which the muscular arterioles and the vaso-motor nervous system are intimately and obviously concerned has not been without interest even for this learned audience, to whom I desire to offer my cordial thanks for the attentive hearing with which they have favoured me.

ON DR. BILLING'S VALVULAR EXPLANATION OF THE HEART-SOUNDS.

By W. J. LITTLE, M.D.,
Late Senior Physician to the London Hospital, etc.

AMONGST the controversial communications on the causes of the sounds of the heart which have recently appeared in the columns of the BRITISH MEDICAL JOURNAL is one dated September 30th, 1876, from Dr. C. J. B. Williams, in which the following statement occurs:—"I reassert that those observations" (viz., Dr. Williams's experiments on the ass stupefied by woorara) "made in February 1835, supplied the first complete knowledge of the sounds of the heart, which has given to the profession the means of distinguishing the physical signs in health and disease." In the same article, it is said: "My experiments established the view that the *first** sound of the heart is produced by the tightening of the ventricular walls and valves in the systole, and the *second* sound by the tightening of the arterial valves by the recoil on them of the column of blood in the arteries by the diastole"; also: "These observations seem to me sufficiently to prove that the essential cause of the first sound is in the walls of the ventricles." He further adds: "I admit that the auricular valves have their full share with the ventricular walls in producing the systolic sound, and I ascribe the *flapping* commencement of this sound especially to them."

Dr. Williams here appears to lay claim to being the first to demonstrate that the first sound is *in part* caused by the action of the auriculo-ventricular valves, and that the second sound is *wholly* caused by the action of the arterial valves. There is some difficulty in reconciling the apparent meaning of the sentences which I have quoted, when they are compared with each other and with what Dr. Williams wrote in 1835. At that period, he assigned more importance to *bruit musculaire* than he now does, as shown by the following extracts from his work on *Diseases of the Chest*, 3rd edition, 1835, page 175:—"That the first sound is not dependent on the closing of the auriculo-ventricular valves (as imagined by M. Rouanet and others) is evident from Exp. 1, Obs. 4, 6, 7, 8, 9, in which the closure of these valves was partially or completely prevented, yet the first sound still continued.....That the first sound is produced by the muscular contraction itself† may be considered as proved by Obs. 8 and 9 of Exp. 1, in which every other possible source of sound was excluded and the first sound still accompanied the systolic action of the ventricles." There appears also some confusion of language in one of the above extracts, where Dr. Williams speaks of tightening of the valves, and in another place of the *flapping* sound of the valves. Surely Dr. Williams would consider himself somewhat at sea, if he imagined the valves to flap in the blood in the manner that the sail of a ship which is loose at one side flaps about during a gust of wind.

I have waited until the probably approaching end of the controversy, in the hope that some of the contributors to it, and especially Dr. Williams, would have alluded to the labours of Dr. Billing, who, before the date of Dr. Williams's experiments, showed, as the result of anatomical, physiological, acoustic, and clinical research, that the first sound of the heart is produced by *tension* of the auriculo-ventricular valves, and the second sound by the *tension* of the arterial valves. Dr. Williams's experiments were made known in 1835. Dr. Billing's views and explanations were given in his lectures on the *Theory and Practice of Medicine* at the London Hospital during the period of my attendance on those lectures, and whilst I was acting as his clinical clerk in the wards previously to August 1831. I was also present as a visitor at the Hunterian Society in February 1832, when Dr. Billing read a paper on the Valvular Origin of the Sounds of the Heart. This paper was published *in extenso* in the *Lancet* of May 1832. I well remember seeing and hearing Dr. Billing illustrate the mode of production of the heart-sounds by means of a strip of paper held by one hand at each end of it and then suddenly rendering it tense. I refer those readers who desire to investigate the matter to Dr. Billing's *First Principles of Medicine*, 6th edition, 1868, page 37.

Whatever honour may spring from the discovery of the valvular origin of the sounds of the healthy heart—and, in my humble opinion,

this honour is considerable—is due to Dr. Billing, my old teacher, colleague, and friend. I hold that clinical study is a firmer basis of knowledge on this subject than experiments on dying animals, especially when, in addition to removal of the anterior wall of the chest and listening through the stethoscope applied to the naked heart, the operator varies his investigation by "pushing the auricles by the end of a finger into each auriculo-ventricular opening, cutting open the auricle, partially destroying the mitral valve, causing the blood to well out at each pulsation, inserting a hook into the pulmonary artery and drawing back its valves". It is not hereby meant to indicate that any of these methods of inquiry were meaningless or unjustifiable; quite the contrary. Having formerly had some experience in vivisections, knowing the difficulty of carrying them out under circumstances in any way analogous to the normal condition of things, I set a smaller value on the results of Dr. Williams's experiments, confirmatory in a great degree as they are of Dr. Billing's previously published views, than Dr. Williams very naturally places upon them. I express the conviction that Dr. Billing is alone entitled to the merit of the discovery of the sounds of the heart being dependent upon valvular tension.

It is an agreeable thing for the old pupils of Dr. Billing to know that many able later investigators have wholly or partially confirmed his views. Of these may be named Rouanet (September 1832), Bryan (January 1833), Von Kiwisch, Valentin (1850), and Halford (1852). It would seem, from the present controversy in the BRITISH MEDICAL JOURNAL, that the minds of many men are still unsettled as to the presumed existence of coexisting simultaneous causes of sound going on in the heart—movements of fluids, *bruit musculaire*, contact of heart with the walls of the chest, etc. I avoid wearying my readers, and, therefore, refer them to the full sources of information contained in Dr. Billing's book already quoted.

It was a grand merit on the part of Dr. Billing, when so many able men—Hope, Latham, Watson, Clark, Williams, and others, his contemporaries in this country—were, like himself, assiduously employing auscultation, to have alone enunciated and demonstrated the valvular origin of the sounds in 1831, at so early a period after the publication of Laennec's immortal discovery of *Auscultation and Percussion*, and at a period when the facts and explanations of Laennec were undisputed as to this matter by men so gifted as Sir John Forbes, the translator of Laennec's work, and Dr. Thomas Davies, the earliest followers, I believe, of Laennec in this country.

THE RECENT CATASTROPHE AT TYNEWYDD COLLIERY, NEAR PONT-Y-PRIDD.

By H. N. DAVIES, L.R.C.P.L. & ED., Surgeon to the Colliery.

THE subjoined narrative of the recent accident at Tynewydd Colliery is so remarkable in some of its features, especially those having reference to the prolongation and sustentation of life in air considerably compressed, that I have great pleasure in sending it for publication in the BRITISH MEDICAL JOURNAL.

I shall not in this report submit any opinions as to the physiological effects of compressed air on the waste of tissue, or in arresting evaporation, and thus preserving the heat of the body and maintaining the temperature of the cell in which the rescued men were entombed.

It is, perhaps, necessary to remind those of the profession who are unused to colliery operations that, when coal is to be dug, a shaft is sunk to the depth at which the mineral is to be found. From the bottom of this shaft radiate one, two, or three principal roadways; and it is on both sides of these roadways, and at right angles more or less with them, that headings are driven. On each side of these headings, openings are made into the coal, called stalls. Tramways run along the main roads and branch off into each stall. Further, it is to be remarked that, with respect to this and many other collieries in South Wales, the headings run up from the roadways, at a dip or angle more or less acute with the plane of the roadway. It can, therefore, be easily understood that, a mine being flooded, it is possible that, though all practical egress from parts of the interior is closed, the air driven into the upper headings and stalls will ultimately assert its limit of compressibility, and prevent the further advance of the water. This compression will, of course, increase with the weight of the superincumbent water above the level of the remote stalls, to which reference has already been made.

With this imperfect summary of the conditions as to the general structure of the colliery, which I think necessary before the gravity of the facts can be fairly appreciated, I at once come to the stall which en-

* The italics are mine.

† The italics in this paragraph are in the original.