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## Sydenham's chorea

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SYDENHAM'S CHOREA

Senior Thesis

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## Introduction

Chorea is a symptom, and in designating as such the spasmodic affection which occurs in the first two decades of life, we are using a term inherited from the epidemic chorea major of the middle ages. Depending upon the beliefs of the time and the locality of its occurrence, this disease has been called: St. Vitus's dance, St. Guy's dance, St. Anthony's dance, dance of St. Modesti or St. John, Tigretier, Tarantism, the dancing mania, choromania, tanzeplage, orchestromania and chorea Sancti Viti. Sydenham was the first to recognize the chorea of childhood as a separate entity, and, unfortunately, he used the name chorea Sancti Viti, first introduced by Paracelsus, in specifying a condition of an entirely different nature. Two centuries have so modified its original meaning that now St. Vitus's dance refers only to the disease in childhood. Recently, since the infection theory has gained precedent, many authors have suggested there is more than one type of the original chorea minor, and would distinguish between an infectious and functional chorea. This division is based chiefly on the preponderance of either psychic or pathologic symptoms in the cases presented to them. In this paper no such division will be attempted but the subject will be treated in its entirety under its original title, namely, Sydenham's chorea.

### Historical

The disease of childhood, which Osler has called chorea minor, was first recognized by Sydenham, who incidentally gave an accurate description of the condition as we now see it, in his *Schedula Monitoria* (1686) and his *Processus Integri* (1693). His description is as follows: "St. Vitus's dance is a sort of convulsion which attacks boys and girls from the tenth year until they have done growing. At first it shows itself by a halting, or rather an unsteady movement of one of the legs, which the patient drags. Then it is seen in the hand of the same side. The patient cannot keep it a moment in the same place, whether he lay it upon his breast or any other part of his body. Do what he may it will be jerked elsewhere convulsively. If any vessel filled with drink be put in his hand, before it reaches his mouth he will exhibit a thousand gesticulations like a mountebank. He holds the cup out straight as if to move it to his mouth, but his hand is carried elsewhere by sudden jerks. Then perhaps, he contrives to bring it to his mouth. If so, he will drink the liquid off at a gulp; just as if he were trying to amuse the spectators by his antics.

"Now this affection arises from some humor falling on the nerves, and such irritation causes spasm". (53)

Prior to Sydenham, epilepsy, hysteria, chorea, various tics, habit spasms and the like, had been considered together. Medicine had inherited from the primeval ages <sup>the belief</sup> that epilepsy implied demoniacal possessions. The Greeks regarded clonic accidents

as soul racking visitations of a divinity. Hippocrates maintained that epilepsy was hereditary and due to phlegm on the brain; while Galen believed it due to an obstruction of the cavities of the brain by phlegm or black bile. Both confounded delerium and "jactatio" of febrile origin with the psychoses. However, the explanation of these great physicians gained little popular credence, and during the middle ages religious fanaticism again dominated the interpretation of nervous phenomena.

Hecker (42) relates, that as early as 1434 assemblages of men and women were seen at Aix-la-Chapelle who had come out of Germany, and who were affected by a common delusion. In those in which the disease was completely developed, the attack commenced with an epileptiform seizure, then, suddenly springing from the ground, they would dance until exhaustion overcame them. In a few months, this disease had spread to the neighboring Netherlands and Belgium. The onset of the first dances appeared in July, just prior to the orgies of St. John's day, and, "the conjecture is probable, that the wild revels of St. John's day, A. D. 1374, gave rise to this mental plague, which thence forth has visited so many thousands with incurable aberration of mind and disgusting distortions of the body." He also tells of similar traditional maladies which occurred in the years 1027, 1237 and 1278. Strassburg and towns of Belgium were visited by the "Dancing Plague" in the year 1418. Those

affected were conducted to the chapels of St. Vitus whose marvelous healing powers, at that time, had gained recognition.

A legend was invented at the beginning of the fourteenth or fifteenth century, that St. Vitus, who suffered martyrdom under Diocletian in the year 303, prayed to God that he might protect from the dancing mania all those who should solemnize the day of his commemoration. His body was moved from its original burial place in Florence, first to Apulia, thence to St. Denys, and finally, in the year 836, to Corvey. Many priests and chapels claimed to be in possession of parts of this body, which, it was believed, had indiscriminate influence on all diseases and especially those of the demoniacal kind.

During the sixteenth century no new epidemics arose, and the disease seemed to have disappeared. However, a similar affection, thought to be caused by the bite of the tarantula, and called Tarantism, reached its height in Italy during the seventeenth century. Robert Watt (100) tells of the execution of three men and four women in 1697, whose evil influences were thought to have produced symptoms resembling the epidemic St. Vitus's dance. In the Tigre country of Abyssinia, as late as 1832 there existed a like condition called Tigretier. Much the same as Tarantism this malady could be relieved only by dancing to the accompaniment of music until exhaustion intervened. There existed in Paris uninterruptedly from 1731 to 1790, a sect known as the Convulsionnaires, whose delusions were of the same genesis as the earlier disease;

and till 1832, there still existed a remnant of this group. The denomination of English Methodists known as the Jumpers, founded in the county of Cornwall in 1760, in many respects excelled the French Convulsionnaires in their religious frenzy. At about this time another group of religious fanatics appeared in Scotland and the Shetland Islands. Felix Robertson (79), in his doctorate thesis at the University of Pennsylvania in 1805, gives an account of epidemics of involuntary gesticulations stimulated by religious zeal, as they occurred in Tennessee, Kentucky and some parts of Virginia from 1800 to 1803. But this outbreak, like others at the end of the eighteenth century, existed in isolated districts, where the majority of the population remained untouched by the growing scientific attitude toward disease. Sturges (91) remarks, "that there is ample evidence in the experience of the present, as well as in the dancing and jumping manias of the past, that convulsive seizures need external support for their perfect exhibition." He further points out, that knowledge that the individual symptoms will be recognized and discredited by the bystanders, makes the circumstances most favorable for their suppression.

In the past, physicians were willing to concede the little understood nervous disorders to the priesthood, whose exhortations often accomplished more than medical science could offer. Nevertheless, explanations were attempted, altho it is true, many times they were incomprehensible. Thus in 1363 Guy de Chauliac stated that epileptic convulsions were due to an excess of humidity; and Ambrose Pare, believed



epilepsy, catalepsy, lethargy and apoplexy were, like hysteria, purely of uterine origin. Paracelsus, at the beginning of the sixteenth century, first studied the disease which he called chorea Sancti Viti, or the lascivious dance. He divided the individuals so affected into three classes: " (1) Those in which it arose from the imagination; (2) those originating from sexual desire, depending upon the will; and, (3) those arising from corporeal causes." In 1667 Willis regarded the central nervous system as the seat of all convulsive accidents, and in 1686 we find Sydenham interpreting the chorea of childhood as an affection of the nerves.

During the following century little progress was made in the organic approach to the disease, and not until the onset of the modern concept do we find much reference to it. Osler (69) dates the beginning of this period from the monographs of Bouteille (1810) in France and Bernt (1810) in Bohemia. Bouteille gives an accurate clinical and historical description, and makes a classification into essential, or protopathic, and secondary, or deuteropathic. He also seems to have been aware of the association, in many instances, with rheumatism. Richard Bright (7) mentions that in the "Syllabus of the Practice of Medicine", published at Guy's Hospital in 1802, "rheumatism is distinctly mentioned as one of the existing causes of chorea". He has often been credited with the introduction of the rheumatic theory of the disease, as have Thomson (92) and Roger (81). Whatever the origin of the association of chorea with the rheumatic

diathesis, it stimulated more intense study, and, since then, many noteworthy contributions have been made by investigators both in this country and abroad. No convincing evidence of its true nature has been produced, however, the rheumatic hypothesis has now gained popular favor. It must be admitted that Sydenham's chorea remains the enigma it was at its inception as a distinct medical disease.

### Etiology

Age: It is generally agreed that by far the majority of cases occur between the ages of five and fifteen years. Stephen Mackenzie (58), in his study of 439 cases, found 43 per cent existing from the tenth to fifteenth years, and 34 per cent from the fifth to the tenth years. Abt (1), reporting on 226 cases, states that the ages ranged from three and a half to eighteen years, but that the greatest number were between the ages of five and fourteen. Burr's (9) analysis of 515 cases reveals age limits of five and sixteen years, with the eighth, ninth and tenth years making the top of a curve. This is in accord with Osler's (69) figures in 1894, based on 522 cases from the Philadelphia Infirmary for Diseases of the Nervous System and the Dispensary for Disease of the Nervous System, John Hokins Hospital. Of this group 380 fell between five and fifteen years, and more than three fourths occurred during the second and third hemi-decades. He makes the observation that the age incidence is somewhat earlier in the United States than in Great Britain, and that females are afflicted earlier than males.

Sex: Females are attacked in a proportion of about three to one. The figures in the past have usually ranged from more than two to one, and seldom more than three to one. Fletcher (31), and Poynton and Paine (72)

place the incidence at three to one, while, more recently, Waggoner (98) has placed it at two to one. Osler (69) reports that about 70 per cent of his cases were females; but that the preponderance of females is much greater after puberty- three and four tenths to one.

Station in Life: Altho chorea is a disease of all classes it is more commonly encountered in the poor. It is essentially a disease of cities. In the poorer school children of London, the disease is prevalent, and Poynton (73) remarks that wet boots, hurried breakfasts, poor clothing, lack of proper recreation, noise nuisances, late bed time, etc., are probably significant factors in its development. The type of food and the amount of sunshine and recreation appear to be equally important.

Race: It is true that, altho chorea seems to be more common in the poorer classes, it is comparatively rare in the American negro. As a result of an inquiry sent to doctors throughout the southern states prior to 1885, Weir Mitchell (66) makes this observation. Burr (9) records only five in his list of 515 patients. In his series, Waggoner (98) found the highest per cent in the American or mixed stock, the Irish second with 23 per cent, the Hebrews next with 21 per cent, and the Hungarians and Italians each with 8 per cent; but there was only one pure negro in the group. No patient of this race has come to my attention and it is the opinion of pediatricians and neurologists of this city,

that such cases are rare indeed.

Season: In the Middle West, at least, most cases are seen during the Spring and Fall months. See (85) believed that three fifths of the cases occur during the six Autumn and Winter months, while Mitchell (66) thought the greatest incidence during March and April. Morris J. Lewis (55) found that in 717 cases, the onset occurred in November, in 3.3 per cent, December 7.8 per cent, about the same in January and February, rising to a height of 14 per cent during March, falling to 8.7 per cent during April, rising again to 11.1 per cent in May, then steadily decreasing until November. He minimizes the role of study in predisposing children to chorea and suggests it is probable that "weather" is a more important factor. The present views have changed in accordance with the greater popularity of the infection theory, and seasonal fluctuation of chorea is now generally regarded as dependent upon a coincident prevalence of acute infectious disease during these months.

Rheumatism: The association of rheumatism with chorea was recognized at the beginning of the last century. Richard Bright (7) mentions that in 1820 rheumatism was said to alternate with chorea. Prior to Bright's observations, Copeland (16) sought to explain the rheumatic origin of the disease on the basis of, "metastases from the joints to the membranes of the spinal cord." His views were somewhat in accord with those of Pritchard (75) who, reporting

several fatal cases, one in which there was a pericarditis, states, "the disease seemed to have arisen from the metastases of rheumatism." In 1841, Babbington (2), of Guy's Hospital, wrote that, "Rheumatism also, when it affects the heart and pericardium may give rise to the disease, through the irritation of the plexus and ganglia, which so entirely surround that organ and the origin of the great vessels." He credited his associate, Dr. Addison, with this observation, altho Bright, previously had published his opinion that rheumatism is a cause of chorea, and endocarditis is the connecting link between the two diseases. As early as 1840 we find Todd (94) teaching that rheumatism, endocardial affections, and chorea, are all a part of the rheumatic diathesis; however, because of negative post-mortem findings, he continues to believe that chorea is essentially of functional nature.

The French writers, Germain See (85) and Roger, (81) were responsible for a greater interest in the rheumatic aspects of the disease. See concluded, that of two rheumatic infants at least one will be choreic; and of five choreic children there are two rheumatic. Roger was the first to suggest that articular rheumatism, chorea and heart disease (endocarditis) are three terms of one and the same pathological state or phase- an opinion that is held by the majority today. On the contrary, the German authors did not stress the incidence of arthritis, and Steiner (90), of Prague, reported only four cases of 252 in which it was present.

In England, statistics were accumulating, and in 1881 Sturges (91) writes: "That the proportion of chorea showing antecedent rheumatism does not exceed 25 per cent of the whole number where children up to 12 year old are taken (viz. 20 per cent in my own 132, and at the rate of something under 26 per cent in Dr. Dickinson's 71 (Guy's Hospital)); and some where between 26 and 28 per cent where there is no age limitation (viz. 26 per cent in St. George's 50, and 26 or 28 per cent in Dr. Peacock's 92)". That these earlier statistics are inaccurate cannot be doubted, for not only was there a great discrepancy in the interpretation of symptoms, but oftentimes, when rheumatic manifestations were not particularly searched for, they must have been overlooked. It is probable, since Osler (69) had included in his history forms questions concerning rheumatism in these cases, that his figures are comparatively honest. In Philadelphia he found an incidence of 15.8 per cent who had had acute or subacute articular swellings, either prior to, with, or subsequent to chorea; and of 175 cases in the John Hopkins Hospital, 18.24 per cent had a history of arthritis. Poynton and Paine (72) in 1905, expressed the belief that the majority of the cases were rheumatic in origin; and more recently, Poynton and Schlessinger (73) have reported that in 1108 cases of first attacks of acute rheumatism under twelve years of age, 613 showed chorea. In Abt's (1) 226 cases, 13 of 143 gave a history of articular rheumatism, 8 a history of pain in the legs, 1 pain in the hip, and in

119 he was able to discover no evidence of preceding rheumatism. In Burr's (9) series, 84 had a definite rheumatic history, 19 came in during the convalescence following rheumatism, in another chorea preceded rheumatism, and 59 gave a history of growing pains.

During the past twenty five years the claims for a specific organism, found alike in rheumatism, endocarditis and chorea, have decidedly strengthened the rheumatic theory of the disease, and now, nearly every medical practitioner is directing his attention in diagnosis and therapy to such manifestations. Helmholtz (43) in making a plea for the specificity of the streptococcus described by Rosenow, cites 138 cases in which 54 per cent exhibited rheumatic symptoms. Abt's statistics reveal an association in 31.46 per cent and Burr's cases, 31.6 per cent.

Tonsils: Focal infections are known to play an important role in arthritis, and it is quite natural that a similar influence should be postulated in chorea. Several investigators have produced choreic symptoms in animals by infecting them with organisms taken from the teeth and tonsils of recognized chorea cases. Morse and Floyd (67) in 1916, found only 11 of their 26 cases had normal tonsils, 42 per cent were diseased, and 4 others had had them removed previously, because of disease; in Abt's (1) series, 33 1/3 per cent had a history of tonsillitis; and 163 of Burr's (9) patients, had had tonsillitis preceding the first attack of chorea, in 93 the tonsils had been removed, and in two cases, tonsillectomy seemed to have been the exciting cause. Bussiere and



Rhea (11) found the tonsils involved in 79 per cent of their cases. Kaiser, in 1927, reported that in a study of 48,000 school children, chorea was found to occur in 0.4 per cent of the tonsillectomized cases and in 0.5 per cent of the non-tonsillectomized. He concludes that tonsillectomy has little influence on the development of chorea, altho carditis is somewhat lessened in the group whose tonsils had been removed previously. Hill (44) states that in 300 non-tonsillectomized cases with rheumatic fever 103, or 34.3 per cent, developed chorea, and 57, or 19 per cent, developed both endocarditis and chorea; while in 50 tonsillectomized cases with rheumatic fever chorea occurred in 16, or 32 per cent, and both endocarditis and chorea in 8 to 16 per cent. Similarly, Gerstley (35) could see no effect of tonsillectomy on the duration of the disease or the prevention of recurrences. Reginald Miller (65) states that chorea is the most likely of all symptoms to recur after tonsillectomy.

Infectious Diseases: Throughout the history of chorea there has been a fruitless attempt to identify it with some infectious disease. Sturges (91) believed that whooping cough was the most frequent antecedent; Trousseau (95) observed that children affected with rheumatism following scarlet fever seldom escaped chorea; Priestly reports that scarlet fever was the only previous disease in 6 per cent of his cases; but Sinkler (86), altho he found scarlet fever frequent in the history, in only 11 of 853 cases did it occur shortly before the onset. Waggoner (98) noted that the precipitating

infection was usually one of streptococcus origin- scarlet fever, acute streptococcus tonsillitis, or an acute rheumatic infection- altho a large number had a history of whooping cough, chicken-pox, and measles; while diphtheria and scarlet fever occurred only occasionally. In Burr's (9) cases 40 had had scarlet fever and 24 diphtheria; but he believed that chorea developed entirely incidentally, and given the proper soil an emotional shock was the immediate precipitating factor.

Syphilis: The possibility of syphilis as an etiologic factor, was first introduced by the French writers. According to Flatau (30), Kowalewsky was the first to propose this question. Milian (63), in 1912, reported that in 73.33 per cent of his cases syphilis was certain, and in 13.33 per cent, doubtful. Babonnieux (3), in discussing Huntiniel's 145 cases, found reasons to justify congenital syphilis in (39) 25 per cent; and Grabois, reporting on the same cases, believed that in 25 per cent syphilis might be considered. (64) In 1914, Milian was of the opinion that all cases were of syphilitic origin, though he seldom employed the Wassermann test to insure his diagnosis. In a study of 33 cases Comby (15) found there was more evidence that latent tuberculosis may be an etiological factor than syphilis, but he recognized that a certain number of chorea cases might also have syphilis. He tested both the cerebro-spinal fluid and blood in seven cases and found them consistently negative. Morse and Floyd (67) believed there was nothing in 21 of their 26 cases to

suggest syphilis, and in only two did they obtain a positive or questionable Wassermann reaction. In the eight cases in which the cerebrospinal fluid was examined all reacted negatively.

Other Factors: It is noteworthy that the literature reveals innumerable possible etiologic factors in chorea. Bastian (4), in 1877, classified chorea as occurring with rheumatic fever as a sequence of fright or in association with anemia, chlorosis, or some other cachectic condition. A more recent case has been recorded in which the removal of an impacted tooth relieved the symptoms. Injection of the nasal ganglia has given relief in another case; removal of eye strain has hastened recovery; and several cases have been reported in which a vermifuge effected a complete cure. These factors serve all the more to direct our attention to the particular diathesis which predisposes to this affection.

Heredity: It is not uncommon to find a tendency to the disease in certain families. Thus Osler (59) cites an instance of 80 cases so related. In Burr's (9) cases, rheumatism was the most frequent disease recorded in the family—more frequent than chorea itself. Occasionally definite psychopathic tendencies are noted. Bastian (4) as early as 1877, stated that chorea patients were usually the offspring of nervous parents. More recently, Diffendorf (23) concluded that heredity influences the forces, direction and development of the disease; and Ebaugh (26) stated that such manif-

estations could be noted in 43 per cent. In Waggoner's (98) opinion, an infection is the precipitating factor, but a predisposition or hereditary component, possibly dependent on an inferior integration of the psychomotor cerebellar mechanism, is essential.

Psychical Influences: The psychic influences have always been recognized to play an important part since chorea was first differentiated from the common hysterical manias. Even today conflicting views concerning the pathology of the disease have led many writers to reconsider the earlier theories concerning its psychogenic origin. Sturges (91) sums up this view, after finding the various organic hypotheses of his time untenable, when he states: "Some structural basis it has no doubt, like all other movements, orderly or disorderly, mental or bodily; but in its ordinary dress it displays none of those symptoms which we have succeeded so far in associating with any material morbid process whatever. . . . I would look to that multiform disorder, whose physical basis has yet to be sought, and which at the next epoch of life, when in its turn the emotional part becomes unduly prominent, is apt to arise in the same sex and the same temperament, upon similar incentive, in strict parallelism with this motor disorder of children." It is most certainly true that the disease is usually seen in the bright, active, ambitious youngster, who is deeply concerned about her standing in school, and who, by virtue of this trait, is constantly striving to maintain or excel the position she has gained for herself. Burr (10),

emphasized, in 1908, that emotional instability is present from the start in all cases and does not develop due to vexation over the uncontrollable twitching; however in 1925 (9), he argued that the disease is not a manifestation of neurotism in the child on the basis of the absence of later neuroses and psycho-neuroses. Recognizing the frequency of chorea in the history of patients admitted to the Colorado Psychopathic Hospital, Ebaugh (26) concluded that the disease is a danger sign for the future, and the patient should be safeguarded from strain, both somatogenic and psychogenic. He believes it is a manifestation of the reaction of the nervous system to repeated infections, to which may be added psychogenic factors leading up to the development of chorea in the same way that mental upset contributes to the etiology of the functional neuroses. Abt (1) finds that worry, grief, environment and neuropathic traits in families are among the most important etiological factors. He sums up his views thus: " I believe chorea is a symptom of a certain nerve condition, depending on various causes". Likewise, Gerstley (37), in 1929, because of disappointing results in treatment directed toward the elimination of foci of infection, was led to doubt the significance of the association with rheumatism. Consequently, in his cases at Northwestern Medical School, he adopted a routine of first, a careful physical examination, next, a social survey, and then, if indicated, a psychiatric examination. In accord with the trend, which now seems to be a reconsideration of the psychiatric aspects, Epstein (29) has advanced

the idea that chorea is primarily a constitutional neurosis occurring most often in childhood when the psychic mechanisms have not acquired poise. Accordingly, he classified the secondary etiologic factors as pathologic, physiologic and psychologic, depending upon what stimulus excites a latent choreic neurosis to an active process. In a survey of the literature it is impossible not to become impressed by the constancy of the psychopathic character of chorea, as compared to the various theories relating to its organic origin. We are forced to conclude that thus far pathology has failed to establish conclusive proof of the essential nature of chorea; and that in directing out therapy so exclusively to tangible rheumatic manifestations, possibly the most important, at least the most obvious, characteristics, have been relegated to an inferior role.

Pathology

Seldom is the chorea in childhood a fatal disease, and in cases that come to autopsy the associated pathologies have so altered the picture that it is has always been difficult to ascertain what might be the choreic lesion. As a consequence, it may still be maintained, that there are no characteristic lesions in fatal cases of chorea. Our knowledge, at the present time, is derived mainly from individual case reports concerning, more often than not, the adult type of the disease; and, while frequently they are contradictory, it is instructive to trace the evolution of hypotheses which have directed our attention to the region of the corpora striata as the most logical site of dysfunction.

As we have seen, the history of the morbid anatomy of chorea first began as an association with endocarditis and pericarditis. It was Todd (93) who first considered the nervous system; and he described chorea as a morbid change in the blood, which, upon adequate cause, leads to a disturbance of the center of emotion. Handfield Jones (48) advanced a step farther when he claimed that the motor or emotional centers fall into a state of paresis; however, it was Kirkes (51) who, as a result of observations made in 1852, first recognized the connection between cardiac vegetations, embolism and brain pathology. His views were accepted and further elaborated by Broadbent (8), Tuckwell (96), Reynolds (78) and others. It soon became apparent,

as recognized by Dickinson (22), and Bastian (4), that not all cases support this conclusion. Dickinson suggested a spinal origin of the disease; but the following year Bastian discounted his views, and on the basis of multiple occlusion of capillaries in the corpora striata, formulated the "hypothesis of thrombosis". Previously, Hughlings Jackson (46), in concurring with the embolic theory, had found the pathology to be "in the nerve tissue forming the convolutions near the corpus striatum, this part of the brain being supplied by branches of the middle cerebral artery". Dana (19), in 1890, analyzed all the autopsies previous to this time and found only 39 in which the condition of the nervous system was satisfactorily described. In 16 cases in which careful microscopic examinations were made, there was intense cerebral hyperemia, periarterial exudations, erosions, softened spots, minute hemorrhages and occasional emboli. These changes were most marked in the deeper parts of the motor tract, particularly the lenticular nuclei and thalami, and in all essentials they resembled those previously described by Dickinson (22) in 1876. Berkeley (6) reported a similar case in 1896. Osler (69) sums up the special histological features recognized in 1894, as chorea corpuscles (so called), described by Elischer (28), and found in the corpora striata and internal capsule; lesions of the pyramidal cells, first mentioned by Turner (97), and; lesions of the medulla and spinal cord. Subsequent investigation gave little confirmation of these findings, but more diffuse lesions were described.



In 1894, Dana (18), reporting on one case of 20 years duration, concluded that the pathology was either meningeal or superficially cortical; so far as the brain is concerned and in the blood vessels of the spinal meninges where it irritates the nerve roots- altho he found degenerative changes extending into the capsule and lenticular nucleus. Poynton and Holmes (71) first suggested the idea that chorea is a meningo-encephalitis. In 1908, Delecourt and Sand (20) described their observations as hyperemia, perivascular infiltration, alterations in the nerve cells, especially of the cortex and basal ganglia, with secondary neuronophagia and nuclear and fibrillary gliosis. Guizzetti and Camisa (41), in two fatal cases, believed the pathology to be a disseminated encephalitis involving the pia; and Marie and Tretikoff (59) found the greatest extent of inflammation equally at the level of the basal ganglia and over the cerebral cortex. It has been questioned by Wilson and Winkelman (103) if this latter case did not represent a true encephalitis, for in their two cases they could find no changes more than would be usual for a febrile condition. On the other hand, Greenfield and Wolfsohn (40) believed that the "pathological basis of chorea minor is a diffuse or disseminated encephalitis affecting chiefly the corpus striatum and involving the cortex and pia arachnoid". Ziegler's (105) findings in one case also point towards widespread changes in the nervous system. He observed chromatolysis of practically all cells of the central nervous system, with swelling of nuclei and eccentric displacement, destruction of some neurons, especially of the sixth nerve

and in the calcarine cortex where glia cells were much proliferated, neuronophagia, fatty deposits in the large cells of the motor cortex and pallidum, fat in the perivascular spaces, and petechial hemorrhages in a small area near the dorso-medial aspect of the restiform body of the medulla. Little difference exists between this description and those given by Dana and Berkeley, altho Ziegler suggests that recent work points to a toxic change in the cells, possibly of a selective nature. On this basis, Lhermitte and Poinez (57) classified two groups of Sydenham's chorea, namely, those with inflammatory lesions of the basal ganglia and cortex, and those that are purely toxic or degenerative; however, they considered lesions of the basal ganglia or cerebellum as productive of choreiform movements.

Thus we find by far the majority of pathological evidence favors the region of the corpora striata and basal ganglia as one of the commonly affected areas in chorea. S. A. K. Wilson (102) states, that "on anatomical ground the localization of 'automatic movements' in the corpus striatum, or its description as a 'subcortical motor center' whose motor function is in any way analagous to that of the motor function of the cerebral cortex is inconceivable". By animal experimentation he was able to show that lesions of the lenticular nucleus in no instance produced anything comparable to chorea. However, d'Abundo (17) found that in kittens lesions of the subthalamie region (including Luy's body) invariably produced chorea of the opposite side and rotation

of the head to the side of the chorea. Likewise, Economo and Karplus (27) produced chorea on the opposite side of the body by interruption of the medial margin of the fillet thru which run the descending fibers from the body of Luy's. In 1927, Martin (61) (62) collected a series of fatal cases, all over fifty years of age, in which the body of Luy's was involved. All cases showed choreic movements of varying amplitude and distribution; and in nearly every case an emotional disturbance (excessive anxiety) was seen from the start. He believes that choreiform movements are controlled, primarily, from the body of Luy's, whose descending fibers hold in check impulses arising in certain lower structures which are probably situated in the mid-brain. Also, the anatomic connection with the lenticular nucleus suggested to him that a higher control center of its activities is represented in certain cells widespread in the striatum and pallidum, altho he finds no valid evidence to show that focal injury of the upper part of the system may produce chorea. In our present state exact knowledge of the anatomical connections and physiology of this group of nuclei is so incomplete that proof of this hypothesis is not available- yet it is in accord with the present conception of the genesis of choreiform movements. Poynton and Schlessinger (73) regard them as due to the replacement of normal involuntary stimuli by choreic stimuli, and Waggoner (98) as release phenomena operating in the higher levels.

Bacteriology: Numerous attempts have been made to isolate a possible causative micro-organism, but prior to 1893 when Pianese (70) published his results at the Pathological Institute of the University of Naples, no serious research had been accomplished. He cultivated successfully a bacillus obtained from the nervous system of a choreic patient. Inoculated animals died with twitchings and convulsions and from the central nervous system of these animals pure cultures were again obtained. Dana (18) isolated a diplococcus from the case he reported in 1894. In 1899 Westphal, Wassermann and Malkoff (101) isolated a diplococcus from the pericardial and cerebrospinal fluids of a child dead of chorea. Poynton and Paine (72), in 1901 - 1903, found a similar coccus which they called the diplococcus rheumaticus. They were able to recover an organism from the blood, cerebro-spinal fluid, brain and meninges which produced carditis, irregular movements and arthritis in rabbits injected intravenously. Camisa (12), in 1910, recovered a diplo-streptococcus from the blood of 6 of 9 patients. Several years later Collins (14) isolated Gram positive cocci, growing in pairs or chains of four to six, from the blood of a severe case. La Fetra (52) reported finding streptococcus viridans in the blood of two patients, and in the following year Morse and Floyd (67) isolated a streptococcus from the spinal fluid in 3 of 26 cases. In his series of 21 patients, in 9, Quigley (76) recovered cocci in blood culture which appeared in short chains or pairs; and in 13 a similar coccus was found in the cerebro-spinal

fluid. Dick and Rothstein (21), in 1913, succeeded in producing choreic symptoms in a dog by intravenous injection of streptococci recovered from the throat of a patient with chronic chorea. A year later, Rosenow (82), using streptococci isolated from the joint fluid, blood or infected atria of patients with acute rheumatic fever who developed chorea, reproduced the symptoms in 51 rabbits and 12 rats of a total of 35 animals. Previously he had obtained similar results in a dog and a rabbit injected intravenously with a streptococcus from the turbid spinal fluid of a patient dying of the disease. Streptococci isolated from cases with other nervous disorders would not produce the symptoms, and he concluded that: "Chorea is due to a streptococcus having peculiar neurotropic, immunologic and other properties". The cocci, when grown on blood agar, produced a greenish zone of hemolysis (83), similar to that isolated from the teeth and tonsillar crypts of acute cases by Floyd (32). In 1927, Rosenow (84) injected a culture of streptococci obtained from the naso-pharynx, tonsils and apices of devitalized teeth, into the right frontal lobe of 52 rabbits. Of this group 57 per cent developed ataxia, 33 per cent rhythmic movements of the head, and 21 per cent spasms of the muscles. Thirty three cultures from the brain and twenty four from the blood exhibited the streptococcus previously described by him; and in cultures from the brain two showed a staphylococcus and two, bacillus coli. During this same year Small (88),

produced choreiform movements resembling paralysis agitans by injecting intravenously a streptococcus isolated originally from the blood of a case with acute rheumatic fever. He described two types of the organism which he believed were a new strain falling in the non-hemolytic, anhemolytic or indifferent group. Subsequently, he prepared a monovalent equine and bovine serum which he found effective in the treatment of active chorea (87). Though his serum was enthusiastically received by the medical profession, his results have not found confirmation; and, while Rosenow's investigations, coupled with those of Small, have given more impetus to the acceptance of a primary bacterial etiology than any discoveries of recent times, it cannot be said that conclusive proof is now available.

Heart: At autopsy, almost without exception, endocarditis has been found. Of 80 fatal cases, representing the combined experience of Guy's, St. Bartholomew's, St. George's and St. Thomas's Hospitals, Sturges (91) reports only 5 in which the heart valves and pericardium were healthy. Raymond (77) states that lesions of the brain and heart were the most common post-mortem finding in the 79 cases he studied. Osler (69) collected 78 additional cases of which 66 presented endocarditis. In 43 of this series the mitral segments alone were affected; in thirteen, the mitral and aortic segments presented vegetations; in 3, the tricuspid was involved with the mitral valves; in two there were vegetations on mitral, tricuspid and aortic segments; and

in one case the aortic valves alone were the seat of the lesion. Morse and Floyd (67) found clinical evidence to suggest acute endocarditis in 6 and chronic valve disease in 6 of their 21 cases. Of 111 cases of subacute bacterial endocarditis, Fulton and Levine (34) found only 3 gave a history of previous chorea and 6 had had both chorea and rheumatic fever.

Usually the endocarditis is of the simple variety shown by the presence of small bead-like vegetations within the margins on the auricular side of the mitral cusps. They differ in<sup>no</sup> respect from those seen in rheumatic fever and occasionally encountered in acute febrile diseases. The similarity of the cardiac lesions in chorea and acute arthritis has been offered as additional proof of the associated etiology of the two diseases, however histiological examination has never produced a satisfactory etiologic classification of the lesions of sub-acute bacterial endocarditis and such views would seem inconsistent.

Osler's (69) statement, in his excellent monograph "On Choreia", are still applicable today. He concludes: "(1) That endocarditis is a very common complication of chorea minor. (2) That in a majority of such cases the endocarditis is independent of, and is not associated with, acute arthritis, unless indeed we regard the valvular lesion as itself a manifestation of the rheumatism, holding with Bouilland that 'chez les jeunes sujets le couer se partage comme une articulation'. (3) That in a considerable proportion of cases, much larger indeed than has hitherto been

supposed, the complicating endocarditis lays the foundation of organic heart disease".



Symptomatology

Generally, altho it may not be recognized by the parent, there are definite prodromal signs of the disease, though a sudden onset may follow physical or moral shocks. A hitherto ambitious little girl will complain of sleeplessness, loss of appetite and fatigue; her studies become too hard, or; she may develop a headache and suddenly vomit. She becomes irritable, resistive, easily angered and oftentimes unmanageable; or a marked inattentiveness and fatuity develop. The perplexed parent too often, when other methods fail, attempts to restore the child's equilibrium through punishment; but this only contributes to the further establishment of impulsive activity. Within a few days a weakness or clumsiness appears, and in attempting to pick up an object her hand may be propelled beyond its mark, a dish is upset, or she frequently drops whatever is in her hand. Then the choreiform twitchings appear about the eyes, mouth and upper extremities, and at this time she is brought to the doctor.

Motor: The frequent, more or less quick, irregular and involuntary clonic muscular movements of almost any part of the body are altogether characteristic. In the majority of cases, first the hands and muscles of the shoulder girdle are involved, then the face, and subsequently the legs. In milder forms the movements may not progress further than an irregular, occasional twitching of isolated muscle groups, causing little embarrassment of the activities of the patient.

On the other hand, the severe cases are bed-ridden and the spasms may be so constant and generalised that methods must be employed to prevent injury. Frequently one side, or one part shows greater involvement, and some observers have found the right side affected almost twice as often as the left. Difficulty in speech is commonly encountered. It may be explosive in character when the patient is still capable, by an effort of will, of controlling the muscles of articulation, or; the muscles of the lips, tongue and pharynx may be in an uncontrollable state of fibrillation so that words are incomprehensibly jumbled together. Dysphagia also results. Twitching and sudden spasm of the muscles of the face produce the most abrupt and bizarre changes in facial expression. Respiration may be jerky and irregular due to the asynergia of the intercostal and accessory muscles of respiration; however, it is never greatly embarrassed for the diaphragm does not seem to be affected. There is no evidence to show that the involuntary muscles ever participate, altho in the last century it was suggested that the irregular and rapid action of the heart is a result of the disturbed rhythm of the ventricular contractions and to choreic spasms of the papillary muscles.

Occasionally paralysis is seen in the affected part. Usually it is transient, disappearing with the movements as the patient recovers. Lhermitte and McAlpin (88) believe that the essential condition for the development of choreiform movements is a diminution in muscular tonus. Most often it consists in nothing more than a muscular weakness. In

28 of his infirmaries cases, Osler (69) reports: ". . . . paraplegic, 6 cases; hemiplegic, 4 cases; loss of power in the left arm, 10 cases; in the right arm, 6 cases; in both arms and legs, 1 case; in both arms, 1 case". Burr (9) believed that a wistful expression due to a change in tone of the facial muscles is common. Recently Carter (13), examining the motor points in active cases of chorea, found a definite increase in electrical excitability of the peripheral motor apparatus which passed off in proportion to the clinical improvement, though up to six months following the disappearance of all signs a slight excess excitability persisted. Paralytic symptoms may appear before, during, or after the active onset of the disease, but only in the severe cases, when considerable wasting has occurred, does the weakness become of consequence.

It is usually reported that the tendon reflexes are exaggerated, and in one case striking of the knee repeatedly with a percussion hammer produced a tetanic spasm of several seconds duration. Waggoner (98) states that a variable diminution or complete absence of tendon reflexes was encountered in his experience; however, by far the majority of writers on this subject are in accord with the former opinion.

Sensory: Sensory disturbances are comparatively infrequent. Occasionally sensibility is diminished and again, there may be painful phenomena, headache, neuralgia, or joint and muscle pain. Epstein (29) has suggested that there is an increased irritability of internal organs due to a sensory

and autonomic neurosis, however no concrete evidence is available in support of his views. That hypersensitiveness is much more common than most investigators recognise is indicated by Stephens (89) who found a hyperesthesia extending over the cutaneous distribution of the third to the twelfth dorsal, all lumbar, first and second sacral, and on both sides of the spine. In one of our cases of a severe chorea a hyperalgesia of the entire skin surface was noted, but, if we may be allowed to draw conclusions from so limited a number, this finding would appear to be infrequent.

Mental: Mental symptoms are the earliest and most constant findings in the literature. Loss of moral sense is almost invariably present. The child displays an increasing peevishness, sensitiveness, disobedience or selfishness, so that it is not uncommon for the mother to complain of a complete change in her personality. Some are apathetic and show an inability to concentrate in school; others merely seem inattentive; and another group show a general loss of memory and mental ability. Night terrors, insomnia, sleep walking, emotional or depressive outbursts, delusions and hallucinations have been encountered. In the malignant chorea, occurring most often at puberty or in young pregnant women, delirium is characteristic and may go on to a furious mania. Melancholia may occur in rare cases, and in some, the impaired mental function may progress to an actual dementia. Burr (9) believes that only 1 in 500 cases of all

types of severity develop insanity. Ebaugh (26) found delinquency consisting of lying, stealing, vagrancy and truancy in 21.2 per cent of 32 cases. Though the mental symptoms are seldom of immediate consequence it cannot be doubted that this period of confusion must leave a definite impression, and may possibly be a starting point for succeeding behavior oddities.

Heart: It has generally been stated that in no other disease, including rheumatic fever, is the heart so often affected. Children seldom complain of subjective symptoms though acceleration of the pulse, palpitation and arrhythmia are common. Pain about the heart may become a marked symptom in cases with recurring attacks associated with endocarditis or pericarditis and rheumatism. Murmurs occur at some time during the course of the disease in about one third of the cases, and may be either organic or functional. During the third and fourth weeks of the disease, when anemia and debility are most often developed, a soft systolic murmur is frequently heard over the pulmonic area extending down to Erb's point. When the heart muscle is greatly weakened a similar murmur often appears at the apex and the cardiac impulse becomes diffuse over the precordium. That these murmurs are functional in nature must be considered, though it is often difficult to accurately differentiate them from the organic.

In cases coming to autopsy the mitral valve is more often affected than any other. Rarely, however, during the

first attacks, are the signs of endocarditis of sufficient intensity to justify a diagnosis of an organic lesion. In the recurring attacks the murmur over the apex may become more persistent, and when associated with any considerable elevation in temperature or with rheumatic manifestations, as in the severe cases, endocarditis is usually present. Occasionally the heart will be enlarged. Murmurs of maximum power over the apex and propagated into the axilla with an accentuation of the second pulmonic sound, adds conclusive evidence to the diagnosis.

Fever: Fever is usually regarded as an index of complications. In most cases there is never any more than a degree or two rise in temperature. On the other hand, when the temperature rises to 102 to 103 F. cardiac complications must be suspected. As a rule, under salicylates, the fever will be short lived, but in the severe chorea insaniens with temperatures rising as high as 105 F. death is not an unusual outcome.

Duration: The duration of chorea has been variously stated to be from a few days to a year, and in some isolated cases the movements have persisted for several years. The length of time in the hospital varied from 1 to 369 days in Abt's (1) series, but the average duration was from 4 to 5 weeks. Osler (69) states that the mild cases may terminate in 8 to 10 weeks, though frequently cases drag on for months. As a rule the mild cases are more resistant to

treatment than the acute or severe type which may recover within two weeks.

Recurrences: Also, the severe form are less likely to recur. Out of 80 cases in Weir Mitchell's (66) clinic, 25 had been attacked before; and of the 25, 14 had had chorea three times, 8 twice, and 3, four times. Abt (1) reports 35 cases in 226 with more than one attack. Treatment seems to have an influence on the reappearance of the disease. Parents should be warned that in the Spring or Autumn of the following year it may again become manifest, though in some, the recurrence is delayed two, three, or even four years.

### Diagnosis

Inspection is usually sufficient, for the irregular movements are almost pathognomonic of the disease. There are several affections however, that may be mistaken for chorea. Cerebral sclerosis has been termed chorea spastica, but the onset in infancy, chronic course, impaired intelligence, and differences in movement will usually separate it. Friedreich's ataxia, in earlier times, has been classed as chorea, and occasionally poliomyelitis and encephalitis have been confused with it. Hysteria, in the absence of other signs, may be impossible of differentiation. Habit spasms and tics may offer difficulties. The history of the onset, the association with cardiac and arthritic symptoms, and the involuntary muscle spasms so characterize the disease that only infrequently is there danger of a mistaken diagnosis.

Laboratory: Examination of the cerebro-spinal fluid is not a routine procedure and such investigation, at present, does not appear to be of much diagnostic value. In 1904 Dupre and Camus (24) found a distinct lymphocytosis of the cerebro-spinal fluid in one case, and Comby (15), in 1915, reported that 30 per cent of his cases exhibited a slight increase in mononuclear cells. Several investigators have isolated organisms from the spinal fluid in severe febrile cases. The Wassermann



reaction has been reported positive when hereditary syphilis was evident. Warner (99) has reported a deficiency of 13 to 15 per cent in the calcium content, and claims that administration of calcium raising substances hastens the subsidence of symptoms. The very nature of most cases of chorea, however, precludes the use of spinal puncture, and these observations await the confirmation of a representative series of cases.

Likewise, the inconsistency of urinary findings fail to give them much importance. Todd (93), in his "Lectures on Disease of the Nervous System", states that uric acid may form a sediment, as in gouty conditions. Urea has been found increased by several investigators. Handfield Jones (48) found an increase in phosphates. Albuminuria is commonly encountered in the severe forms, and frequently, in the mild cases, as in febrile conditions, it may be transient. In the severe fulminating type of the disease acute nephritis has been reported. An increase in urates and a decrease in calcium is described by a few authors.

Blood examination usually reveals a more uniform picture. Chorea may occur in thin, anemic children and in the past it has been associated with chlorosis. More often a secondary anemia develops during the course of the illness, and the erythrocyte count may be reduced as low as two million with a corresponding reduction in the hemoglobin content. Wilson and Winkelman (103) reported an eosinophilia of 6 per cent in an acute case, and others have

reported a moderate increase in the leucocyte count. Blood chemistry has revealed no departure from the normal in the majority of cases; however, Warner (99) believed the serum calcium content to be relatively lowered. In 21 cases Fordyce (33) found the blood calcium between 9 and 11 mgm. per 100 cc., in 21 it was below normal, and in 8 above normal. He concluded that diminution of calcium in the blood cannot be an important factor in the causation of symptoms.

### Prognosis

Recovery is the rule for the mild and moderately severe forms. The Collective Investigation Committee of the British Medical Association (58) reported a mortality rate of 2 per cent in all types of chorea. Oppenheim (68) places it at 3 to 5 per cent. In Abt's (1) cases less than 1 per cent ended in death. Generally the fatalities are limited to those cases with high fever, violent movements, extreme psychotic manifestations, complicating endocarditis and extreme exhaustion- the truly malignant chorea.

Seldom are there any important sequelae of the disease. The incidence of cardiac murmurs occurring five or six years after the disappearance of symptoms has been placed as high as 50 per cent, though rarely is there any serious cardiac insufficiency. A state of mental subfunction or dysfunction may persist for a time, but permanent impairment of the mind is exceptional. Chorea has been considered a danger sign for the psychic future of the individual, and it is true that behavior problems do arise in the subsequent history of these cases. This, at present, seems the most ominous residual.

### Treatment

Developing, as it does, in children of a particular diathesis, it would seem that some prophylactic measures might be useful in chorea. The active, bright child of neuropathic parents should not be permitted to overtax her mental powers. Fright, emotional episodes and worry must be removed from her sphere. Foci of infection, anemia and undernutrition should be combated when they appear. In treatment of an active case such procedures are usually sufficient to effect a cure.

Rest and seclusion are the most beneficial of any therapeutic expedient once the disease is established. Care in the home is entirely unsatisfactory. The patient must be removed from her usual environment and placed in a hospital where absolute rest in bed with a minimum of exciting influences may be assured. At first, entertainment must be avoided, but later occupation and amusements of the least exciting kind are to be permitted.

In some cases with severe jactitation injury must be avoided. Restraints have been used but well padded boards attached to the sides of the bed are far superior. When there is danger of the patient coming in contact with some hard object it is well to pad the knees, ankles and elbows. Bed sores offer a difficult problem and must be avoided from the start.

The diet should be abundant and nourishing. The fact that the disease is more prevalent among the poorly

nourished and during the colder months suggests the need for fresh vegetables and fruits. Sunshine and fresh air are to be desired when they can be obtained without exciting the patient. Some have recommended a low meat diet, however, the consensus of opinion is that a full balanced diet is adequate.

Oftimes the patient becomes greatly perplexed with her lack of muscular control, and it is advisable to explain this to her. In the protracted mild cases exercise should be given. At first a passive leg exercise with encouragement and suggestion may be attempted, then as confidence is restored and symptoms abate, greater freedom may be allowed. Parents must be urged to refrain from discussion and concern before the child; and the necessity of definite supervision and habit training during the illness and in the future should be understood by them. In the maniacal forms employment of sedatives is necessary.

The indiscriminate use of sedatives in cases of chorea is of doubtful value. At the beginning of the nineteenth century cold douches to the spine were frequently used, and as late as 1885 Weir Mitchell (66) recommended them. When movements are sufficiently violent to produce exhaustion, or an intractable insomnia is present, some depressing drug can be used to advantage. Chloral hydrate in 10 gr. doses three or four times daily has met with good results. If necessary an equal amount of bromide may be added, or potassium bromide may be given alone. W. E. Wynter (104) recommended 5 gr. of chloretone morning and

night for three days in cases under close observation. Trional, luminal and barbital have been tried and all with about an equal success. Antipyrin has been employed in ascending doses to 8 gm. daily. Marinesco (60) attempted to inhibit the action of the diencephalon and mesencephalon by a combination of sodium luminal (0.22 gm.) subcutaneously and magnesium sulphate (0.008 mg. per Kg.) intra-spinally. In 1926 Duzar (25) claimed he could obtain a cure within seven to nine days by the administration of epinephrine intravenously and sodium bicarbonate orally. Neither Benix's (5) results nor those of Karelitz (50) confirm his observations. Chloroform, in severe cases, may become necessary. Hyoscine hydrobromide (1/100 gr.) has been recommended for psychotic symptoms. One of the best and most appreciated methods of quieting a choreic patient is the continuous warm tub bath of several hours duration. The cool wet pack consisting of sheets wrung out of water at 80 to 85 degrees F. wrapped about the entire body with sufficient outer coverings to hold the body heat, is also of benefit when used for an hour daily. In cases with fever, indicative of endocarditis and arthritis, this procedure combined with full doses of salicylates is most effective.

Cures within three days have been reported by Goodman (38) who injected 18 to 20 cc. of the patient's blood serum intraspinally. His work has not been corroborated. Leopold and Rothstein (54) claimed good results were obtained in 9 of 12 cases in which a severe gradual ketosis was induced. There method does not offer any advantage over others and

cannot be used in cases with cardiac involvement or acute respiratory infection. In two of Hymenson's (45) cases definite improvement followed intra-muscular milk injection.

Nirvanol, first introduced by Roeder (80) in 1919, has been warmly recommended by Poynton and Schlessinger (73) in their book on "Recent Advances in Rheumatism". They used a daily dose of 0.3 gm. for children from nine to fourteen years of age, continuing for twelve to fourteen days or until a sudden pyrexia or rash appeared. Usually the Nirvanol reaction was manifest within a week to ten days, and with the disappearance of the rash the patient rapidly recovered. The most successful cases were of the acute type, who developed a marked fever, rash and eosinophilia; while more often, the chronic, sub-acute chorea remained unaffected. Secondary reactions, thought to be brought about by exposure to sunlight, have occurred, however, good results with a minimum of risk have been obtained both in Germany, England and America.

In 1927, Small (88) produced a monovalent serum which he believed specific in chorea; and though his results were extremely promising, other investigators have been unable to substantiate his claims.

Of all the therapeutic measures which have been attempted, arsenic has remained most securely throughout the past hundred years, though a question still remains whether or not it has any value other than as a tonic. Ebaugh (26) recommends it in the form of tryparsamide, 1.5 to 3 gm.

weekly for six injections. Hydriodic acid, cod liver oil and iron and arsenic tonics are more commonly employed at present in combating anemia.

A diligent search many times reveals foci of infection which may be contributing to the anemia and debility. The poor tonsil, because of its easy accessibility, is usually considered the chief offender in spite of evidence to the contrary. Cases with chorea rarely escape tonsillectomy, and in some instances operation has been performed during the acute stage of the disease. It is generally agreed that infective foci should be removed, but not until after the abatement of the choric symptoms.

Constipation soon develops in the bed-ridden cases. A mild laxative or warm normal saline enema should be employed early. It is interesting to note that Sydenham's treatment consisted chiefly of purges alternating daily with blood letting.



Case Reports

Case 1.- A well developed, well nourished white school girl, age 14, was admitted to the Methodist Hospital, March 19, 1932, with a diagnosis of acute Sydenham's chorea. Three weeks prior, purposeless, incoordinated, involuntary movements became so severe and generalized that, on entrance, she was unable to walk or talk. Physical examination revealed an internal strabismus of the right eye, normal reflexes, diffuse pain over the epigastrium, choreiform movements in all muscle groups, and hyperalgesia of the entire skin surface. No cardiac or arthritic manifestations were present, nor was there any history of such. She had had measles, chickenpox and whooping cough. The mother was a nervous type and she states that one cousin had chorea.

The first attack occurred July 4, 1929. Previous to this time, an increased incapability and emotivity was noticed by the mother; and on this day, following the refusal of one of her requests, immediately a vermicular, athetoid-like movement of the right fingers about the mouth appeared. Rapidly generalized choreiform movements developed, and for three months she was unable to write, walk or talk. Following the rupture of an abscess in her nose she improved, and on August 8, 1930, she was able to walk into the University Hospital, though moderately severe movements were present over the entire body. Her tonsils were removed in 1922, but a tonsillar tag was excised at

this time, though it exhibited no evidence of infection. She was discharged as improved on September 30, 1930.

She returned to school but failed to pass her grade that year. Nervousness, fatuity and antagonism persisted until the following summer when all symptoms were absent. The next September, after four days of school, headache, vomiting, and jerky movements of both arms developed. Under the care of the Out-call students she improved, though she was not cured at the time of her most recent acute attack.

Psychotic manifestations were present from the start, and her history reveals several episodes which explain their genesis. Three weeks after birth colic developed and lasted about two weeks. At the age of seven months she refused to nurse and would accept milk only from a glass. She was over-weight and did not begin walking until sixteen months old. She recalls a fright that occurred during infancy incident to rolling down a hill in her carriage. At the age of seven years two colored children beat her, and to this day, she has retained a fear of negros. She was forced to sit near a colored boy in school at the time of onset of the attack in September, 1931. At this time too, she learned of the assault of her younger sister. When nine years of age she was assaulted by her grandfather, who threatend punishment if she diclosed the incident. This she did two days later in a fit of screaming and crying, and for two or three months she remained in an hysterical state, associating <sup>pictures</sup> with the

man. Three months ago, when her symptoms recurred she was greatly impressed by a newspaper story concerning the death of a little girl following a similar episode. Her mother and father have been separated for the past two years. Three months ago the patient saw her father and since then has refused to see him again. After two weeks in the hospital she revealed that he planned to have her keep house for him. Her mother states that she has always been a happy, ambitious child, fond of dolls, sewing and the like. She had always been congenial with her playmates until her illness. The onset of her menses in May, 1930, did not trouble her. Enuresis was present from the fifth to the eleventh years.

Blood examination revealed- hemoglobin 75 per cent, erythrocytes 4,870,000, leucocytes 8,950, polymorpho-nuclears 84 per cent, and lymphocytes 16 per cent. The urine was consistently negative.

At no time during her stay in the University, or Methodist Hospitals, did the temperature exceed 101 F. The pulse usually ranged from 70 to 90, although it reached a peak of 120 on two separate occasions.

Treatment consisted of absolute rest in bed and isolation, Fowler's solution in ascending doses, mild laxatives, bromide, and continuous warm tub baths of twenty to thirty minutes duration. Passive foot and leg exercises were begun after the first week, and after a few days she was encouraged to actively carry out the movements.

This patient has not been dismissed from the hospital, altho she has been there 23 days. Psychic trauma has consistently contributed to the onset of the attacks, and she exhibits most strikingly, the characteristics regarded as indicative of the psychogenesis of the disease.

Case 2.- A well developed, well nourished, white, school girl, age 13, was admitted to the Methodist Hospital, February 2, 1932. About four weeks previously she noticed when she reached for anything her hand jerked convulsively. She seemed tired after school; complained of weakness of her knees and ankles; and soon, jerking of all limbs and muscles of the face appeared. On entrance she seemed restless. There was a quick, bizarre change in facial expression, irregular respirations, jerky, explosive speech, and occasional choreiform movements of the arms and hands. Physical examination revealed infected tonsils and a soft systolic murmur over Erb's point.

A sister had chorea, and both the mother and father had had rheumatism. The patient had measles, whooping cough, chickenpox, pneumonia, tonsillitis, scarlet fever and diphtheria. Three days before Xmas, 1931, she developed an acute tonsillitis which lasted a week; a month later an acute upper respiratory infection occurred, remaining about three days, and; in two weeks choreic symptoms appeared.

At the age of six months the patient had colic. The

mother says that following a severe attack of diphtheria at the age of two years, she received considerable attention. She was babied all of her life; frequently had temper tantrums; enuresis persisted from the fourth to the eleventh years, and; she had always been quarrelsome with her playmates. Her scholastic standing was excellent. She had been more or less nervous and despondent since the onset of her menses in May, 1931, and frequently she flared up in a fit of temper and weeping. In January, 1931, shortly after the disappearance of one of the men in the town, she attended a show (Guilty Hands) which upset her. After this she seemed afraid, noticed people in windows, and frequently recalled the disappearance of this man. She was always a secretive child, and when questioned concerning her personal affairs, she would become angry. After the onset of the twitching increased emotional lability was evident.

On March 10 a tonsillectomy was accomplished, and the following day the temperature reached its high point, 99.8 F. The pulse ranged from 60 to 90, but usually remained around 72.

The urine was consistently negative. Blood examination revealed- hemoglobin 85 per cent, erythrocytes 4,580,000, leucocytes 7,650, polymorphonuclears 66 per cent, and lymphocytes 34 per cent.

Treatment consisted of isolation and absolute rest in bed, the cool wet pack daily, acetylsalicylic acid gr. 10, t.i.d., sodium citrate and sodium bicarbonate of each gr. 20, t.i.d., and syrup of iodide of iron mm, 20, t.i.d.

On March 22, 1932, she was discharged from the hospital free of symptoms. No cardiac murmur was elicited at that time.

The danger for this patient lies in the future. Before the onset of chorea she was a behavior problem, and unless supervision and proper training have been adopted, it is quite probable she may develop more serious psychopathic manifestations.

Case 3.- A well developed, well nourished, white, school girl, age 11, was seen on the Out-call service, September 16, 1931. Following the assignment of sixty four problems on the first day of school, she became extremely nervous and was unable to concentrate. Further attempts at solving the problems only served to aggravate her condition, and during the ensuing few days crying spells and involuntary movements of the face, hands and shoulders increased in frequency. She complained of headache and inability to sleep. Physical examination revealed slight involuntary, irregular movements of both hands, frequent blinking of the eyelids, jerking of the head, jerky speech, sudden changes of facial expression and a persistent restlessness. She reached for a glass of water and knocked it over before she could grasp it. The tonsils were hypertrophied and inflamed. Reflexes were normal. A soft systolic murmur was heard at the apex alone.

The mother stated that she had always been a nervous,

ambitious child who succeeded in maintaining a high average in school. No emotional or psychic shocks could be elicited in the past history. She had whooping cough throughout the preceding winter. One sister and the mother had had chorea, and both the father and mother were of a nervous temperament.

The urine was consistently negative. Blood examination revealed- hemoglobin 98 per cent, erythrocytes 5,240,000, leucocytes 10,000, polymorphonuclears 78 per cent, and lymphocytes 21 per cent.

She developed an acute upper respiratory infection on November 8, at which time the temperature reached 100.8. Usually it ranged from normal to 99.8.

Treatment consisted of elixir of triple bromide, one half teaspoonful t.i.d.p.c., sodium salicylate, gr. 80 per day during the acute infection, daily tepid sponge baths, and syrup of hydriodic acid, one half teaspoonful daily. It was impossible to secure adequate seclusion in her home and circumstances would not permit of proper nursing care. After fifty four days she was discharged as improved. On April 2, 1932, she reported to the Dispensary, at which time slight movements of the face and hands and jerky speech still persisted, altho the heart murmur had disappeared. She had returned to school, though intense study or scholastic competition were not allowed. At this time the tonsils were not inflamed and she was referred to the Nose and Throat department for possible tonsillectomy.

This case illustrates the mild type of chorea, and also the ineffectiveness of home treatment. Here too, neuropathic traits were present in the family history. On the basis of previous infection, tonsillectomy was advised, however it is believed that time alone will completely irradiate all traces of the disease.

Case 4.- A well developed and nourished white school girl, age 16, was admitted to the Methodist Hospital, April 21, 1930. About six months prior to entrance she first noticed an increasing nervousness, and later the muscles of the right face and arm began twitching. This progressed and within a few days the left face and arm were involved. She was extremely interested in school at that time and believed it caused her nervousness. On January 30, 1930, she was confined to bed in her home. After five weeks she was up again, but three weeks later she returned to bed where she remained, without improvement, until entrance into the hospital. Inspection revealed almost constant irregular movements of the hands and arms in addition to occasional twitchings about the eyes and mouth. These movements could be voluntarily controlled for a short period. No dental pathology was revealed by X-ray. She had had measles, mumps and chickenpox. When nine years of age she had St. Vitus's dance, and a year later a tonsillectomy was accomplished.

The temperature remained within normal limits throughout her stay in the hospital, and the pulse ranged from



72 to 88.

The urine was negative. Blood examination revealed hemoglobin 75 per cent, erythrocytes 4,100,000, leucocytes 9,700, polymorphonuclears 64 per cent, and lymphocytes 36 per cent.

She was given Neuronidia, drams 2 in a glass of hot milk at bedtime, sodium cacodylate, gr. 3 intramuscularly, and acetylsalicylic acid, gr. 10 t.i.d. The cool wet pack was employed for one hour daily. Agar agar, dram  $\frac{1}{2}$  with hot water was used to combat constipation.

April 28, 1930, she was discharged as improved. The choreiform movements and nervousness had largely disappeared.

In the absence of more evidence of infection, we are led to believe that a more detailed history would have revealed emotional episodes of etiologic significance.

Case 5.- A fairly well developed and nourished white boy, age 7, entered the Methodist Hospital, May 30, 1930. At that time choreic movements of both arms and legs, particularly the left, fine movements of the fingers and toes, difficulty in speech, twitching of the facial muscles, and pain in the back were noted. About February 1, 1930, the child had an attack of acute tonsillitis, and in a few days pain in the back and painful swelling of the hands and feet developed. He recovered in about two weeks, but in April, after a check-up examination at the Univer-

Case 6.- A well developed, well nourished, white, high school boy, age 19, was admitted to the University Hospital, Dec. 1, 1931. About Sept. 1, 1931, he first noticed an involuntary jerking of the left hand. He was irritable and nervous and unable to concentrate. He became progressively worse and, following an injury in October, the symptoms became so severe that he discontinued school. October 23rd he was ordered to bed where he remained until sent to the hospital. On entrance involuntary movements of both arms, especially the left, occasional jerking movements of the left leg, twitching of the left side of the face, difficulty in writing, talking or swallowing, nervousness, gas on the stomach, loss of weight, and a sense of oppression about the heart were his complaints. Physical examination revealed a sub-acute rhinitis and sinusitis, post-nasal discharge, marked dental caries and pyorrhea, inflamed tonsillar fossae, cervical adenopathy, hyperactive reflexes and a marked adiadokokinesis. There was a roughening of the first sound of maximum intensity over the apex. At the age of nine he had an attack of acute rheumatic fever, with swelling of the hips, knees, ankles and shoulders. He was in bed two weeks and shortly afterwards had a relapse requiring rest in bed for thirteen weeks. At that time mitral insufficiency was detected. In June of 1931 he again had a mild attack of pain and swelling in the left ankle. The latter part of August, 1931, he noticed a weakness in the left hand preceded by pain in the left hip and right ankle. Soon afterwards choreiform

sity Dispensary, the symptoms recurred. Five days prior to entrance muscular twitchings were present in the left arm, then in both legs, and later, in the right arm, neck and face. Physical examination revealed hypertrophied and infected tonsils, cervical adenitis and a slight tenderness in the lower left abdomen. He had had whopping cough, measles, and chickenpox, and at the age of four years, following the "flu", a chronic discharge from both ears persisted for several months.

On one occasion the rectal temperature reached 101 F., but it usually ranged between 99 and 100 F. The pulse reached 130 on one day, but more frequently fluctuated from 90 to 100.

The urine was consistently negative. Blood examination on May 31 revealed- hemoglobin 65 per cent, erythrocytes 4,080,000, leucocytes 10,700, polymorphonuclears 76 per cent, lymphocytes 24 per cent; and on June 17- hemoglobin 78 per cent, erythrocytes 4,150,000, leucocytes 12,050, polymorphonuclears 50 per cent, and lymphocytes 50 per cent.

The cool wet pack was employed daily from twenty to thirty minutes. Sodium bromide, gr. 10, was given on entrance but not repeated. He was given acetylsalicylic acid daily, gr. 10 every four hours for five doses, sodium cacodylate, gr.  $7\frac{1}{2}$  intramuscularly, and enemas as required.

He was dismissed as improved on June 9, 1930.

movements developed.

During his course in the hospital the temperature remained within normal limits, and the pulse reached 90 only on two occasions.

The urine was consistently negative. Blood examination revealed- hemoglobin 94 per cent, erythrocytes 5,100,000, leucocytes 8,000, polymorphonuclears 58 per cent, lymphocytes 41 per cent, and eosinophiles 1 per cent.

Rest in bed, in addition to sodium salicylate, gr. 10 and Fowler's solution, mm. 3, every four hours, rapidly relieved the symptoms, and he was discharged December 13th. There was adequate cardiac compensation, and continued rest, it was believed, would effect a complete cure of the chorea.

In this case, as in the one preceding, there is ample evidence of the association with the rheumatic diathesis. These cases represent what has been termed infectious chorea; however, as usual, no investigation of the emotional life of the patient was attempted. It is impossible to determine the incidence of psychic influences from the ordinary hospital records.

### Conclusions

The pathology of chorea has not been proved. Recent observations indicate a toxic degenerative process in the cells of the central nervous system, possibly of a selective nature. By far the majority of investigators have directed their attention to the corpora striata, and animal experimentation suggests that a lesion of the body of Luy's permits the development of choreiform movements. No specific organism has been shown to be the cause of chorea, nor has serum treatment been effective.

The only therapeutic measures of consistent value are those which tend to alter the environment of the individual. Tonics and sedatives have always been of secondary importance. Removal of foci of infection is advisable, just as at any other time of life, but assurance is lacking that by so doing the cause is being eliminated.

The failure to establish the disease on a definite pathological basis has led to a reconsideration of its psychic manifestations. In two cases presented here, a detailed history revealed not only serious emotional episodes throughout the lives of the individuals, but definite psychopathic traits in other members of the families. Recognizing the frequency of such characteristics, some authors have stressed the necessity for proper training of children with this particular diathesis. Certainly, at least, until the infectious nature

is conclusively determined, a possible psychogenesis should receive adequate consideration.

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