding in this country. (5)

Heimbeck in Oslo, Norway was one of the earliest investigators in Europe, building a program as early as 1924 which included the use of skin testing and roentgenography. His study included only nurses, but Scheel carried out similar studies, beginning in 1926, on medical students. (6)

Along toward the latter part of the 20's, these above mentioned studies had created enough of a stir to attract the attention of Student Health Directors in many of the Universities which had student health programs.--The American Student Health Association had



been formed in 1920. (7) Interest was stimulated to the extent that many of these schools began to look back in their records to determine what the incidence of tuberculosis had been.

Stiedl of Harvard was quoted as saying in 1930, "Tuberculosis might be called an industrial hazard for the medical profession. It is the most important chronic disabling disease, for the medical student, the young physician and the nurse." (8)

In 1932, however, Stiedl (9) reported a survey by questionnaire of graduates in medicine between 1921 and 1929 in whom the incidence of tuberculosis had been 2.5 percent. A similar study of law students, 1920-1924, showed an incidence of 2.08 percent not very well bearing out his earlier statement. He also said that he thought it "unlikely that full light will ever be shed on the problem of tuberculosis in medical students by the statistical method."

The most significant thing he noted was in relation to Trudeau Tuberculosis' Sanatorium where from 1922-1930, of 143 medical students and doctors admitted, 70 percent of all patients entered in the same classification indicating a lack of careful observation of the disease even in professional men. (9) \*

It was also noted at the same Sanatorium that

\* See page 75

between 1916 and 1931 that 7.1 percent (239) of the discharged cases were medical students or physicians and that in that period only 25 percent of the medical people entered the sanatorium while the disease was minimal whereas the lay admissions of minimal cases were 21 percent--evidence of poor diagnostic methods. (11)

Fitz (13) at Harvard also reported in 1931 four years of observation as physician to the medical students and found little tuberculosis. He says, however, "Tuberculosis has been an important cause of disability on account of the length of time necessarily spent in recovery and also because of the demoralizing effect of a long illness on a young man's morals and ambitions. Tuberculosis has not been easy to recognize in its early stages....while it may be impossible to prevent the occurrence of occasional cases of pulmonary tuberculosis, determined effort should be made to recognize it early, since the disease is serious from the point of view of time necessary to cure it, and it may develop unexpectedly. To accomplish this, if for no other reason, a well organized efficient student's health service is an essential part of the equipment of a modern medical school."

Soper and Wilson (18) at Yale reported results of case-finding prior to the use of modern methods of

tuberculin-testing and x-ray, for a ten year period of 1922 to 1932. Thirty-eight students broke down, of which only ten were found on routine physical examination and history. Twenty-seven were not recognized until they broke down from one to sixteen months following their physical check-up.

Herman (12) of Johns Hopkins University in 1931 reviewed some data as to tuberculosis morbidity. He figured a 1% morbidity in the general population ages 20-29 by use of statistics from the Framingham experiment. There were 3% rejected among World War draftees ages 18-30 because of tuberculosis. The Army and Navy had a morbidity of 2.2 to 2.7 per 1000 for all ages. Western Reserve University Medical School over an 8 year period (1923-31) with an average of 250 students per year had 11 cases in the whole period.

The University of Michigan he reports as having an incidence from 1917 to 1930 of 1.83 lesions per 1000 in law students, 2.12 in dental, 2.52 in engineering and 2.81 in medical students while at Johns Hopkins he states the computed incidence 1926-1931 was 6.5 per 1000 students.

These figures are very confusing and misleading and solely based on finding tuberculosis by the older

methods of symptoms and findings. Such data as the above added impetus to the institution of adequate case-finding methods in various schools and prompted Herman to write, "The question of tuberculosis infection in medical students has aroused great interest for many years. It will be admitted that medical students during their clinical years are subject to greater exposure than are other persons of similar age and social status such as for example students in the professional schools. However, it is not established (1931) that exposure in adult life per se is the deciding factor in the development of tuberculosis, although this may be the case. On account of their age alone and without any excessive exposure, tuberculosis would be expected to be the most important cause of disability and death among medical students. The matter will not be settled until adequate statistics are available, not only for this particular group, but for a comparable control population." (12)

SURVEY OF RESULTS OF CASE-FINDING PROGRAMS  
IN VARIOUS SCHOOLS OF MEDICINE

The American Student Health Association in 1931 established the Tuberculosis Committee largely due to the pioneering work mentioned above and that of the Pennsylvania group and the Minnesota group which will be mentioned more in detail later. Lyght (14) the chairman of this committee in 1940 made the statements,—"It is 20 years since Myers set up his student Chest Clinic at the University of Minnesota which developed into the exacting plan of case-finding to meet trouble more than half-way--of searching for it constantly, of harrying and badgering tuberculosis instead of waiting patiently, idly for the manifestations of advanced disease to appear through the development of signs and symptoms...other schools have caught the vision largely through the leadership, example, and enthusiasm of men like Myers until today there are nearly 200 institutions of higher education in the United States providing some degree of tuberculosis case-finding among their students." (14)

A survey of the case-finding programs reported in the literature reveals that much has been done in the last decade. Heimbeck (15,16,17) working at

the Ulleval Hospital in Oslo, although already mentioned, should be recorded as the first investigator to use modern methods. He started his study in 1924 using the von Pirquet test on nurses followed by chest x-rays of the positive reactors. Up until 1935 he had observed some 625 nurses enter the training-period--which included special tuberculosis services--positive reactors to the skin test and of this group 27 contracted the disease none of whom died. On the other hand, of 280 who were negative reactors on entering the training there were 96 instances of disease and 10 deaths. (15,16,17)

Heimbeck reported (29) a small group of medical students--183--of whom 88 were tuberculin positive on entering the hospital. Only one of these developed tuberculosis while of 51 negative reactors on admission 6 developed the disease. Also a group of 44 who were vaccinated with B.C.G. did not develop the disease. His reports have always been quite startling as can be seen from the above and that very fact stimulated interest in the United States. It will be noted that he observed great differences in the incidence of infection in positive and negative reactors and also advocated B.C.G. vaccination. These facts will be considered more in detail later on.

Scheel of Oslo according to Soper and Amberson (6) studied the incidence of tuberculosis among medical students at Ullevål Hospital 1926-1934. His studies covered 1176 students divided into several groups all of which served a period of time in the tuberculosis wards of the Ullevål Hospital. He like Heimbeck was greatly impressed by the relatively lower morbidity in the students who were positive to the von Pirquet test. By a statistical computation taking into consideration the period of exposure in the tuberculosis wards he found that group 1 comprised of 361 students tuberculin-positive before exposure showed an annual average morbidity of 1.47% while group 2--comprised of 207 students tuberculin-negative before exposure showed an annual average morbidity of 4.31%--almost three times as high.

Both Heimbeck and Scheel were using the most complete technique, that of von Pirquet or Mantoux test on admission to the course followed by x-rays of all positive reactors and repetition of the skin test on all negative reactors at intervals of 6 months or a year along with chest up x-rays on all who react positively--at same interval.

At Yale University Soper and Wilson (18) started a program in 1930-31 when they made stereograms of the

chests of all students. This proved a bit expensive and in 1931-32 they instituted a tuberculin testing system--fluoroscoping all positive reactors and following with roentgenograms if it was deemed necessary. They also checked 300 cases with both fluoroscope and x-ray plates and decided to abandon the use of the fluoroscope because of the fact they missed a few cases by that method which were picked up by the x-ray plates.

They found among 838 undergraduates of average age 18.5 years an incidence of 53.5% positive tuberculin reactions and 0.2% occurrence of demonstrable lesions. Among 64 law students and 52 medical students--average age of 24 years they found an incidence of 57.8% and 76.9% positive reactors respectively, with an occurrence of lesions of 1.6 and 3.8 percent in the two groups. These were freshmen. In 119 upperclassmen in the medical school they found 94.1% positive to the Mantoux test.

A later report from Soper and Amberson (6) in 1939 states that among 427 students entering from 1930 to 1937 only 6 cases were diagnosed by x-ray as having parenchymal lesions on admission. Since 1933 the students have been x-rayed in their final year also--and in that time 4 lesions have been found and 2 more students broke down during their course--so that



It might be considered that 6 students contracted the infection or superinfection during the medical course.

Dr. Heath reported to Soper and Amberson (6) that at Harvard Medical School previous to 1937 tuberculin testing followed by chest x-rays was a routine procedure for the 1st and 4th year classes. In 1937 the system of annual tuberculin testing of all students until positive reactors, with x-ray of all students on entrance and annual repeats of those who were tuberculin-positive was initiated. He reports 60% positive as freshmen and 85% positive as seniors. He believes there is an average annual incidence of pulmonary tuberculosis requiring treatment of about four in a student body of 500. He concludes, "There is no doubt that tuberculosis is the most important organic medical problem in the medical school."

Forsythe and Fopeano (19) at the University of Michigan (1936) surveyed the whole University and found a constant rate of 2 cases of tuberculosis per 1000 students for the previous 20 years in spite of increase in efficacy of diagnostic procedures-- possibly explained because of a drop in general morbidity and mortality. The distribution as to Departments shows the average for the whole school to be 1.94 per 1000 while in the Medical School the incidence

of lesions found was 3.34 per 1000 yet in the graduate school the incidence was 3.32 per 1000. They explain this increase in occurrence entirely on basis of the older age and higher percentage of foreign students whom they found to be especially susceptible. They had not as yet (1936) instituted such a program as that described at Harvard, although they used x-ray in 100% of the class in 1935-36 uncovering only one case which they say could not have been suspected on the basis of foreign residence (x-rays were made of all foreign students), colored race, history of contact or suspicious of contact, or through physical examination.

Herman (12) at Johns Hopkins University experimented with tuberculin testing and x-ray 1929-1931 but his results with 0.1 mg. doses of O.T. were not satisfactory and there was not complete coincidence of his tuberculin findings with his x-ray findings giving him results difficult to interpret but at that time (1932) he concluded that the evidence was insufficient to prove that medical students suffered a higher incidence of pulmonary tuberculosis than persons of similar age and economic status engaged in other occupations, but that such data as were available suggested that the student of medicine might be subject

to a higher risk.

Doctor Herman reported to Soper and Amberson (6) in 1938 that between 1926 and 1937, 1132 students had entered the Medical School with a total of 16 developing outspoken pulmonary or pleural tuberculosis. The last case developing in a medical student was in 1935. He stated that routine x-rays are taken of all matriculents and they are urged to have annual check-ups with about 60% doing so. They had not used the tuberculin test for several years but hoped to reinstitute the use of this screening test.

F. H. Steihm (20) at the University of Wisconsin has been an ardent supporter of the case-finding campaign and has done much well controlled work, although it has been more especially concerned with the University as a whole rather than just the Medical School alone. Some of his figures are interesting, however. From 1919-1933 an average of 10 cases a year were found in the University by clinical signs. In 1933 by use of tuberculin-testing and x-ray a total of 43 cases were found, an increase of 430% over the 14 year average. Seventeen students as compared with a former yearly average of 4 were advised to withdraw from school--an increase of 425%--rather vivid evidence of the efficacy of the new case-finding technique. In

1933 he found the college freshmen with a 30% positive tuberculin, the medical freshmen as 44.7% reactors while the seniors were 55% tuberculin positive.

In 1939 Stiehm (21) reported the results of an intensive five-year program of case-finding, but without any special reference to the Medical School. He in 1938 reported to Soper and Amberson (6) that there had been but one case of active tuberculosis in a Medical student since 1933 (this included 250 students who had graduated in that time and 250 who took only the first two years at Wisconsin) in spite of the fact that those graduating from the Medical School spend a three weeks period on tuberculosis wards during their fourth year. In this service a rigid isolation technique is employed. Stiehm follows the plan of tuberculin testing all new students--x-raying the positive reactors--retesting the negative reactors each year--and re-checking the positives by fluoroscopy at 3 to 8 month intervals. He believes now that the medical students at Wisconsin have little opportunity for infection with tuberculosis and that this fact probably explains the small incidence of disease among them.

At Columbia University--College of Physicians and Surgeons, Dr. Heck (22) reported his 8 years (1925-33)

of experience as physician in charge of Student Health. He says there have been diagnosed only 8 cases in 8 years, two of which were inactive. Of the six active cases none were found in the first year, three each in the second and third years and two in the fourth year. These were discovered by physical exam, two had pulmonary hemorrhages and two had fever. He stated that x-rays were made of the chest only when indicated!

Dr. Flood of Columbia reported to Soper and Amberson (6) in 1938 that x-rays were then made of the entering students and again late in the fourth year. No tuberculin testing had been done--as yet. He stated that the recognized tuberculosis for 15 year period 1922-1937 was about 0.4 percent, and remarked that the recognized tuberculosis was much lower than at other schools.

Keller and Kampmeier (23) at Vanderbilt University reported in 1939 that they have carried on a case-finding program at the Medical School since 1929. Between 1929 and 1937 they found 555 entering students to be 60% positive to tuberculin. In the four years of Medical School this was boosted to 70% which is not as high as other schools have reported. They explain this by the fact that the number of tuberculosis patients contacted is small, a rigid isolation technique is

maintained and undiagnosed ward cases are a rarity. An interesting fact noted by these investigators is the occurrence of 21 negative reactors in the fourth year class who had previously been positive. They reported a survey of Emory University College of Medicine, where out of 120 admissions 48.3% were positive reactors.

Dr. Sarah Morris reported to Soper and Amberson (6) that at the Women's Medical College of Pennsylvania they test the students on admission with tuberculin and every six months thereafter until they become positive. Roentgenograms are made of all at least once a year and those changing from negative to positive are watched more closely. By the senior year all are positive reactors. The program was instituted in 1932. The highest number of positive reactors on admission was in 1933-34 when 63% reacted while in 1937-38 only 32% were allergic to the skin test, showing a tendency for decreasing numbers of early infections. In 1937 out of 107 students there were 17 healed and 7 frank or unstable lesions found all but one of which were seen in 3rd and 4th year students.

Baker and Holoubek (24) at Louisiana State Medical School report in 1941 that in the past two years five cases of tuberculosis were diagnosed clinically, therefore a case-finding survey was started to see

how it might compare. In 1939-40--P.T.D. tuberculin testing was done followed by x rays of all positives plus negative reactors also--85% of the school responded--298 students. The freshmen showed a positive reaction in 68% of the cases. The greatest increase was between freshmen and sophomore years as the 2nd year men were 90% reactors--94% for 3rd year and 98% for seniors. In the light of these findings, these investigators speculated upon the advisability of discontinuing the tuberculin tests because of the high percentage of reactors and proceeding to x-ray all the students--saving the expense of the tuberculin testing as well as the time necessary for administration and reading. Eighteen percent of the non-reactors showed calcified nodes by x-ray which seems to be a rather common occurrence--a state of tuberculin anergy so-called. Because of the great increase of reactors between the freshmen and sophomore years they questioned whether hospital contact was the greatest factor in producing tuberculin allergy as the students at Louisiana State have no patient contacts before the junior year.

Dr. Barnett at Stanford University Medical School reported to Soper and Amberson (6) in 1938 a program in effect since 1933 in which first year students are tuberculin tested with x-rays of all positive reactors

as well as most of those with negative reactions. When the students enter the clinical years at San Francisco they are all given chest x-rays and again at the beginning of the 4th year. Of 420 students in the junior and senior years since 1933 only four active cases of tuberculosis have been diagnosed with six more having suggestive x-rays findings. Of these latter six, one has been confined to bed while the remaining five have fully recovered. In 1938 a more thorough tuberculin-testing program was started--that of retesting the originally negative reactors through their medical course.

At the New York University College of Medicine Connor (8) reports the results to date of a five-year program started in 1937--a tabular summary follows:

TABLE I

Year--	'37-38	'38-39	'39-40
	No.-Pos.-%	No.-Pos.-%	No.-Pos.-%
Class '41	117- 86- 73.5	121-94- 76.9	125-105- 84
Class '42		122-61- 50	123- 67- 54.5
Class '43			128- 72- 56.3

Eight cases in this group showed tuberculosis in filtration which has remained unchanged through the period of observation. Five cases of infiltration



have shown some progression. The program has not been in force long enough to draw any very accurate conclusion--there is an estimated case rate of four per 1000 or 0.4 percent. A summary of the clinically diagnosed cases 1932-1938 shows no deaths and all who became sick have returned to school and graduated.

At the University of Nebraska College of Medicine there has been a case finding program with the use of tuberculin testing and x-ray follow-up for several years. It was not until 1939, however, that this work was well organized under the direction of the Student Health Service and accurate records kept.

TABLE 2

School year--	1939-40	1940-41
Total No. tested--	285	311
: Class of 1940	53%	--
percent : Class of 1941	31%	31%
positive. : Class of 1942	32%	45%
reactors. : Class of 1943	17%	22%
: Class of 1944		36%

Le Mar (25) has compiled data presented in Table 2. In general it can be seen that the percentages of positive reactors run much the same as those reported from other mid-lands schools. He states that there are

as a rule several cases of tuberculosis disease found each year. In the 1939-40 group one case of pleural effusion appeared in a senior necessitating a years lay-off from school. Two other seniors were found to have fibrotic lesions which proved to be regressive. One sophomore was found to have a lesion requiring Sanatorium care, and that student is now back in school with a regressing lesion.

In the 1940-41 group one senior student developed a pleural effusion requiring seven months treatment of bed rest. The entering freshman class had a high percentage of positive reactors as noted in the table. Also in this class two students showed lesions demonstrable by x-ray. One of these is still in school and the lesion is regressing satisfactorily while the other was a progressive lesion and the student is now in a sanatorium. Neither of the two cases of pleural effusion showed any parenchymal involvement after the absorption of the fluid. Both were negative reactors turned positive shortly before their illness.

An interesting observation of Le Mar's is the reversion of positive tuberculin tests back to a negative reaction. The Mantoux tests are repeated each year on all students whether positive or negative reactors previously and it has been interesting to note

that each year several previously positive reactors turn up negative. Keller and Kampmeir (23) at Vanderbilt noted a similar incidence of reversion of the tuberculin reaction. This is a phenomenon not much mentioned in the literature and it will be interesting to note the results of further studies.

At Creighton University Dr. J. F. Gardiner (26) reports that a case-finding program of tuberculin-testing and x-raying of Mantoux positive students has been<sup>a</sup> in force for three or four years. Retesting of originally negative students is done each year and recheck x-rays are made of those who are positive reactors. He states that the percentage of positive reactors is a bit higher than those of other midwestern schools because of the fact that many of the students come from either coast where the rate of infection is much higher. As a rule, there are one or two cases uncovered each year through this program.

One of the most complete case-finding programs in relation to medical students and students of the University in general has been carried on by Hedvall (27) at Lund University in Sweden. The study was instituted in 1930 with a very elaborate technique being employed. They have obligatory examination of all students not only at entrance to the university

but each year while in attendance. These examinations include history and physical plus tuberculin testing, sedimentation rate, fluoroscopy and radiography. Pirquet's method of testing is used and if a negative reaction is obtained the students are retested by the Mantoux method. When tuberculin reaction changes from negative to positive an x-ray is taken every third month during the first year and every six months during the second year after the primary infection. This is the first mass investigation of the kind in Sweden the practical result of which has proven so important that mass investigations are at present being carried on in various parts of Scandinavia not only on students but also on different groups of workmen.

The principles under which the investigations have been operating include attempts to diminish the danger of contagion, to reduce the risk of tuberculosis infection and thus prevent the occurrence of new cases, to diagnose the cases that do occur as early as possible and arrange for early and suitable treatment. The incidence of primary infection among medical students was carefully studied in an attempt to discover what course or courses were more dangerous than others from the point of view of tuberculosis infection. The results of this investigation led to important

prophylactic measures which led to important discoveries and will be mentioned more in detail later on.

Up to the time of Hedvall's report in the American Review of Tuberculosis in 1940, this study had included 3336 students of all departments and 133 cases of tuberculosis infection had been found of which 72 cases were found in medical students--more than 54% of the total number of cases discovered in less than one-fifth of the student population. These facts are best illustrated by the following table of the occurrence by departments:

TABLE 3

	No. of students	% of whole group	No. of Cases of T. B.	% of T. B. Each Group	% of total Cases of T. B.
Medicine	638	19.1	72	11.3	54.1
Nurses	434	13.0	23	5.3	17.3
Totals for hazard group	1071	32.1	95	8.9	71.4
Philosophy	1367	41.0	17	1.2	12.8
Law	488	14.6	9	1.8	6.8
Theology	409	12.3	12	2.9	9.0
Total for non-hazard group	2264	67.9	38	1.7	28.6
Totals	3336	100	133	4.0	100

Thus it is graphically seen that this study definitely emphasizes the importance of tuberculosis, as a rather special hazard to the medical students and nurses as Hedvall puts it, "an enormously greater occurrence almost twice that of all other departments together."

Hedvall divided these 133 cases of "indisputably active tuberculosis" into three groups--group 1 comprises 47 cases which were tuberculin negative and x-ray negative on entrance to the University. Group 2 was made up of 43 cases which were tuberculin positive and x-ray negative on admittance. And Group 3 comprises 43 students who were tuberculin positive and also had x-ray evidence of tuberculosis in some stage of development on entrance to the University. Thus it is noted that Hedvall found little difference in the spread of cases found in relation to the state of tuberculin allergy on admittance.

The break-down of these groups of cases as mentioned above shows the following types of diagnoses: Chart shown on next page.

TABLE 4

Group 1. Erythema nodosum.....	3 cases	
Erythema nodosum / primary lesion	21	6 cases
Phlyctena / primary lesion		
Primary lesion		14 cases
Pleurisy.....	6 cases	
Tuberculosis of cervical or abdominal lymph nodes.....	2 cases	
Miliary tuberculosis.....	1 case	
Pulmonary tuberculosis.....	<u>14 cases</u>	<u>47</u>
Group 2. Pulmonary tuberculosis.....	37 cases	
Tuberculosis of hilar lymph nodes.....	2 cases	
Pleurisy.....	<u>4 cases</u>	<u>43</u>
Group 3. Pulmonary tuberculosis.....	<u>43 cases</u>	<u>43</u>
Total.....		133

Hedvall insists that the tuberculous changes were progressive and of importance even if they might occasionally at first appear to be rather benign. He says,

"The significant role played by tuberculosis in the lives of the students and probationary nurses in Lund, however, is not fully understood until the cases have been followed for a very long time. For instance, one of the 3 cases of erythema nodosum has already developed tuberculous changes in the lungs, another bilateral phthisis and tuberculous peritonitis and died about 18 months after the appearance of the erythema nodosum. Five of the 21 cases with primary lesions have since been complicated with exudative

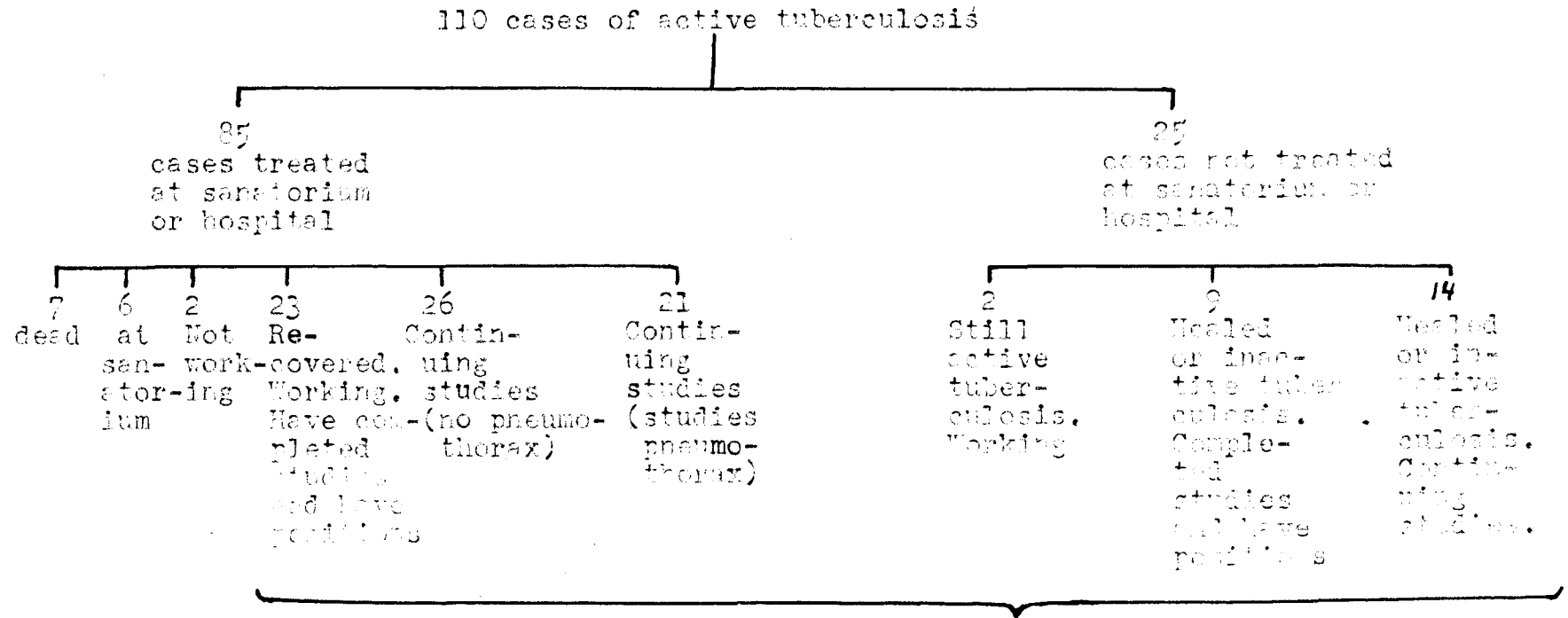
pleurisy, and 4 others with pulmonary tuberculosis. Of the pleurisy cases (group 1) one subsequently developed tuberculous peritonitis and another secondary perihilar infiltration. Another 2 of the pleurisy cases have, since the collocation of the results of the investigation, developed incipient pulmonary tuberculosis. The case of miliary tuberculosis died soon after diagnosis. Of the cases of pulmonary tuberculosis one had died, several have developed changes of such a nature that pneumothorax had to be induced (bilateral in 2 cases). One of the cases of tuberculosis of the hilar nodes belonging to group 2 has since developed perihilar infiltration, one of the 4 cases with exudative pleurisy developed pulmonary tuberculosis, as a complication, and died. The cases of pulmonary tuberculosis in groups 2 and 3 frequently showed progression, rendering pneumothorax treatment necessary. A great many of them required sanatorium care."

A very interesting chart showing the present condition of these students is presented below:  
Chart shown on next page.



TABLE 5

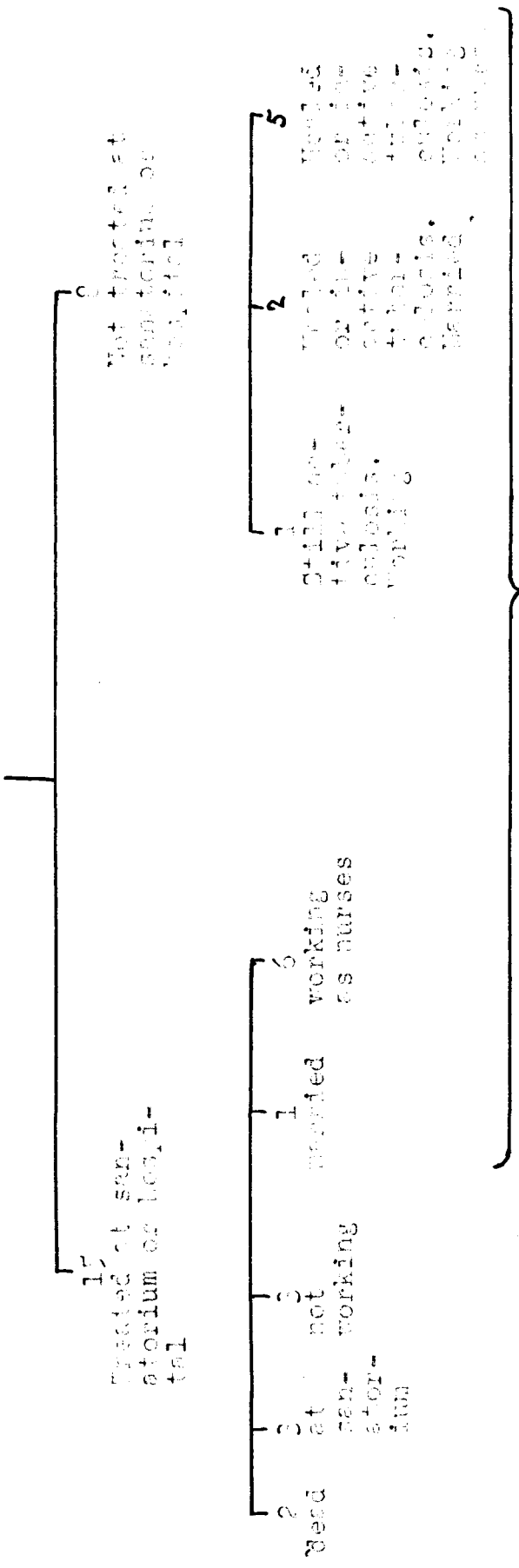
A. Tuberculous Students



Of 110 cases 95 are at present fit for work

B. Tuberculous Nurses

23 cases of active tuberculosis



15 cases out of 23 are at present out of work

It can be seen that 110 of the total of 133 are now fit for work--evidence of early diagnosis and early treatment of disease which in many cases--more than one-half was completely asymptomatic subjectively at time of diagnosis.

In this country one of the earliest programs to be initiated and most thoroughly followed up was that of the group of workers at the University of Pennsylvania. Stimulated by the work of Heimbeck in Norway and the comments of Stiedl and Fitz at Harvard as well as those of Myers at Minnesota and roused by the apparent frequency of interruptions in the schooling of medical students because of tuberculosis infection, Hetherington, McPhedran, Landis, and Opie (28) began their studies at the University of Pennsylvania in 1929.

The first report in the literature by this group appeared in 1931 with the results of their first year's studies. Among 279 college students of ages 18-21 they found 85% positive reactors in the freshmen year and then an increase each year till seniors registered a 98% positive tuberculin test. X-ray studies of the college students revealed 11 (3.9%) cases of manifest or minimal apical tuberculosis distributed quite evenly among the four classes, while

in the medical students 61 casts were found (13.5%) with distribution by years of 4-12-19-26 or percentage figures of 4.1-11.6-14.7-21.3 which shows the continuous increase. These workers concluded from this ~~percentage and~~ preliminary survey that there was a lack of comparative data for the age grouping of the medical students, but the high incidence of apical lesions rather indicated that medical students were peculiarly subject to tuberculosis.

The study was continued and again reported by McPhedran (29) in 1933 when the earlier figures were confirmed as far as tuberculin reactors by classes was concerned. The cases of tuberculosis discovered in the first year of the campaign had been followed and by proper treatment were kept under control. This paper was given before a meeting of the Association of American Medical Colleges and it was just then being realized of what great value adequate records in regard to tuberculin reactions and chest x-rays could be. McPhedran made the following statement from his experience at Pennsylvania:

"The majority of these students with tuberculous onsets show a lesion for at least six months before they develop the acute symptoms and that is exactly the point of special technique to pick up the apical

lesions. I do not wish to insist on that except that it is so important from the point of view of picking out the men who are likely to have rapid spreads and see if we can modify their lives and prevent this rapid spread six months or four months before the man is conscious of it and the symptoms may come on with what is apparently an acute upper respiratory condition . . . . there, again it all comes back to the question of what lesions are radiographically significant, and that is a matter of investigation. There is no doubt that these lesions above the clavicle indicate infections--and where you have an infection severe enough to implant in the lung, the probability of its spreading and favoring development of another infection is at least to be considered."

This group--Hetherington, McPhedran, Landis, and Opie (30) reported further progress of their investigators in 1935. From 1929-33, 521 students had graduated from the Medical School and among them 21 had developed clinical tuberculosis either during or after graduation. This was an incidence of about four percent. However, when advanced latent *apical lesions* were included the number was considerably increased. New or progressive tuberculosis lesions were demonstrated in 75 percent of the students during their medical course;

10 percent showed small apical infiltrations with no change during the observation period, 15-20% had calcified foci in the lungs or tracheo-bronchial lymph nodes. Advanced infiltrations were discovered as follows by classes:-1930--11.5%, 1931-6.0%, 1932--5.3%, 1933--8.3%; while in dental and law students such lesions were found in 2.2 and 2.4 respectively.

As to the tuberculin reaction, the incidence of allergic individuals continued high and it was also found that dental and law students at Pennsylvania were almost 100% positive reactors by the end of their final year of school. A summary of the results of tuberculin testing of the medical students 1921-1933 is given on the next page.

TABLE 6

Class	1929-30			1930-31			1931-32			1932-33		
	No. tested	Pos.	%	No. tested	Pos.	%	No. tested	Pos.	%	No. tested	Pos.	%
1930	111	109	98.2									
1931	126	121	96.0	129	128	99.2						
1932	103	97	94.2	129	125	96.9	134	131	97.2			
1933	99	84	84.8	101	95	94.1	138	136	98.5	138	136	98.5
1934				122	102	83.6	108	99	91.7	134	130	97
1935							118	104	88.1	113	102	90.3
1936										132	115	87.1

This table shows that the original study was borne out in that the students came to the medical school about 85% positive reactors and leave practically 100% positive. This is good evidence of the much higher percentage of positive reactors in the coastal states among students of this age grouping. As has been seen and will be brought out again, the students of the Middle West enter Medical School more nearly 30-50% positive and graduate 60-80% positive.

These men found that in their earlier records previous to the use of x-rays when symptoms were considered sufficient warning to detect tuberculous processes in the lungs, 32 percent of the cases were incipient, 55 percent moderately for advanced and 13% for advanced when they were discovered. With the use of their case finding technique subsequent to 1929 an additional 60 percent of the cases were found in the incipient stage- the most easily treated stage.

Dr. Lees of the Pennsylvania group reported to Soper and Amberson (6) in 1938 that the continuance of the program had presented the following results between 1935 and 1938.

Table on next page.



TABLE 7

Year	Total Students	Cases Diagnosed	%
1935-6	514	30	5.8
1936-7	418	19	3.9
1937-8	379	14	3.7

... He stated that 12 of the cases found in 1937-8 were in the senior class, what he believed to be evidence of results of the intensive program carried on at that school.

In March 1940 Hetherington and Israel (31) published more or less of a summary of the work at Pennsylvania and also a study of a group of 400 students who had been observed for six to eight years after graduation. These were members of the classes of 1930-31-32 where thorough examinations were carried out each year. Of this group 98% responded as to course and occurrence of tuberculosis since graduation.

Seventy-one of this group of 400 showed some sort of tuberculous infiltration during their school course, 24 of these or 6% were of the clinically progressive type. These workers divided the lesions found into several grades as to extent and activity. Grade I included small infiltrations--spots or strands at the extreme apex and for these no treatment was

advised yet none developed clinical tuberculosis showing these lesions to be of slight significance. Grade II lesions were more extensive with slight density above the clavicle--grouped or flocculent spots. For this typed lesion a restriction of activities was advised with increase in hours of rest and frequent x-ray examinations to detect evidence of spread of disease. Grade III lesions were more advanced in type with infiltrations extending below the clavicle from supratations extending below the clavicle foci. More marked restrictions of activities were advised for this group. Any of a Grade II or III who showed questionable physical signs were advised to take sanatorium treatment. Those with clinically diagnosed tuberculosis, active, quiescent, or arrested were grouped together. Thus at graduation these 400 students were grouped as shown below and from these we find 15 developing clinical tuberculosis requiring collapse therapy or sanatorium care within one to six years. Table on next page.

TABLE 8

Development of Clinical Disease Following Graduation

Diagnosis at Graduation	No. Students	1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year	7th Year	8th Year	Total
Clinical	7	1	2	0	1	0	0	0	0	4
Grade III	25	2	1	1	1	1	1	0	0	7
Grade II	11	0	0	0	0	0	1	0	0	1
Grade I	28	0	0	0	0	0	0	0	0	0
Neg. x-ray	325	1	1	1	0	0	0	0	0	3
Not x-rayed	4	0	0	0	0	0	0	0	0	0
	400	4	4	2	2	1	2	0	0	15

Thus it is seen that the development of clinical disease after graduation is for the most part in those students who had asymptomatic disease in school. With the 3 who developed clinical disease in school there were 18 altogether with clinical disease at some time during the period the study covered or a percentage of 4.5, which is somewhat higher than ~~than~~ the **incidence** in the general population for that age group. It is quite evident that impairment of health sufficient to arouse suspicion of tuberculosis was apparently not noted even by physicians while lesions were minimal.

Summarizing, this group found that--"Tuberculous infiltrations, mostly asymptomatic, were found in almost 18% of students of classes 1930-31-32. Studies at the University of Minnesota and at the University of Copenhagen also show high incidence of infiltration in medical students. Although reported to be considerably lower in other American schools, the incidence is sufficiently high to result in the general realization that pulmonary tuberculosis is a special hazard to medical student. Paradoxically the death rate from tuberculosis among physicians is low and knowledge of this fact has influenced some observers to question the seriousness of the tuberculosis problem in medical students."

The fact that the mortality among physicians continues to be low is attributed to an excellent response to treatment due to the superior facilities available to physicians for treatment and the willingness with which the medical students and physicians took adequate treatment even when symptoms were slight or absent.

The real pioneer in the field in this country is J. Arther Myers of the University of Minnesota who has been an indefatigable worker in relation to the degree of hazard of tuberculous infection that medical students and nurses undergo in pursuing their chosen professions. He has also been one of the most ardent supporters of a thorough program for case-finding, prevention and treatment in order to reduce this hazard.

Myers (5) states that in his Chest Clinic at Minnesota which was started in 1920 (see above) they were laboring under the delusion that all tuberculous disease gave signs that could be elicited by physical examination and it took several years to live this down. Also x-ray was at first used only as an adjunct but gradually became the guiding factor. Finally in 1928 they instituted a tuberculin testing program--

expecting that about 100% would be positive but were quite surprised to find only 33% of entering students positive reactors. At this time, Myers suggested that a program should include tuberculin testing and re-testing every six months of those with negative reactions, also chest x-rays of all students at least once a year.

In 1933 Myers (4) showed great alarm at the evident high incidence of tuberculous infection in medical students and nurses. He wrote, "Just now there are few phases of tuberculosis work demanding greater attention and requiring more immediate action than having to do with tuberculosis in students of nursing and medicine." He mentioned a doctor from whose graduating class of 20 years ago 25% were ill or dead of tuberculosis, another class 17% and of 21 classmates of a nurse graduated 5 years before that date 7 were ill with the disease.

He states that mortality tables do not give a true picture of the tuberculosis infection rate in physicians. He says, "Mortality is a poor basis for estimating the significance to the race of any slowly progressive disease like tuberculosis. Therefore we believe that the death-certificate gives us very little information concerning the problem of tuberculosis

TABLE 9

<u>Class Grad.</u>	<u>Total in Class</u>	<u>Reactors on entrance</u>		<u>Reactors 3rd year</u>		<u>Reactors 4th year</u>	
		<u>no.</u>	<u>%</u>	<u>no.</u>	<u>%</u>	<u>no.</u>	<u>%</u>
1933	78	26	33.3	33	42.3	45	57.7
1934	127	47	37.0	52	40.9	79	62.2
1935	113	39	34.5	46	40.7	79	70.0
1936	131	48	36.6	53	40.5	102	77.9
Totals	449	160	35.6	184	41.0	305	67.8
Percent of non-reactors becoming reactors--50.2							

Table 9 shows that the average incidence of positive reactors on entrance to the Medical School at Minnesota has been about 35 percent while the average at the end of the course for the four years included in the study was 67.8 percent, and 50.2 percent of those who reacted negatively to tuberculin on entrance to the medical school became positive before graduation. The greatest jump in tuberculous infection was noted during the senior year when the students had more contact with tuberculosis patients. Of the 449 students in this group, 160 (35.6%) reacted to the test on entrance, 145 (32.3%) became reactors while in school, and 144 (32.2%) were non-reactors on graduation.

This group has been followed as closely as possible since graduation. Of the 449 graduates 369 have been heard from. Of these 102 were from physicians

who did not react to tuberculin at the end of the senior year. Sixty-five of these have had skin tests since graduation among whom 30 (46.2%) became reactors as interns, 15 (23%) became reactors following their internships and 20 (30.8%) are still non-reactors. With the data gathered subsequent to graduation it is known that 350 or 78.2 percent of the 449 students have become positive reactors.

A control group of students from the College of Education were observed--coming from the same general environment as those of the medical school although in general a year or two younger and having no tuberculosis contacts involved in their work. On entrance to the college 24.8 percent of the students reacted positively while on graduation 28.5 percent were tuberculin-allergic. Thus only slightly more than one percent of the non-reactors became infected last year. According to these results and those of Stewart (32) the infection rate of the community studied is about one percent, also.

Among the 160 students who had primary complexes on entrance to the school of medicine two developed clinical tuberculosis prior to graduation and three developed the disease after graduation a total of 3.1 percent.



apparent from his figures that the occurrence of disease in those students tuberculin negative on entrance to the university was twice that of those entering with an established primary complex, but he makes no special mention of the fact.

Soper and Amberson (6) summarize the situation as to medical students as follows:

"They are as a rule, less rapidly and less certainly infected than pupil nurses, but they still acquire infection to an excessive degree. The morbidity among them appears to vary. It seems alarmingly high in a few instances, but not in the majority of schools whose figures are known. Many of the leading schools have already instituted programs of prevention and case finding. Where a definite program is lacking there is an increasing consciousness of the problem and effort to cope with it. The mortality seems not unduly high, probably because the cases developing are apt to be diagnosed and treated early."

COMPARATIVE DATA--IS THE  
APPARENT HAZARD REAL?

There has been presented a rather extensive survey of the work being done at the various universities

throughout this country and a few in Europe. Various sets of figures have been obtained as to the incidence among medical students of tuberculous infection. Some men have already drawn comparisons with other groups of similar age and social status, still other investigators have pointed out the need for adequate comparisons before definite conclusions can be reached.

Some of the comparative data which has been gleaned from the literature will here be presented. Myer's (3,10) comparative figures of the College of Education have just been mentioned, however there is a discrepancy of age in that group which on the other hand could not explain the very much higher incidence of infection and morbidity.

In some of the Eastern schools infection as indicated by the tuberculin test shows very little difference in occurrence among students of medicine, law, dentistry--as at Pennsylvania (30) we see 98.2, 97.2 and 100 percent positive reactors respectively in fourth year students. There is found, however, a much higher incidence of advanced infiltrations, 5.3 to 11.5 percent in medics as against 2.2 and 2.4 percent for dental and law students.

Michigan (19) shows comparisons of 3.24 cases per 1000 in medical students with 3.22 in graduate students

in general an incidence which would tend to minimize the problem. Stiehm (20,21) at Wisconsin had 55% reactors to tuberculin as seniors at medical school and an average of about 50% reactors at ages 25-30 for the whole university. Hedvall (27) at Lund presented convincing comparisons with twice as many cases diagnosed in medical students as were discovered in a group of law, philosophy and theology students which numbered 5 times as many as the medical group.

The compilation of data from the Tuberculosis Committee of the American Student Health Association (33) show an average of 50.2% reactors in the age group 26-30 and at the University of Washington (34) the 26-30 age group showed an incidence of 42.4% positive reactors. These figures should be comparable to those of senior medical school classes and are definitely lower.

Lindhardt (35) found in Denmark 1925-34, a three and one half times higher morbidity in physicians and medical students than in other groups based on age grouping of 25 to 34 years.

Fellows (36) found among employees of the Metropolitan Life Insurance Company an incidence of 1.66% in age group 20-24 and 3.79% in age group 25-29 the latter figure not being much below the 4% morbidity

Brahdy (39) also, argues that if exposure in hospitals increases the morbidity of clinical tuberculosis in later life, there should be an increased mortality from tuberculosis among nurses and physicians. Quoting Whitney's statistics, he shows that death rates from tuberculosis among physicians are among the lowest compared with those of other occupational groups. He says, "In spite of the theoretical possibilities, one must accept the fact that the group most exposed to tuberculosis in adult life, namely the physicians, does not have any more fatal tuberculosis than others of the same social-economic class. Whatever may be the reason for the high mortality among some of the social-economic groups, occupational contact in adult life with tuberculosis patients is certainly not a factor."

Dr. Harold S. Diehl (40) of the University of Minnesota presented very interesting comment in discussion of these statements made by Brahdy in 1939:-

"Dr. Brahdy's paper is to me both reassuring and disturbing. It is reassuring to know that as dean of a medical school I need not feel responsible for any undue mortality from tuberculosis among young men and women who become infected with tuberculosis while they are students of medicine or nursing. At the same time,

I am seriously concerned for fear that this presentation may give rise to a false security and a disregard of the hazard of the patient with open active tuberculosis. Dr. Brahdey's data indicate that the mortality rate from tuberculosis among physicians and nurses is not excessive in comparison with the rest of the population. This, however, takes no account of the years of complete or partial disability, the modified lives, the changed careers which many physicians and nurses undergo because of this disease. Physicians and nurses who contract tuberculosis usually receive the best of medical care, and the result is a low mortality; but what about the morbidity? Dr. Brahdey has spoken about this also but on this point his conclusions are at variance with those of practically every one who has seriously studied this question."

Thus we see that in spite of the vast amount of work which has been done on the subject there is still a great deal of controversy among some observers as to whether there really is a greater tuberculosis morbidity among medical students than among similar groups of equal age grouping and economic status. From the work of the more thorough investigators, however, there is apparently a considerably higher morbidity and a definitely higher primary infection rate. The meaning

and significance of adult primary infection from the standpoint of the individual's future health is a much debated question and a full discussion is beyond the scope of this paper. Many notable articles have recently appeared in relation to this subject. (41,42, 43,44,45,46,47). Some of the more recent views will be presented later on.

#### SOURCE OF INFECTION FOR STUDENTS

Granted that there is a greater occurrence of tuberculosis among medical students, what is the source of infection? Myers (2) writes in answer to the query:

"Large numbers of explanations have been given for the prevalence, such as bad air of dissecting rooms and overwork of the student. One wonders how the list of possible causes could have been so nearly exhausted without mention of the only true cause of the great prevalence of tuberculosis among nurses and physicians, namely, the tubercle bacillus. Here we have the complete explanation of the prevalence of tuberculosis not only among students of nursing and medicine but also among graduates in these professions."

It was formerly believed that a good percentage

of the tuberculous infection was of endogenous origin because of general health breakdown, but now it is quite generally conceded that the greater percentage is of exogenous origin. (5).

Myers (46) early suggested the probability of infection of medical students and nurses on the wards of general hospitals from the unsuspected cases of active tuberculosis which co-exist with some other diagnosed disease for which the patient is being treated. He reports (2) that he investigated one hospital by xraying all patients in one wing to see if there might be any undiagnosed tuberculosis. There were less than 20 patients examined yet 2 were found to have frank pulmonary tuberculosis--undiagnosed--and were being cared for by students without any sort of protection. He emphasized the fact that tuberculosis is communicable just as scarlet fever, diphtheria etc. but usually there is a longer period between the time of exposure and the development of disease to such proportions as to cause illness with a resultant loss of appreciation of the contagious nature of the disease.

Many <sup>Papers</sup> have been published by the Minnesota group recounting cases which, after known contacts with tuberculosis patients, have come down with clinical disease. The effect of work on tuberculosis wards is vividly

illustrated in Table 10 showing the results of tuberculin testing in nurses of several different schools of nursing, some requiring a tour of duty on tuberculosis wards and some not. (1)

(Table 10 is found on the following page)

Boynton (49) found at the University of Minnesota also, a tuberculosis infection rate 100 times greater in the student nurses on general hospital service than in students of the College of Education, and 500 times greater in student nurses on special tuberculosis service. These statistics rather definitely point to the general hospital wards as a potent source of infection for students and to the tuberculosis wards as a particularly virulent source.

Riggins (50) in studying several New York hospitals decided that there was no greater incidence of infection--development of tuberculin-allergy--following service on a tuberculosis ward than in the general wards. His studies of hospital personnel especially nurses showed that about 55 percent were positive on entrance and that 85-92 percent of those who were negative become positive. Probably the studies of Myers and Boynton give a clearer picture of the effect of services in various wards because of the smaller number of positive reactors on entrance. Riggins



TABLE 10

Type of school	No. of students	% Pos. entrance	% Pos. grad.	% neg. to pos. increase	Lesions diagnosed
College of Education	224	24.8	28.5	5.3	0
School II No. TB Service	120	15.0	41.2	34.3	3
School III no TB Service	204	24.5	45.6	27.9	2
School IV 6 weeks TB Service	550	30.0	67.1	33.0	30.
School I 12 weeks TB Service	226	21.2	81.8	77.0	16

makes note of a higher incidence of clinical disease in the group which entered the hospitals tuberculin negative. He believes this to be an indication that those students tuberculin positive on entrance to school tolerate re-infection during their course better than those who were negative on entrance tolerate first infection.

Early in the work at Pennsylvania an effort was made to trace the source of infection. Pepper (51) commenting on the work of McPhedran, et. al., states, "Studies made to ascertain from where those students with tuberculous lesions became infected have not uncovered any clues. Our students handle specimens removed at autopsy made on tuberculosis patients. Very much of our clinical teaching is done at the Philadelphia General Hospital which cares for a large number of tuberculous patients. But our medical students do not seem to be more liable to other ailments than the rest of the University students."

It has been noted at Pennsylvania as at Minnesota that the greatest increase of infection is in the years when the students have their clinical work. Lees (52) states that the increased morbidity is not gradual through the four years but jumps considerably during the 3rd and 4th years. He says, "The distribution of cases in the clinical years of training as

contrasted with non-clinical years, approximately eight to one, has followed much the same pattern during the past five years."

At Lund, Sweden, extensive work has been done in an attempt to determine the source of the excessive infection evidenced by the studies of Hedvall (27). It was found that the students live practically the same as other students at the university--some clubs, meals, living quarters, and about the same number are tuberculin negative on entrance. Much of the increase of infection was noted at that school prior to any sort of hospital work. The course in general pathology was suspected and investigated by use of tuberculin testing before and after the course. The results seemed to indicate that quite a number of students became positive following this course. An exhaustive search for the infective source revealed tubercle bacilli in rooms 24 hours after autopsies in spite of precautions. They even decided to cut down the number of autopsies on tuberculous patients. This has been in force for about two years and appears to have given results in that tuberculin negative students are remaining so through the pathology course.

Hedvall also noted the marked increase of morbidity with the entrance of students into the

clinical years of study when active tuberculous patients might be contacted. Thus the incidence of cases by years at Lund was 0--4--10--10--10--6--4--2--1 in the nine years for which data were available-- the greatest incidence showing up in the 3rd to 5th years when clinical exposure was greatest.

Again Myers (10) reports the following statements from the Central State Hospital at Indianapolis in 1932, "Since 1896 all the autopsies were performed in the large amphitheater, which is also used for clinical instruction of medical students, nurses, and social workers. During the performance of every autopsy on patients who died of an infectious disease such as military or pulmonary tuberculosis, streptococcic septicemia, typhoid fever, there is a certain spreading of infectious organisms. It is practically impossible to disinfect safely the autopsy table and its immediate surroundings after every autopsy. In the interest of the students who receive clinical instruction in the amphitheatre we removed the autopsy table to other quarters, since in our opinion the postmortem table and its surroundings constitute at times a distinct health hazard."

An interesting speculation is presented by Soper and Amberson (6) in relation to source and severity

of infection in students of medicine and nursing. It follows:-

"Infection of nurses and medical students is presumably most often by aspiration. Scheel (7) cites the experiments of Chausse and of Lange to the effect that larger droplets adhere to the tracheal tract and bronchial mucosa and are expelled by the ciliated cells; that smaller droplets containing only one bacillus or a few units may be inspired into the lung alveoli. Slight infections would accord with relatively long periods before allergy develops and pathological changes become manifest by x-ray. Is it not perhaps assumable that the positive tuberculin reactions acquired by medical students and nurses may be from very few bacilli in one institution and, therefore, accompanied by but little manifest disease; that in another institution more bacilli are offered, and to the degree of producing an alarming amount of disease? In both instances there might be a parallel increase in the number of positive reactors to tuberculin."

Many investigators (Brahdy (39), Riggins (50) Heimbeck (15,16,17) have called attention to the greater morbidity in tuberculin negative students and the question is presented as to whether this acquisition

of the primary infection at about the age of 20 produces more tuberculosis in later life. And also the question is raised whether a positive tuberculin reaction gives any protection from further exogenous infection. Is it better to have a positive or negative tuberculin test?

As to the significance of primary infection in young adulthood Myers (2) writes,

"The student who has not already been infected is in the same situation as the uninfected infant; that is he is susceptible to infection, and if infected will develop the primary complex. This initial infection carries some hazard of developing into a continuously progressive disease, but it is usually passed through without symptoms, after which the individual is in the same situation as are those who have developed primary complexes earlier in life. The person who reacts positively to tuberculin and is in good health has shown his ability to resist tuberculous infection and probably has developed more or less immunity to the infection. On the other hand, his tissues are allergic to tuberculin and if they are unable to destroy such exogenous infection as he may later take into his body he may develop a destructive, so-called reinfection type of tuberculosis. Furthermore he harbors in his

body a focus of living tubercle bacilli, which if his resistance is lowered may spread to set up an endogenous reinfection type of disease. From these comments it is obvious that whether one reacts positively, or negatively to tuberculin it is best to avoid infection and, if one becomes infected, to recognize the condition and place it under treatment just as soon as possible."

As to the question of immunity produced by tuberculin-allergy, Soper and Anderson (6) have presented the present day point of view in all its variable degrees. I quote from them directly:--

"The question enters as to whether an earlier infection manifested by definite allergy gives any protection from further exogenous infection. Where the number of observations is sufficiently large and sufficiently controlled there seems to be little argument. The Norwegians are convinced of this protective action and Heimbeck and Scheel are so certain of it that they vaccinate originally negative nurses and students with BCG and are not satisfied unless allergy is produced therewith. Indeed, Heimbeck's (36) last sentence in an article in 1933 was, 'Tuberculosis allergy is tuberculosis immunity, regardless of whether it is produced by tubercule bacilli or BCG.'

"Allen Kratze has always maintained that allergy

is accompanied by relative protection, and we personally agree. If one discards this concept he disregards a great mass of painstaking experimental work and a long series of attempts at active immunization of man and cattle. No one maintains that the protection conferred by an existing infection against exogenous infections is absolute. But one is justified in maintaining that relatively much protection is conferred, enough, in the opinion of many, to more than offset the harmful effects of allergy. However, the point seems relatively unimportant unless one acts upon his conviction to the extent of excluding either the allergic or the non-allergic student. What really is vital is the avoidance of infection."

#### CONTROL OF INFECTION

Myers (4) wrote in 1933 in regard to the necessity for some rational sort of a program of attack on the problem of tuberculosis in medical students:-

"Our observations on students of nursing and medicine during the past 12 years have convinced us that it is a reflection upon the professional schools to have students report with such symptoms as pulmonary



hemorrhage, loss of weight etc., and find that they have a moderately or far advanced pulmonary tuberculosis. Because of the chronicity of this disease their lesions could have been detected months or even years before if school authorities were on the alert with tuberculin tests and chest x-rays. The necessity of such careful observations of students of medicine and nursing should be so impressed upon all students that they will continue it throughout their practice."

It has been largely through the efforts of such men as Myers that the extensive case findings surveys as presented earlier in this paper were instituted. In 1938 Hirsch (53) reported a survey of medical schools to determine the number of schools supporting an active program. Forty-one of seventy-seven schools responded to questionnaires and of these forty-one 28 reported having an active case finding program. In 21 schools it was obligatory and in the remaining seven it was available to all students, but from 33 and 1/3 to 100% availed themselves of the service indicating that medical students too are blind to their own advantage--hence the import of Myers last statement above.

The efficacy of the case finding technique should no longer be in doubt. Myers (3) sets a standard--

at least once a year the tuberculin reaction should be determined or preferably every six months. Positive reactors should be x-rayed on admission at least and followed with x-rays according to the tuberculin reaction. Any lesions found should be studied and if treatment is indicated it should be instituted at once, otherwise the lesion should be watched carefully. Controversy as to the 100% reliability of the tuberculin test must be thrashed out by further investigation-- until that time it seems that the views of Myers are perhaps the more rational.

The question of immunity has been mentioned before. There have been advocates of BCG vaccination and there have been those who advocate excluding negative reactors from courses which entail exposure to tuberculous patients and on the other hand there have been some writers who suggested the elimination of positive reactors. These latter suggestions would be difficult to carry out; --to find originally positive reactors in the mid-west or originally negative reactors in the eastern metropolitan areas might necessitate considerable search. (Myers (43))

As to the use of BCG vaccine the Tuberculosis Committee of the American Student Health Association in its Ninth Annual Report (54) sums up the attitude of American workers toward its use quite thoroughly. Quoting from their report:--

"Mention has been made of special hazard groups, and we shall attempt to state the position of the Committee with regard to routine BCG inoculations for undergraduate students. Some schools have asked our opinion, citing results claimed in certain European countries. We would be very reluctant to appear to oppose properly controlled experiments with BCG or any other ethical product. However, we feel it fair to state we have yet to be convinced that BCG vaccinations of adults result in definite prevention of infection with virulent tubercle bacilli, when, later, exposure to such infection occurs. Larie, in a very comprehensive review stated recently that we cannot hope for BCG to protect against serious exogenous reinfection in adults."

As to prophylaxis--reduction of exogenous infection to a minimum--what has been done? At Ancker Hospital in St. Paul Gear (55) has instituted what is termed a strict aseptic technique to apply alike to all who come in contact with tuberculosis patients: nurses, students, physicians, personnel, visitors--a very elaborate set-up with use of not only gowns but caps and masks. Stiehm (21) at Wisconsin advises utmost precautions and Myers (2,3,56) advises safeguard for students from points of exposure in clinics

and laboratories and in sanatoria or tuberculosis wards--  
"an isolation technique adequate to protect all  
personnel should be observed, if not, the value of  
the experience in the light of the hazard should be  
weighed." (3)

Soper and Amberson (6) go on to say:-

"Institutions will go to differing lengths to  
prevent infection, but certain minimum measures  
should always be taken. There should be a contagion  
technique, at least to the point of wearing of special  
gowns and frequent washing of hands; methods of  
autopsy rooms and laboratories should be carefully  
scrutinized; every medical and nursing student,  
before beginning work with tuberculosis patients, should  
be carefully instructed as to hazards and as to the im-  
portance of technique, especially that of the patient's  
completely covering his mouth with sufficient layers  
of paper to retain expelled droplets; living and  
working conditions should be thoroughly healthful.  
In addition every effort should be made to discover  
tuberculosis in unsuspected cases admitted to the  
general hospital for conditions other than tuberculosis.  
The ideal plan to this end would be a roentgenogram  
of all cases on admission regardless of diagnosis, and

routine examination of the sputum, whenever present, for tubercle bacilli. The unrecognized case of open tuberculosis in the general ward is a serious menace." Routine tuberculin testing and chest x-rays of patients entering the University of Minnesota Hospital have shown interesting results in Myers experience (2,3) and Hodges (57) presents data of similar import following an eleven day survey with routine chest plates of all admissions to the University of Michigan Hospital.

Nelson (58) intimates that a program of routine x-rays on admission to the hospital might be difficult to carry out universally until the general public is better informed about this disease and could fully appreciate such a procedure. He suggests that until the medical profession itself is more alert to the presence of unrecognized tuberculosis in general hospitals a routine sputum on all patients who cough or expectorate would discover the more advanced cases that are a menace.

Dobbie (60) in a recent article gives a comprehensive summary of what should be included in a "rational technique for safeguarding of hospital personnel and medical students." and Soper and Amberson (6) close their discussion of the preventative phase of the subject with the following statements:--

SUMMARY AND CONCLUSIONS

Dloch (61) of the University of Chicago, writing in February 1941, seems to believe there has been an over emphasis of the problem of tuberculosis in medical students although he apparently bases his belief on some of the less thorough studies. He says:

"Probably more than half of the reports published on case finding in adults concern themselves with university students, hospital personnel and student nurses, with special interest in medical students. Consequently a rather exaggerated impression of the importance of the tuberculosis problem among these groups has become wide-spread. Brady (quoted earlier, (39)), thought the incidence of tuberculosis among hospital personnel is about the same as that in any similar group. This coincides with the findings at the University of Chicago....Of course, the health problem of students and especially medical students, as well as of hospital personnel, should be one of great concern in any medical school or institution and there should be no limit of protective measures against danger of tuberculosis. However, beyond the best attainable health protection, we of the medical profession will still incur unavoidable hazards

which are the duty and privilege of our calling. The elimination or curtailment of the badly needed and widely neglected training of medical students and nurses in chest diseases would be as little justified as their avoidance of contact with other and more acute infections. Certainly, the assumption that tuberculosis in universities and medical institutions is a public health concern of major proportions is erroneous. Measured against the problem in other groups of the population it can be taken only as the preliminary of a great attack against the enemy's main position. The student of medicine and nursing has been the fitting object of a study in the epidemiology of tuberculosis, but disproportionate emphasis on his problem is not justified."

In spite of Block's attempt to minimize the possible hazard encountered by medical students in contacting tuberculosis we find in this review of the literature a few facts which rather definitely point to a high incidence of tuberculous infection. In the East--in metropolitan areas, medical students enter school about 50 to 60 percent positive reactors to tuberculin while they graduate 90 to 100 percent positive. These figures hold for European schools. It is interesting to note, however, that other

graduate students show a similar increase of infection.

In the South the rate of infection is somewhat lower than in eastern states, but in the mid-western states we find a much lower entering infection rate about 25 to 35 percent, with senior students reacting in about 60 to 70 percent of the cases. Here in the mid-west is also seen the most striking increase in tuberculin reactors following service on tuberculosis wards or general wards of hospitals.

As to morbidity from tuberculosis among medical students opinions and statistics vary greatly. It is definitely high in European schools. Statistical estimates have run from 2 to 11.3 percent of morbidity. Myers, at Minnesota, tends to show a high morbidity for the age group and social status. Hetherington, (31) at Pennsylvania summarizes the results of investigations at that institution by saying, "It appears that medical students and physicians despite an unusually high incidence of tuberculosis lesions have an incidence of clinical tuberculosis that is probably not strikingly greater than that in laymen of the same age."

The mortality from tuberculosis among medical students is definitely low and should be because of superior facilities for treatment available to physicians



Error- page 6-- paragraph should read:-

The most significant thing he noted was in relation to Trudeau Tuberculosis Sanatorium where from 1922 to 1930, of 143 medical students and doctors admitted, 70 per cent were moderately or far advanced cases, while for the same period 79 per cent of all patients entered in the same classification indicating a lack of careful observation of the disease even in the professional men. (9)

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