Special Articles

THE STORY OF THE CEREBELLUM*

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We accept placidly the results of the labours of our predecessors: but it is stimulating and inspiring to follow the steps by which order has been evolved from confusion and to see pioneers wrestling with difficulties.
Sir Wm. Broadbent.

One of the earliest discoveries of our ancient forefathers of the forest or the cave must have been the deadly nature of a blow delivered on the nape of the neck; yet in this they did but follow the instinct shown by the tiger and the hawk in striking down their prey. As Homer sang, here lies 'the fountain of the nerves.'[1] This Herophilus found to be in the ventricle of the cerebellum or parencephalon,[2] an organ recently described by Aristotle.

Herophilus, who was the first professor of anatomy at the school of Alexandria, taught that "the purer blood from the heart ascends through the veins to the torcular, the wine-press; there it yields up the vital spirit and this, mixing with the air inspired through the ethmoid cells, is in the ventricle of the parencephalon converted into animal spirit, the breath of the rational soul. This diffuses through the ventricles and into the substance of the brain, and by the channels of the nerves it is carried to all parts of the body, as well to impart movement to the muscles as to carry to the seat of the rational soul the sensations received by the sense organs."

Five hundred years later, Galen[3] seems to have been responsible for a few additional points. The passage of air and spirit to and from the cerebellar ventricle is guarded by the vermis, a sort of spiral valve under the control of the pineal body; the cerebellum is of a hard, firm consistency to impart strength to the motor nerves, while the cerebrum is softer for the reception of impressions conveyed to it by the sensory nerves. Until recent years the motor part of the facial nerve was still known as the pars dura, the sensory auditory as the pars mollis of the seventh nerve.

Galen knew nothing of the dissociation of the mental faculties, nor of the separate seat in the various ventricles of perception, imagination, judgment, and memory; this theory was first advanced more than a century later by a noted alienist, Poseidon. Through him, the cerebellum, more particularly the cerebellar ventricle, became the organ of memory, a sort of chest for the safe storage of ideas and images. It was protected by the vermis against a too sudden access of spirit from the anterior ventricles, a function later assumed for the anterior medullary velum, the valve of Vieussens. The concept was warmly received by the Arabians and by them handed down to the mediæval scholasts. Cupping over the hollow of the occiput was forbidden, lest loss of memory be induced, not only in the patient but also in his progeny.[4] Benivieni, the pioneer of autopsies in the 15th century, relates the story of a confirmed thief, who at each fresh trial evinced a remarkable, if somewhat convenient, lack of memory for his past misdeeds. Post mortem, his cerebellum was found to be represented by a mere tag. It was an Irishman who opened the skull to remove the organ of forgetfulness.[5] Though Vesalius reverted to the older, simpler Galenic position, others, as Ambroise Paré and Nicholas Tulp, preferred the more complex differentiation. We find evidence of its appeal to the popular imagination in Burton's 'Anatomy of Melancholy,' while in 'Love's Labour's Lost,' the would-be learned schoolmaster speaks of 'forms, figures, shapes, objects, ideas, apprehensions, motions, revolutions, begot in the ventricle of memory, nourished in the womb of pia mater.' We still store ideas in the back of the head and go to the brain-box for inspiration.

Galen's association of the cerebellum with the motor function lay dormant until revived by Varolio in his short unpretentious 'Anatomia' of 1573. Born in the year of the 'De Fabrica,' Varolio became physician to Gregory XIII, the pope who changed the calendar and sent Philip of Spain against England. He made a special study of the base of the brain and was the first to describe the 'pons transversus cerebelli.' To him belongs also the credit of being the first after Galen to emphasize the importance of the brain substance as distinct from the ventricles: he considered that the vital spirits pass into the brain from the veins coursing in its sulci, that they are there converted, as by a gland, into animal spirits, and that the effete products are drained through the ventricles into the infundibulum and thus to the pharynx.

In the cord, Varolio distinguished four columns, two anterior descending from the cerebrum, two posterior from the cerebellum. He found the nerves coming from the posterior column thicker and greyer than those from the anterior; thus they are the better adapted to the motor function and to conveying the common or dull sensations of the body that do not reach consciousness; by the animal spirits flowing through them the cerebellum therefore controls movement, particularly of progression, and becomes the centre of unconscious sensibility, one might almost say the head-ganglion of the proprioceptive system. The more delicate anterior routes serve the finer sense of touch.

It is idle to speculate how neurophysiology

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might have been spared centuries of detour through hypothesis and dogma had Varolio followed Galen in his experiments as he did in his dissection. It was the same idea of four spinal columns descending from the cerebrum and cerebellum that led Charles Bell to experiment on the nerve roots and, thus to his demonstration of their separate functions, the very foundation of modern neurology.[6] But the time was not yet ripe. Rather did Varolio indulge in speculation based on anatomical relationships. Finding that the nerves from the ear and the tongue pass to the pons and thus, apparently, to the cerebellum, he considered this to serve also as the centre for hearing and for taste. Its solidity made it an excellent sounding board, while it contained just the right quantity of moisture to render particles appreciable to the taste without over-diluting them.

Varolio's glandular theory was gradually accepted, but his other arguments do not seem to have carried much weight. The cerebellum remained the organ of memory until, on the accession of Charles II, Thomas Willis was installed as Sedleian Professor of Natural Philosophy in the University of Oxford. Willis was a scholar of the old school, ready to build a whole doctrine of the nervous system on pure supposition and argument, "to form,' as he himself acknowledged, 'a certain poetical philosophy and physick neatly wrought with Novity and Conjectures."[7] This was by no means the measure of the seventeenth century, so Willis was driven to an examination of the brain to seek the relationship of its several parts. The actual dissection he entrusted to his friend and pupil, Richard Lower, who made of it a work of classic importance. The *Cerebri Anatome*, illustrated by Sir Christopher Wren, was published in 1664 and gained for its author world-wide recognition and the title from John Freind of "the first inventor of the nervous system." Willis found his original ideas abundantly confirmed, and evolved many excellent reasons and illustrations. Memory he placed in the convolutions of the cerebrum in closer association with phantasy and imagination. In the regular arrangement of its leaves or lappets, he saw the cerebellum to be an ideal organ, withdrawn from the busy commerce of fresh ideas and cogitations, for the orderly, unconscious control of the vital functions, the heart beat, respiration, and digestion.

The pons, with its prolongation, the pyramid, is but the pathway of the spirits generated in the cerebellum. From the pons arise the 5th, 6th, and 7th cranial nerves; from the neighbourhood of the pyramid, the vagus; the intercostal—our sympathetic nervous system—is derived from branches of the 5th and 6th. The wide area of the distribution of these nerves and their common ultimate origin in the cerebellum account for many interesting reflex actions that occur independently of the will. Thus, visceral content or discomfort is unwittingly betokened by the facial expression. The contact of the lips in a lover's kiss, the very sight of the beloved, awaken sensations of love and lust, quicken the heart-beat, stir the breast. The sounds of music are conveyed to the cerebellum and there stored in its orderly lappets to be reproduced as required through the nerves to the larynx. The softer and more impressionable the cerebellum the greater the musical talent. Even Willis could not altogether escape the association of the cerebellum with the faculty of memory.

The very boldness of the theory gripped the imagination, but its chief importance to the progress of science lies in its challenge to experiment, then in its infancy. If the cerebellum does govern the heart, then its removal must be followed by instant death. The clarion note was sounded by the famous Dane, Nicholas Stenson, who quickly followed the publication of the *Cerebri Anatome* with a well-directed criticism. Thus the cerebellum became the main object of attack in the investigation of the nervous system. The usual procedure was to make a trephine hole in the back of the skull and either to scoop out the cerebellum with a spoon or to mush it with some sharp instrument. The experimental animal was generally the dog. Naturally the medulla oblongata was frequently involved, and there was heavy hæmorrhage from the blood sinuses. Little wonder that at first Willis's teaching was nearly always substantiated.

The most prominent supporter of the theory was the great Boerhaave, the teacher of half Europe. He regarded the lethal outcome of blows on the head and the securely fortified position of the cerebellum in the deeply seated posterior fossa under the strong, in many animals bony, tentorium as powerful testimony to the special, vital import of the organ. Moreover, in his experiments, he found that "on injury to the cerebellum, the action of the heart ceases immediately, together with all the senses, voluntary motion, respiration and life itself."[9] Certain investigators did, however, report that animals had, for a short space of time, survived injury to and even the removal of the cerebellum. This was attributed to spirits that had remained in the trunks of the nerves going to the heart and lungs and to a certain supply through connections from the spinal cord. Still such reports and the records of acephalic monsters and decapitated animals gradually undermined the theory until Haller delivered the final blow with his demonstration of the independent beating of the excised heart, albeit this was a phenomenon already described by Harvey. In the numerous experiments that constituted his enquiry into the sensibility of the brain, Haller failed to obtain any response to injury or to irritation of the cortex, cerebral or cerebellar. On the other hand, when a stiletto was pushed into the white matter, strong convulsions were excited, originating, it may be surmised, in the corpora striata or in the brain stem. Damage to the cerebrum or to the cerebellum seemed to have equal chances of a fatal issue; so he concluded that neither part is more vitally important than the other, that the brain is a homogeneous organ of which one part can function for another if damaged; that, further, the cortex is merely a protective covering for the functioning part of the brain, the sensus commune, the white matter.[10]

But since Willis it has ever been an axiom that variation in structure denotes difference in function, so there was a quick swing of the pendulum. Gall, of Vienna, was soon teaching the elements of phrenology, that the brain is a composite of various organs, of which the cerebellum is the seat of the sexual instinct. While yet a boy, Gall had observed that his companions of the bull-neck type tended more than others to be sexually inclined; the distance between the occipital protuberances became for him the index of amativeness; later he found that this was correlated with the size of the cerebellum. Clinical histories with post-mortem findings and studies in comparative anatomy, made by himself and by others, lent ready support to the suggestion. Thus Baron Larrey, Napoleon's surgeon-general, reported instances of sterility following wounds in the back of the head. Asylum records showed disease of the cerebellum to be common in sexual perverts. At a somewhat later date, Serres demonstrated the association of tumours of the cerebellum, more particularly of the vermis, with uncontrollable priapism, due, as we now suspect, to irritation of the medullary centres.[11] As a matter of at least passing interest, it may be mentioned that Gordon Holmes has reported a family of three brothers, all of whom showed congenital underdevelopment both of the cerebellum and the testicles.[12] Boerhaave and Haller ruled the eighteenth century with true Johnsonian gravity, while in France and Italy, the foundations of accurate, unbiassed investigation were being truly laid.

Within ten years of the publication of Willis' theory, Du Verney had removed both cerebrum and cerebellum from the skull of a pigeon, filling the space with flax-seed. The bird continued to live for some time and even to search for food.[13] Chirac, of Montpellier, succeeded, by blowing air into their lungs, in keeping dogs alive for some hours after the removal of the cerebellum, an experiment already reported in ancient time by Oribasius.[13] In 1760, Lorry succeeded in showing that the part of the brain, injury to which is followed by instant death, is not the cerebellum, but an area near the beginning of the spinal cord, at a level between the second and the third cervical vertebrae.[14] Pourfour du Petit had already noted the occurrence of nystagmus on cerebellar lesions, and had corrected his earlier impression of its sensory function. Lorry demonstrated the first indication of inco-ordination. He pushed a long needle through the one hemisphere of a pigeon's cerebellum, avoiding with great care the brain-stem; the bird seemed to stagger in its walk, as though one half of the body were weaker than the other. Saucerotte was the first to call attention to the forced rolling movements and to the forced positions, the opisthotonus, pleurothotonus and skew strabismus, consequent upon cerebellar lesions. Mehée de la Touche investigated the cause for the cerebellar position of the head.[15] He injured first one side of the cerebellum, then the other. As the head remained in the position assumed after the first injury he argued that the position was not due to muscular contraction, but rather to paralysis, or, as we would say to-day, hypotonia.[16]

With interest roused in the phenomena of electricity, a resemblance was early found between the alternate layers of grey and white matter, seen on section of the cerebellum, and the metals in a voltaic pile; the organ was thought to be the analogue of the electric organ of the torpedo. Rolando, the celebrated anatomist of Turin, found that, on bringing one lead of a voltaic pile into contact with the cerebellum and the other with a limb, stronger contractions were obtained than when the first lead was placed on the cerebrum. He also noted that, in contradistinction to those with damage to the cerebrum, animals with cerebellar lesions made attempts to avoid obstacles, to pick up morsels of food, but frequently failed; the will was there, but not the power to carry its purpose into effect. Total removal of the cerebellum caused paralysis. He therefore concluded that its chief function is the reinforcement of the motor impulse, particularly in voluntary movement.

A new era opened in 1823 with the presentation to the Academy at Paris of the researches made by Flourens on the functions of the various parts of the brain. His account of the pigeon, deprived of the cerebellum formed, as Miller justly remarks, the basis of all future studies. His success was partly due to the advances in the anatomy of the brain, thanks largely to Gall, partly to improvement in technique. He operated chiefly on young pigeons and removed sufficient of the skull to obtain a fair view and thus avoid much of the hæmorrhage from the blood sinuses. We cannot do better than quote his own words:[17]

> I removed the cerebellum from a pigeon, slice by slice. During the removal of the first layers the bird only showed a little weakness and lack of harmony in its movements.
>
> On removal of half the organ it showed an almost universal agitation—but no sign of convulsion. Its movements were brisk, but ill-regulated: it heard and saw. On total ablation of the cerebellum, the animal completely lost the ability, which the previous mutilations had altered more and more, of flying, jumping, walking and standing. Placed on the back, it could not recover its position, try as it might; far from remaining quiet as a pigeon deprived of its cerebral lobes, it kept up a wild and almost continuous movement, though not of a set or determined character. For example, it saw the threatening hand, attempted to avoid it, made a thousand twists and turns to do so, but could not. That is to say, the will, the senses, the perception remained, the power of movement was retained, but the co-ordination of movement, the ability for controlled and determined movement was lost.

Flourens was so struck by the close resemblance of the animal's reeling gait to that of a drunkard as to be persuaded that alcohol has a selective action on the cerebellum.

In consonance with the development of the reflex theory, Lussana, in 1862, suggested that the co-ordination of movement depends upon impressions from the muscles, the muscle-sense described by Bell, of which he presumed the cerebellum to be the centre. The weight of evidence, as adduced by Pourfour du Petit, Flourens, Luciani, and more recently by Holmes, goes to prove the cerebellum devoid of all sensory function, even muscular; yet to a certain extent the idea foreshadows Sherrington's concept of the organ as the head-ganglion of the proprioceptive system.

As a result of numerous experiments in which in various ways he injured the cerebellum of pigeons, Weir Mitchell,[18] in 1869, held that those that survive the immediate effects of the operation gradually regain the co-ordination of movement, but lack the power of sustained effort. He considered the apparent incoordination of movement to be rather a confusion of motion due to irritation of the various nerve paths passing from the cerebellum to the voluntary musculature. In terms similar to those of Rolando, he defined the cerebellum as a "great reinforcing organ, capable of being more or less used in volitional muscular motion."

Also in line with Rolando is Luigi Luciani, whose work forms the basis for the modern analysis of cerebellar activity. His first announcement was published in 1891 after seven years of diligent study. Profiting by the recent introduction of aseptic technique into surgery, he was able to operate with accuracy and assurance and to use the higher animals, dogs and monkeys.[16] Many of these he was able by careful supervision to keep alive and in good health for several years.[19]

Magendie, Ferrier, and others had paid much attention to the forced movements elicited by damage to the cerebellum, and had therefrom deduced a theory of equilibration in accord with the vestibular connections. Luciani showed them, however, to be but an initiatory stage, and considered them "dynamic symptoms," due to irritation of the centres in the brain-stem and cord. They have been more recently explained as "release symptoms," due to the removal of various cerebellar regions, which have an inhibitory influence on muscle tone.[20]

Luciani found the essential defects following the removal of the cerebellum to be muscular weakness, lack of muscle tone, and tremors: asthenia, atonia and astasia, three manifestations, as he suggested, of the loss of a single process—the action of reinforcement. After a time the lost powers were in great measure regained. This was due , as he proved by their subsequent ablation, to compensatory activity of the remaining part of the cerebellum, if any, or of the sensori-motor cortex in the contralateral Rolandic area. Of Flourens' concept of co-ordination, Luciani spoke very scathingly, stigmatising it as "an abstract and fictitious entity, obscure, imperfect and unintelligible."[21]. Yet it is the first groping toward the present idea of synergia, the co-operation of the various muscles in movement or posture.

In the "nineties" began the epoch-making enquiries of Sir Charles Sherrington into the integration of the nervous system. A movement is but a series of postures; the smoothness and effectiveness of movement depend upon the regulation in postural tone of the various muscles and groups of muscles that act as agonists, antagonists and fixators; this tone, in turn, is regulated reflexly by the afferent impulses from proprioceptors in the contracting muscles themselves, in joints, in tendons and in the vestibules; the head-ganglion of this proprioceptive system is the cerebellum.[22]

On the clinical side, the most important contribution has been that of Gordon Holmes, based on cerebellar tumours and on gun-shot wounds received during the late war.[23] Luciani's observations were confirmed in nearly all particulars. Practically all the symptoms of cerebellar defect could be correlated with the loss of postural tone; fatigability, as described by Weir Mitchell, was a marked feature and was attributable to the reliance on voluntary contractions, which involve fatigue, without the assistance of postural tone, which is indefatigable. Many cases showed in addition marked weakness on voluntary exertion, as though lacking some reinforcing moment.

In 1924, Magnus, of Utrecht, and his colleagues made the startling announcement that the thalamus animal can maintain its correct posture in standing, running and jumping, with every evidence of refined adjustment whether the cerebellum is intact or not. On the other hand, Rademaker has shown that animals deprived of the cerebellum, with the cerebrum and remainder of the nervous system left intact, exhibit a gross and persistent ataxy of movement, a characteristic release phenomenon. Thus, as stated by Walshe, "It is only when the cerebral motor cortex activates the reflex mechanisms of brain-stem and cord that the cerebellar intervention in the motor taxis of the organism occurs, *i.e.*, it is solely voluntary." It is one of the triumphs of modern neurology to have shown that "the secret of cerebellar function is to be sought in a close functional relationship between cerebral motor cortex and the cerebellum."[24]

The association of the nerves from the cerebrum and from the cerebellum had been vaguely indicated by Sir Charles Bell:[25] it was more definitely formulated by the philosopher, the disciple of Herbert Spencer, Hughlings Jackson, who, as Sir William Broadbent has said, "penetrated more deeply than even experimental science into the relations of the different nerve centres with each other and with the periphery, bringing to bear upon nervous physiology and pathology the speculations of evolutionary philosophy." (*Brain*, 1906) "All the muscles of the body," said Jackson, "are innervated both by the cerebrum and by the cerebellum. The cerebellum is the centre for continuous movements, for tonic contractions; the cerebrum for changing movements, for clonic or phasic contractions. Every combined muscular adjustment necessitates the co-operation of both these organs; no steady movements can be produced by the alternate contractions of some groups of muscles, except in so far as other groups of muscles are maintained in a state of continuous contraction. Hence it may be inferred that all movements of the body are coordinated both in the cerebellum and in the cerebrum.[26]

This intimate association has been confirmed clinically and by experiment. Sir David Ferrier observed that in cases of long-standing disease of one cerebral hemisphere the opposite lobe of the cerebellum frequently degenerates.[12] Luciani noted the compensatory action of the cerebral motor cortex for the loss of the contralateral cerebellar lobe. In 1893, Risien Russell found that ablation of one lobe of the cerebellum lowers the excitability of the opposite Rolandic area, while, later, (1912), Rossi showed, conversely, that the cerebellar faradic stimulation enhances it.

The correlation of anatomy with the findings of experiment and the clinic is nowhere so important as in the unravelling of the nervous system. We have seen the endeavours of Varolio, of Willis and of Gall to deduce its functions from a study of its anatomy alone. Since, however, it has been proved that the enquiry after function is the domain of experiment, by nature or by design, the duty of anatomy has been to demonstrate the basis for the facts revealed and, sometimes, to give impetus to further research.

The introduction of the achromatic lens afforded opportunity for the development of the cell theory. One of the foremost in this move was Johannes Evangelista Purkinje, of Breslau, by whom the characteristic cells of the cerebellar cortex were first described in 1837. By the study of consecutive hardened sections of the brain and spinal cord, yeoman work was done by Benedikt Stilling who was one of the first to use the microtome. In 1874 he described the intrinsic nuclei of the cerebellum, of which he issued a fine album in 1878. Marchi, acting on the Wallerian theory of neuronic degeneration, traced the paths destroyed after Luciani's operations on the cerebellum. Sir Victor Horsley and Clarke demonstrated with the aid of the stereotaxic needle the efferent paths leading from the central nuclei and showed that the cortex is purely afferent. By the diligent studies of these and many other pioneers, the complicated structure and connections of the cerebellum have been worked out.

Nerve paths reach the cerebellum from the cord through the inferior peduncle, and, by the tract of Gowers, through the superior; from the vestibule by the inferior; and from the cerebrum by the middle. Efferent paths pass through the superior peduncle to the red nucleus and thence to the cerebrum and all parts of the central nervous system. The Purkinje cells are in constant communication with the labyrinth, muscle, joint and other proprioceptors. From the cerebrum they learn through the middle peduncle the desire of the will; by the manifold connecting system of the molecular layer the messages are sorted and correlated; instructions are thence sent to the intrinsic nuclei; the efferent impulses pass by way of the superior peduncle to the red nucleus; "they set or tune the segmental motor mechanisms so that they respond immediately, effectively and with appropriate force to cerebral messages" (Holmes, 1917). Thus is produced the necessary synergic contraction of all the muscles in a smooth co-ordinated movement.

An intimate association of definite areas of the cerebellar cortex with corresponding parts of the body has been suggested by various authors, pre-eminently by Bolk, on grounds of comparative anatomy, and by Weisenburg after cinematographic study of his cerebellar patients.[27] It is, however, generally held that while each hemisphere is in relation with the homolateral limbs and the vermis with the trunk a further localization is not proved.

In a fascinating paper, Tilney[28] has suggested that the function of the archeparencephalon (the inferior vermis and vertibular nucleus) is the maintenance of posture; that of the paleoparencephalon (the superior vermis), the control of automatic associated movements; that of the neoparencephalon (the lateral lobes), of voluntary movements of the individual limb; with the neoparencephalon appears the middle cerebellar peduncle; their development is an index of the connection between the cerebral cortex and the cerebellum, an association that develops *pari passu* with the use of the smaller muscles, notably of the hand, and, consequently, as Anaxagoras would have, with the intelligence.

As recently expressed by Sherrington and Leyton, "the motor cortex selects and combines into an infinite number of combinations and sequences the component elements of the simple movements represented in spinal cord and brainstem." Walshe suggests that in this analysis and synthesis the cerebellum plays an executive rôle, that it is the "organ by which the cerebral cortex achieves integrative synergia in voluntary movement."[29]

Ex tenebris lux. Gradually the view becomes clearer and more distinct. The path of progress is by no means straight or narrow; there are wanderings far and wide; yet those very hypotheses that seem to have led farthest astray have provided lessons and revealed truths indispensable to the general advance. Neither does progress consist in the bare collecting or marshalling of facts, but in their fortunate, or, if you will, inspired, arrangement in their proper sequence. The lead is taken by skilled imagination under the guidance of revealed fact.

In conclusion, I would express a deep debt of gratitude to Professor Neuburger's 'Die historische Entwicklung der Gehirn-und Rückenmarksphysiologie vor Flourens'. This classic roused my first interest in the study and has been my guide over the major portion. I would also like to thank Miss Monk of the Medical Library, University of Manitoba, Dr. C. F. Wylde of the McGill Medical Library, and Mr. H. E. Powell of the Royal Society of Medicine for their ready help at all times.

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Men and Books

THE MEDICAL HISTORY OF BRITISH COLUMBIA*

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MEDICAL MEN OF THE CARIBOO

It is estimated that from thirty to thirty-five thousand men were attracted to the Fraser River and Cariboo gold fields during the period 1858 to 1865. Among these, no doubt, were numbered a score or more of medical men, but when, even with the assistance of men yet living who as boys were in Barkerville in 1865, an attempt is made to single out some of these pioneer medical men, one finds that less than ten are remembered as having actually practised their profession—the rest engaging in the mining business. There was little sickness among the miners, as only the strong and hardy could stand the strain of the life. However, owing to the numerous accidents and injuries, many of them of a serious nature, and which were due to the nature of the industry, a strong appeal was made by the miners to Governor Seymour to establish a public hospital.

The fall of 1863 saw the erection of the William's Creek Hospital at Barkerville, and Dr. John Chipps, an English graduate, was appointed its first medical officer. The financial position of the institution a year later was decidedly precarious, so much so that Dr. Chipps and the steward consented to remain on duty without salary on condition that their board be furnished. In September, 1865, Dr. Chipps sent in his resignation and Dr. Thomas Bell was appointed in his place. Dr. Chipps, who continued in practise in Barkerville, was then about fifty years of age, and was generally held in high esteem, being trusted by everyone. During his stay in the Cariboo his daughter came out from England to keep house for him, and together, when the mining business waned at Barkerville, they moved to Granite Creek and from thence to Vernon, where it is reported he died about 1886. From all accounts now available, Dr. Thomas Bell, who succeeded Dr. Chipps in the Barkerville Hospital in 1865, was the foremost medical man of the district and continued so up to the time of his death, which occurred about 1870.

Not many of the old Cariboo pioneers are left, but from Mr. J. B. Leighton, of Savona, now over 80 years of age, but still hale and hearty and with a most retentive memory, who resided in the Cariboo from 1865 and on for more than forty years, the following facts were gleaned.

"Dr. Bell was an Englishman, well qualified in his profession. He attended to his practice and did not indulge in mining as did nearly all the other doctors at that time. He was of slender build, not very robust, a skilful surgeon and well liked by all. He was the outstanding medical man of the Cariboo at that time, as he stuck to his work and was always sober. I recall a case that will illustrate his surgical skill. A miner by name of George Murdock had the end of his nose bitten off in a fight in 1866. Dr. Bell did a plastic operation, using the skin of the forearm to make a graft to cover the denuded area. I saw the man walking about with his arm tied to his head. The result was perfect.

* The previous instalments of this article can be found in the *Journal*, 1931, **25:** 336, 470; 1932, **26:** 88.