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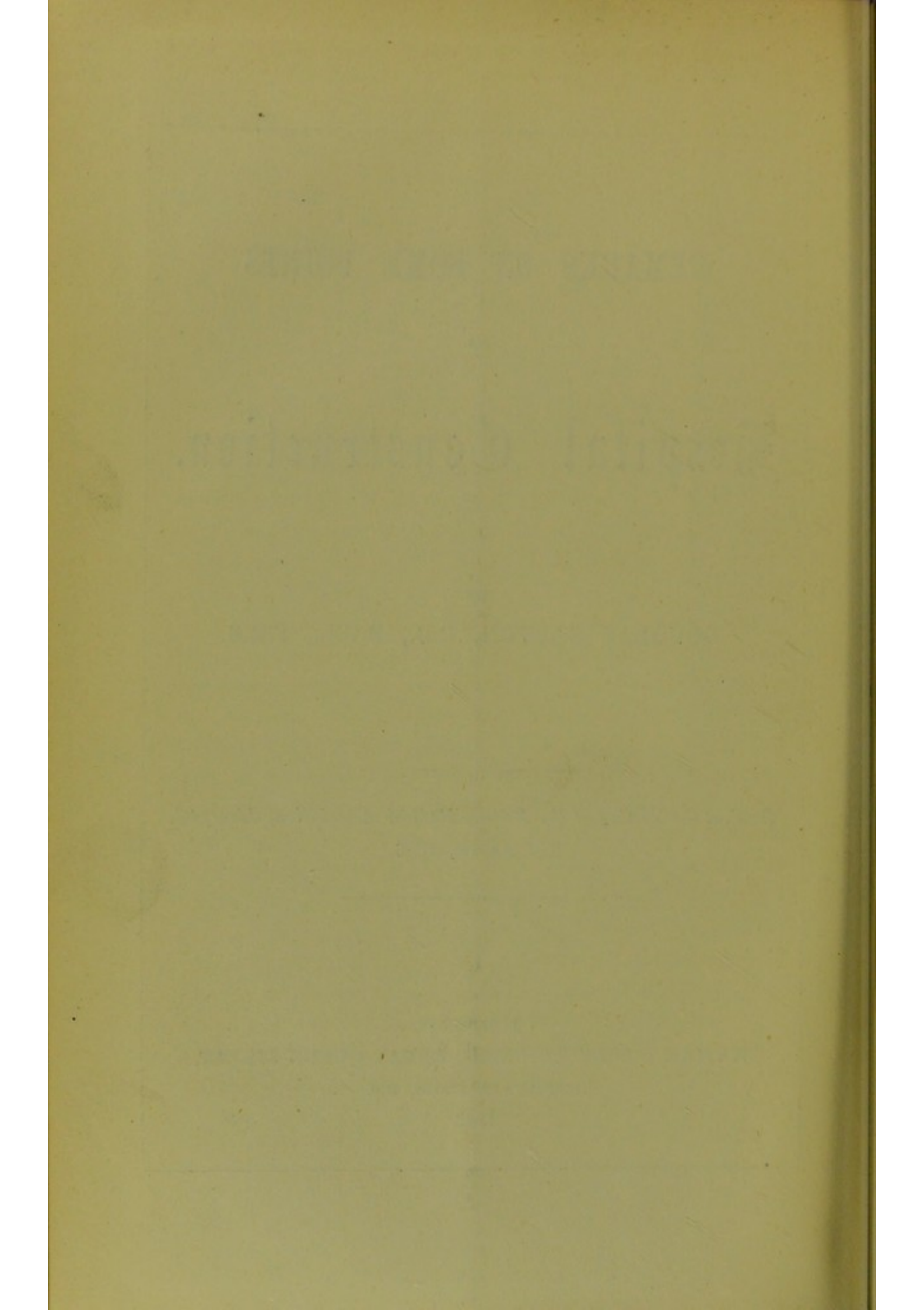
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REMARKS ON SOME POINTS
OF
Hospital Construction.

BY
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HOSPITAL CONSTRUCTION.

IT is now seventeen years since I had the honour of addressing the British Medical Association on the subject of Hospital Construction.

During these seventeen years the subject has received continual attention, and principles of construction which were then comparatively new are now accepted as axioms.

But in the construction of Hospitals, as, indeed, in all matters of human progress, there is no finality. That which was looked upon as perfect yesterday is somewhat antiquated to-day, and may possibly be obsolete to-morrow.

It is not only that the science of medicine and surgery progresses; but with the increase of wealth, of mechanical knowledge, and of constructive skill, our ideas of fitness also expand, and arrangements which were formerly considered to be luxuries come to be looked upon as necessities.

A hospital is not only a place for the reception and cure of the sick poor; it has, so far as the community is concerned, a far more important function. It is the technical school in which the medical student must learn his profession, and it is an experimental workshop for the matured physician or surgeon.

In order that the effect of the curative art may be studied under the most favourable circumstances and

without disturbing causes, it becomes necessary that the hospital building in which the patients are lodged should be placed in the most favourable hygienic conditions, and furnished with the most complete curative appliances.

Therefore, whether the hospital be looked upon as a place for the relief of misery, or as a place for education, the same necessity prevails of making it as perfect as possible.

It is, I think, now generally admitted that hospitals should be built on the pavilion principle; that is to say, that the buildings for the sick should be apart from the administration; that in town hospitals the number of beds should not exceed from 50 to 60 under one roof in a single pavilion; that there should be ample circulation of air round the ward buildings; that the wards should have windows on opposite sides; that the ward offices should be separated by a ventilated air-space from the ward itself; that water-closets should be outside the main walls of the building, ventilated and warmed independently, and the drains cut off by traps and air-spaces from the town drains or from any long length of drain-pipe; that all drains in the hospital enclosure should be ventilated and be entirely free from deposit; and that every part of the hospital buildings should be light, so that all accumulations of rubbish and all want of cleanliness should be at once apparent. Various other matters of detail are also admitted. But when a new hospital is proposed to be built in a town I am frequently asked certain questions which I think it would be useful to consider here. These are :—

1. What area per bed should a town hospital occupy ?
2. What number of wards can be superimposed ?
3. What shape of ward is preferable ?

In the first place, what space in a town area should a hospital occupy?

So far as the site is concerned, it would be preferable if it were possible to place the hospital on the outskirts of a town, where houses are widely distributed; for it is certain that the larger the open space is round hospital buildings the better. On the other hand, it has generally been the practice for hospitals to be placed within reasonable reach of the population for which they provide. Many cases suffer from conveyance to a distance. Hospitals must be accessible to the leading physicians and surgeons of the town, who necessarily reside near the centres of population.

These centres of population consist often of districts closely built over, which are under questionable sanitary conditions, and where the circulation of air is often much impeded.

It is, therefore, necessary to consider not only what is likely to be the effect of the surroundings upon the health of the hospital, but whether the aggregation of disease in the hospital will have any effect on the surrounding population.

We have hitherto been accustomed to ignore this question; but it has forced itself into prominence in the case of the Small-pox Hospitals in London.

A very full inquiry as to the health of the neighbourhood was made in the case of each of the five Small-pox and Fever Hospitals established in London. The Royal Commission of Inquiry upon these hospitals say:—

“That by some means or other the Asylum Hospitals in their present shape cause an increase of small-pox in the neighbourhoods appears to us clearly established by the experience of the five hospitals during the last ten years, and we feel that so long as it is not proved that ‘personal communication’ is adequate to the explanation of the whole spread of small-

pox, and so long as distant 'atmospheric dissemination' is not shown to be in the highest degree improbable, it is essential that in the construction and management of small-pox hospitals both sources of danger should be with the utmost care guarded against."

The Commission state that the same influence on the adjacent locality has not been proved with respect to cases of Fever.

And they express the opinion that some hospitals must be placed in the vicinity of the inhabitants, on the alleged ground, that in many cases the patients are too ill to be transferred to a distance.

That some effect has been produced by the aggregation of persons suffering from small-pox seems thus beyond doubt. Cases have been mentioned where a large hospital suddenly filled with wounded men has been alleged to exercise a pernicious influence on the neighbourhood; but there has not been any clear proof that the aggregation of disease in the case of ordinary hospitals affects the health of the surrounding population. It is very difficult to collect statistics of the health-rate of any area, as distinguished from the death-rate; but if any harmful influence was to be exercised by a hospital, it would seem probable that it would be more apparent in a poor neighbourhood, where the houses are under bad sanitary conditions, than in the neighbourhood of good houses, and therefore that the hospital, if possible, should be placed near the better class rather than amongst the poorer class of houses.

It is difficult to find examples of recently-erected town hospitals the air-space round which is restricted entirely to the ground on which they stand. For instance, the new St. Thomas's Hospital has a river frontage.

The Glasgow Infirmary adjoins a Park.

The space occupied by the Heidelberg Hospital, which may be considered one of the German model hospitals, affords 1,070 feet per bed, but the grounds adjoin the Neckar.

Of the new hospitals the following appear to occupy an area surrounded by streets. In these the area occupied per bed is as follows :—

Name.	Patients.	Feet per Patient.
The New York Hospital	163	200
The St. Marylebone Infirmary	744	264
Leeds General Hospital.....	328	512
Antwerp Hospital	380	1,126
Berlin Military Hospital	504	1,308
John Hopkins Hospital, Baltimore	400	1,519
Dresden Public Hospital	260	3,297

The New York Hospital is built with wards in six stories, and its ventilation and warming depend on very perfectly-arranged mechanical appliances; but on the occasions when I happened to visit it the fans were not at work.

The Marylebone Infirmary is mainly intended for chronic cases from the workhouse, and therefore is not under the same conditions as a hospital.

The Leeds Infirmary was constructed some years ago, and provided 512 feet per patient, exclusive of the area of the surrounding roads; but it will be seen that the recently-constructed Continental and the model American hospitals afford from 1,126 to 3,297 feet per patient, exclusive of the roads around them.

The sites occupied by the best-arranged hospitals for

infectious diseases in this country afford more than 2,000 square feet per patient.

I observe from the plan of the ground proposed to be acquired for the new hospital in Liverpool that the area extended to Pembroke-place contains over 200,000 square feet; and assuming that the hospital is to accommodate 250 beds, that would afford about 800 square feet per bed, which is much less than the space thought necessary in the newest Continental hospitals, *e. g.*, at Antwerp, Berlin, and Dresden; but it must be observed that the space is supplemented, for the present at least, by the adjoining open ground occupied by the Medical School and University.

The figures above mentioned show a very great increase of space in the most approved modern hospitals over that formerly thought necessary.

Let us, therefore, consider what has been the experience which has led to this change of opinion. In doing so we at once come to the second and third questions, *viz.*, as to the number of stories of wards and the shape of a ward.

A preliminary consideration, however, in the matter of the space occupied by a hospital in a town site with buildings all round is, no doubt, the one as to how far sunshine will be obstructed by surrounding buildings.

Thus the latitude has some influence upon the question, for in the north the sun in midwinter is very low above the horizon; moreover, the buildings should be so arranged that there may be as few spaces as possible in the hospital area to which sunshine does not penetrate.

From this point of view the distance between the hospital buildings and the surrounding buildings should be, in England, at the very least three times (and, if

possible, more) the height of the buildings above the level of the hospital enclosure. The distance between adjacent pavilions should be, at least, twice the height of the pavilions measured from the level of the ward floors to the parapet of the building if in the Italian style, or to half the height of the roof if the pavilions have steep roofs.

In the Heidelberg Hospital the pavilions are a distance apart of $3\frac{1}{3}$ times the height from the ward floors to the eaves; and in the Berlin Hospital, more than 4 times in the case of two-storey pavilions.

The question of the position of the pavilions with respect to the points of the compass must be considered with respect to the sunshine.

In the Heidelberg Hospital the wards, after much discussion and careful consideration by leading German sanitary authorities, were placed east and west.

With wards so placed the open space adjacent to the northern side of a pavilion would not, in the winter, receive any sunshine. For this reason the arrangement of the axes of the pavilions of the new French Hospital at Montpellier, which are S.E. and N.W., would appear preferable.

The details of the Berlin Civil Hospital received the most careful consideration of Dr. Esmarch, of Kiel; Professor Baum, of Gottingen; and Professor von Langenbeck, Dr. Wilms, and Dr. Quincke, of Berlin; as also by the Government officials Dr. Esse and Director Herfordt; and the building may, therefore, be considered to embody the deliberate views of the leading German authorities.

In this hospital the wards are placed with the axes north and south; this is the arrangement which is adopted in the John Hopkins Hospital at Baltimore; and it is

the one which has been generally preferred in England on account of its allowing the sunshine to fall on both sides of the ward at some period during the day.

This arrangement certainly seems preferable in this country, but it is always desirable that wards whose ends face the south should have end windows.

The shape of the ward would have some bearing on the question, and the considerations above mentioned relate chiefly to rectangular wards. The rectangular form of ward has hitherto been preferred; it enables the windows to be placed opposite each other, so that they may act efficiently for changing the air of the ward. The breadth which combines convenience with this condition is from 24 to 28 feet; beyond 30 feet the width becomes too great for this purpose. The beds stand between the windows, and to prevent any stagnation of air or accumulation of dust in the corners, it is desirable, in allotting the window spaces, always to place a window in the corner adjacent to the end wall of the ward. In this form of ward the floor and cubic space allotted to each patient is all available in the immediate vicinity of the bed. The floor space around each bed is of more importance than great height; the latter often gives an excess of cubic space; but this is not necessarily an advantage, provided the ventilation or change of air is adequate; because, if we assume that the exhalations of the patients are uniformly diffused, the degree of purity in the air will ultimately depend upon the rate at which the emanations are produced and at which fresh air is introduced, and in no way upon the size of the room.

Mr. John Marshall, F.R.S., proposed in 1878 to construct hospital wards in the circular form, with the beds round the circumference of the circle, and this form has

been adopted in the new Hospital at Antwerp for 380 beds.

In a circular ward the walls are all available for wall space for beds, but in the rectangular ward the end walls of the ward are additional. Hence the circular form gives the maximum floor space with a minimum of wall space, but the enlarged floor and cubic space is not by the side of the patient, but in the middle of the ward, away from him. In the Antwerp Hospital a ward of twenty beds has a diameter of 61·6 feet. The wall space per bed is about 9·6 feet, the floor space is 149 feet, the cubic space is 2,525 feet.

A rectangular ward, affording similar floor and cubic space, would be 31 feet wide. Therefore, whilst in the Antwerp ward the distances between the feet of opposite beds would be 47 feet 6 inches, it would be only 16 feet in a rectangular ward.

In the Antwerp circular ward the actual space between the adjacent beds is 8 feet at the head, and 6 feet at the foot; in the rectangular ward the beds would be 8 feet apart at both ends; and, in the circular ward, of the 149 feet of floor space and 2,525 cubic space between one-fourth and one-fifth would be beyond a distance of 16 feet from the vicinity of the head of the patient. This proportion of floor space at a distance from the patient is comparatively useless for its object; and the consequent additional cubic space is objectionable; for the large volume of air, at a distance from the patient and not of much use to him, would have to be removed and replaced just as much as the air immediately round the patient. A measure of this waste of cubic space is afforded by considering that in the circular ward the floor space per patient within 16 feet

of the wall would only be 114·2 feet, and the cubic space only 1,923 feet; whilst in a rectangular ward, with a similar wall space, and 32 feet wide, the floor space per bed within a distance of 16 feet of the patient would be 149 square feet, with a corresponding cubic space of 2,525 feet.

In large wards the distance between opposite windows in the circular ward is far greater than is desirable, if the windows are to be mainly depended upon for ventilation. The wards of the Antwerp Hospital do depend upon the windows for ventilation, except in winter, when certain arrangements for the inflow of warm, and the removal of foul, air are provided.

The circular form of ward thus appears open to many objections, but in cases of hospital construction practical experience is of more value than theoretical arguments.

The Antwerp Hospital is not yet completed. When it shall have been in operation for a sufficient time, the experience derived from it will be watched with great interest.

Dr. Burdon Sanderson has suggested the adoption of circular wards, or rather annular wards for Fever and Small-pox patients, with the especial object that the hospital should be ventilated artificially, in order that the air which is used by the patient may, after it has passed through the hospital, be subjected to high temperature, or to some other process for destroying whatever dangerous properties it may possess before it is discharged. He lays down the following conditions, viz. :—The outlets of air are the sources of danger, and not the inlets, therefore it is preferable that the air should be drawn out of the hospital, and not driven into it; the beds for the patients should therefore be placed as near the outlets for air as possible; the outlets themselves should be as near

together as possible; the communication between the outlets and the source of motion, whatever its nature may be, should be as direct and ample as possible. He proposes that each ward should be in the form of a ring, with the chamber from which the air is directly extracted in the centre of the ring; because the annular is the simplest form for making it possible to make the opening for extraction of air communicate directly with the space in which each bed is contained. For a ward of twelve beds, having a capacity of about 1,200 cubic feet per bed, he proposes that the removal of air should be about 120,000 cubic feet per hour, and consequently, the removal of air per patient 10,000 cubic feet per hour.

The beds would be placed as near as possible to, and immediately below each extracting opening, and would therefore be placed against the internal wall, and between the beds would be placed screens, passing to a certain distance out from the internal wall into the annular space, so that the head of each bed would be included in the space between each two neighbouring screens.

A fan working in the central ring would collect the air from the ward, and at once discharge it into a chamber, where it could be subjected to a high temperature, so as to destroy all organic matter it might contain. Dr. Burdon Sanderson would, if necessary, construct these wards in three stories. At Boston, U.S., a square ward with a central square inner space or shaft has been built with the object of drawing the ward air into the central space or shaft.

The arrangement of beds thus proposed, with their heads against the inner wall, is the reverse of that intended in the Antwerp Hospital, and the ward must be

dependent at all times for its ventilation upon mechanical means ; if this could be relied on, and if it be conceded that it is really necessary to pass the air through a disinfecting chamber, Dr. Burdon Sanderson's arrangement would probably answer the purpose. If this view of the danger of the aërial dissemination of the disease when so concentrated is sound, the danger from any failure of the mechanical ventilation would be excessive.

Is there any proof that, provided excessive aggregation of sick be avoided, the free-moving atmosphere does not of itself afford adequate protection ? Experience has not been favourable to mechanical ventilation. If mechanical ventilation is to be efficient and economical, it must never be intermitted, and must emanate from and be controlled at some central source.

In the hospitals which I have visited which depend on mechanical appliances I have always found that some interruption to the action has occurred at intervals more or less frequent.

The whole efforts of the most advanced of the recent constructors of hospitals in Europe, and the constructors of the John Hopkins Hospital in America, have been directed to the separation of the several ward units which make up the Hospital, and this separation is adverse to economical arrangements for mechanical ventilation.

It has therefore been considered preferable to obtain the free movement of air in the wards by means independent of mechanical appliances, and it has been with the view of securing this object that the present recognised form of ward construction has been designed.

The circular form of ward appears to have had partly for its object to round the angles of the wards so as to

prevent them from being places for the stagnation of the organic matter in the air.

This object has been sought to be attained in another way by M. Tollet, in France. He adopts what he terms an "ogival" shape for the vertical cross section of the ward. The walls are of brick lined with glazed tiles, which also form the ceiling, and are supported by iron ribs carried up from the floor to the ridge, where the iron ribs from opposite sides join in the shape of a Gothic arch, and the tiles thus form a curved lining for the ward, reaching from the floor to the ridge of the roof. The form renders cross-ties unnecessary; there are no corners or projections on which dust can lodge; the warmed air draws up to the apex of the roof, where it escapes. There is outside the ceiling a roof of tiles, between which and the inner lining of glazed tiles is an air space. Light and, when necessary, fresh air are admitted into the upper part of the ward by skylights in the curved roof.

This method of construction is very simple, free from angles, and fireproof, as the roof is constructed without wood; and the air space between the tiles on the roof and the tile ceiling keeps up an equable temperature in the wards.

The military hospital at Bourges was constructed for 330 beds, with single-storey pavilions, on this plan. The wards are raised to a height of somewhat over 5 feet from the ground, and they are about 26 feet 3 inches wide. The wall space per bed is 6 feet 10 inches, and the cubic space about 1,870 cubic feet per bed. The hospital appears to have cost, exclusive of the land, about £105 per bed.

There are some military hospitals in the fortifications round Paris on the same plan. The new hospital at

Montpellier is the most complete adaptation of this system. The wards are raised nearly ten feet above the ground and connected by terraces which afford covered access for the service. M. Tollet's method of ward construction appears to be the most approved system of hospital construction in France.

Like the new system in Germany, and the system adopted in the John Hopkins Hospital at Baltimore, it is based upon the separation of the ward units as contradistinguished from their aggregation.

It is interesting to consider the grounds which have led to this view of hospital construction.

One of the recent experiences which appears to have largely influenced the plans for new Continental hospitals has been that acquired in Germany and France during the Franco-German war.

This experience may be summed up as the curative effect of fresh air treatment of surgical cases.

This is in no sense a new experience, but it is one which the designers and architects of hospitals in the first half of this century seem to have continually ignored.

Dr. Guy, in his lecture on Public Health, recalls to notice the experience of Dr. Brocklesby in 1758, who found that soldiers ill with fever landed from an expedition from France died rapidly when placed in houses and barns, whilst they recovered when removed to a temporary shed erected with deal boards and a thatched roof, in the open forest.

Sir John Pringle recorded many similar experiences, and the experience of the Crimean War led to the general adoption of the pavilion system of hospital construction in this country.

The Franco-German War in 1870 furnishes us with numerous examples of the curative effect of fresh air,

of which I will mention one. The wounded after the battle of Weisenbourg were placed in the houses of the adjacent villages and in farmhouses. Pyæmia and hospital gangrene largely prevailed. The wounded were then removed into tents in the open country, the sides of which were looped up so as to allow of free perflation of air, and the patients were, moreover, daily carried out in their beds into the adjacent fields and left there quite in the open air all day. The result was that in a short time the patients recovered.

In the temporary hut hospitals which were organised by the Germans in the several towns adjacent to the frontier, to which the wounded from the field hospitals were removed, the sides were furnished with large flaps hung on hinges, so that they could be lifted up and left open in the day-time to admit of full circulation of air, and even when these were closed at night the ventilation was very plentiful.

This experience has not been lost on German surgeons.

A leading surgeon employs in his hospital a tent enamelled inside for patients under operations, and the advantage of moving the patient into the open air is recognised in the constructive arrangements of permanent hospitals. The more recent and the most carefully devised forms of hospital construction on the Continent provide some arrangement for enabling patients in certain circumstances to be moved in their beds into the open air and to lie there. Attached to the wards of the new Town Hospital at Friedrichshain, in Berlin, are wide verandahs into which the beds may be wheeled. The Dresden Hospital possesses a similar arrangement.

In some of these hospitals places are specially provided in the hospital enclosure where tents may be

erected, and places for tents are also a feature of the John Hopkins Hospital.

The new hospital at Montpellier has large verandahs along the sides of every ward, where the patients' beds may be placed when desired. In some of the hospitals in the United States of America there are conservatories adjoining the wards into which the patients can go, and where their beds can be placed. A conservatory and gymnasium on the roof of a children's hospital in New York is an especial feature of that hospital.

The terraces which connect the upper wards of the Herbert Hospital were designed for the same purpose.

A sun-room or glazed verandah attached to each ward is becoming a feature of hospital construction in this country.

These experiences of War Hospitals appear to have led the Germans to introduce single-storey pavilions for surgical cases in their new hospitals; and the French, who seem to be quite as much advanced in hospital construction, have adopted single-storey pavilions for the whole of their sick wards in their most approved new hospitals.

The question of the effect of the aggregation of the sick under one roof, or in one hospital, has also received much consideration in this country and in America during the last twenty years.

The subject was brought into prominence in America during the American Civil War; and in this country Sir James Simpson took up the question as an ardent advocate for diminishing the size of hospitals. It will be in the recollection of the members of this Association that he took the results of the major amputations of limbs (that is to say, of the thigh, the leg, the arm, and

forearm) as a test of the healthiness of different hospitals ; and adduced statistics derived from 6,000 cases of limb amputation, which showed that the mortality increased according to some law in ratio to the size of the hospital. In the large Parisian hospital of the Hôtel Dieu (which in its old form was very bad) three men out of every five died when the limbs were amputated,—in British hospitals of over 300 beds the mortality was two out of every five,—in hospitals containing between 300 and 150 beds it was one in four ; and this figure was, to some extent, corroborated by Professor Erichsen's experience at University College Hospital, which contains from 150 to 200 beds, in which he showed that in his wards the mortality in amputation cases during a period of thirty-eight years had been one in four ; in hospitals with from 150 to 25 beds, Sir James Simpson's statistics gave the mortality as one in five or five and a half,—and in Cottage Hospitals it was only one in seven. Moreover, in country practice, where country surgeons were in the habit of operating, it was one in twelve ; and he deduced from the fact that these patients in the country were treated in their own dwellings or isolated rooms, and that the patients recovered in a proportion so immensely greater in poor cottages than in rich hospitals, that our system of great hospitals should be changed from palaces into villages, from mansions into cottages.

Mr. Burdett, following the statistical plan adopted by Sir James Simpson, published, about a year ago, statistics obtained from sixty-one Cottage Hospitals, showing a mortality in similar cases of amputation of one in five or six, or seventeen per hundred.

But Mr. Burdett shows that the statistics of the individual hospitals vary much, and that they present great

differences in their sanitary condition. He observes that more favourable results might be expected from Cottage Hospitals if the arrangements in all cases were all that could be desired. He observes that :—

“It is now more than twenty-five years since the first Cottage Hospital was opened, and many of the older of these hospitals are now beginning to be reconstructed ; but the new hospitals are often worse for the patients than the old cottages. These had no system of direct drainage ; in the new hospitals the sanitary arrangements are generally faulty, and constitute a danger to the health of the patients, for frequently sewer gas is directly laid on to a new hospital, whereas earth-closets, or the old-fashioned outside privies, were generally at the old cottages.”

These statistics are based on one only of the agencies to which the case is subjected, viz., segregation ; whereas there are many others upon which the result in an individual case depends.

The management and nursing has often more to do with the success of a case than the form of the ward ; and whilst it may be true that a fair general idea of what are the difficulties of large hospitals may be obtained from results of the large number of cases, it is equally clear that we may produce bad results by neglect in a good Cottage Hospital, whilst possibly with eminent care we may produce good results in a badly-constructed Town Hospital.

In this discussion of Cottage Hospitals we must not forget that one main object of a town hospital is that it should be a school for the education of the future surgeons and physicians ; and that this object could not be fulfilled if the large Town Hospitals were replaced by numerous scattered Cottage Hospitals.

Since the first publication of Sir James Simpson's views Professor Lister has developed his system of antiseptic treatment for operations. Mr. Lister says :—

“It is immaterial how many stories of wards there may be in a

hospital, provided that the details of the antiseptic method are accurately carried out in all of them. If these details are faithfully observed, hospitalism can be prevented."

And Mr. Burdett gives the following comparison between the results, as compiled by Dr. Scheede, of the treatment of surgical cases in German hospitals by Lister's method, and the results of treatment by the ordinary methods in different classes of hospitals :—

	Per cent.
Sir J. Simpson's results of Town Hospitals show an average } mortality of }	41·6
Mr. Erichsen—University College Hospital	25·7
Mr. Burdett—Cottage Hospitals... ..	15·0
Sir J. Simpson—Country practice	10·0
Lister's method. Dr. Scheede—German Hospitals ...	4·36

Of course, the question depends much upon the particulars of the individual cases. There can be no question but that the additional care in surgical operations which has been more generally practised since Lister's antiseptic system was promulgated, has of itself done much to diminish the number of fatal results of major operations. And it is certain that any system of treatment which could be applied universally, and which would produce results such as those shown by Dr. Scheede, with absolute certainty, ought to have a material influence on hospital construction, in that the special evils which arise from open wounds would no longer require to be provided against in the manner hitherto deemed necessary by largely-increased space and expensive construction. The surgical wards might then be approximated in size to the ordinary medical wards, as the general health of the patient alone would be in question.

The antiseptic treatment, even if it were always perfectly administered, could not relieve us from the necessity of resorting to the best-known methods of

keeping a pure atmosphere in the wards ; and although in an extreme case, like that of the New York Hospital or some of the London hospitals, it may be necessary occasionally to retain a hospital on a limited area in the centre of a dense population, the health of the general wards, as apart from the surgical wards, would render such a course always undesirable if it could be avoided.

The recent report of the Royal Commission on Small-Pox and Fever patients bears on this question of the aggregation of sick.

If a disease is so intensified by aggregation as to produce danger to the surrounding population, what is the effect of the aggregation of one class of disease into one hospital ? And still more, what is the effect of many such cases in one ward ?

In regard to this question the Commission state that at Homerton it became necessary to receive fever patients into the Small-Pox Hospital and small-pox patients into the Fever Hospital. There were fever cases at the West End and small-pox patients at the East End ; but there was not a single case of small-pox amongst the fever patients, or of fever amongst the small-pox patients.

As bearing, however, on the subject, there is in Mr. Burdett's paper on Cottage Hospitals, a quotation from a letter of Mr. Thomas Moore, F.R.C.S., which deserves notice :—

“The way in which wounds heal in the pure air of this Cottage Hospital (Petersfield), where there are good nursing, and every available creature comfort, and where no ward contains more than two beds, is beautiful ; and I think I could persuade even Mr. Lister himself that antiseptic precautions are not necessary under all circumstances, if I could get him to spend twelve months in the unexciting but germless air of our Cottage Hospital. Out of 272 surgical cases, many of them of a serious nature, only one has been attacked by erysipelas, and that occurred when there

were several cases of puerperal fever in the neighbourhood, and could thus, probably, be accounted for. It is only right to mention that some of the healthiness of this hospital may be attributed to the fact that we have no sewer gas laid on, as is too frequently the case, I fear, even in the best drained towns. The closets are on the earth principle, and the drain from the kitchen sink is made to open well into the outer air."

Dr. Mouatt, in his recent work on Hospital Construction and Management, written by him and Mr. Saxon Snell, in referring to aggregation of sick, observes that :—

"Any one person can bear his own exhalations with comparative impunity, but that he is liable to be poisoned by those of his neighbours, in an increasing ratio proportionate to their number."

He illustrates this view by an experiment which he performed in one of the prisons in Bengal :—

"Towards the end of the Orissa famine a large number of half-starved sickly men were sent to a district jail. The majority of these prisoners were placed in fairly ventilated wards, with ample room for each, according to the standard measurement allowed. About 120, however, for whom there was no spare room elsewhere, were put in as many separate cells, having 480 cubic feet of space each, and practically without ventilation ; for, although they had open grated iron doors, they were situated in long corridors at right angles to the prevailing winds. A considerable number of the former died, chiefly from diarrhoea ; while there was not a single casualty among the latter, who were said to have been the sickliest of the lot on admission, and who were on this account placed in the cells."

It would be interesting to know to what extent other observers would support Dr. Mouatt's conclusion, and whether a really well-ventilated ward would not have produced more favourable results than this segregation.

Mr. Greenway, of Plymouth, has long advocated the absolute separation of patients in hospital.

The following is the description of his system, which I

allude to because he states it is about to be tried at Plymouth:—

“The ward consists of a building, containing a smaller one, the sides and end spaces between the two forming corridors. The inner building is made of glass, or enamelled sheet-iron and glass, fixed in iron framework, and is divided longitudinally by a partition into two equal parts, and these are subdivided by partitions transversely, so as to form a double row of compartments, each of which has an entrance from its corridor. Each compartment is supplied with fresh air from a grating in the floor by means of an air-tube which lies underneath, and also by an extra tube over the door, and the foul air is extracted by a heated flue which passes from the summit of the inclined inner roof or ceiling up through the outer roof. The building is heated by hot-water or steam pipes.

“The nurses’ rooms are so placed that the nurse has a view of the patients through either row of transparent compartments.

“By this plan of hospital construction each patient is surrounded with air uncontaminated by himself, by his fellow-patients, or by the building, the materials of which the compartments (including the floors) are made being non-absorbent, and the ventilation constant and complete.

“Although each patient would be isolated, he would not feel lonely, as he could see and converse with his neighbour through the glass partition. He would also not be exposed to draughts, as in ordinary hospitals, where the amount of ventilation, which is useful to some patients, is frequently injurious to others.”

As regards the facility of inspection it is quite certain that a view of the beds in a distant cubicle could not be obtained through a series of glass partitions; and, admitting the desirability of isolating the patients, the complications of Mr. Greenway’s method seem to present difficulties, and to create corners for dirt.

The pavilion is 35 feet wide, the area of each cubicle is 10 feet by 10 feet, and, including the corridor, he gives 175 feet of floor space to each patient.

The patient is absolutely dependent for ventilation, even in summer, on artificial means, because the corridor prevents the direct flow of fresh air from the windows into the cubicle where the bed is placed. The large

amount of glass surface to be cleaned would be a continual trouble.

It would seem far preferable to place each cubicle against the outside wall and give it a 3 feet window to itself, which would leave ample space for the bed.

But to what extent is this isolation desirable? Is there any proof of its necessity, except in special cases? For special cases a limited number of wards would suffice.

The isolation wards in the John Hopkins Hospital are on each side of a 9 feet central corridor in a building 39 feet wide; and the separate rooms are 10 feet by 14 feet, with a window 3 feet wide, and a fireplace in each. Including the corridor, the area per bed is 185 feet.

It is probable that rooms 10 feet by 12 feet, in a one-storey building, placed on the south side of a 7 feet corridor, also provided with windows (or still better an open verandah), would be the most satisfactory for isolation wards. The floor should be raised several feet above the ground; each cubicle having in addition to its window such other openings for ventilation as might seem necessary.

The recent forms of hospital construction which have been adopted, show that the absolute isolation of patients has not been thought necessary if free ventilation can be secured. The experience as to the effect of fresh air and free ventilation which I have enumerated above has induced the leading Continental and American constructors of hospitals to place their surgical wards in one-storey buildings. In the case of medical wards one of the objections made by the German medical men to a one-storey building is that it is difficult to keep warm.

The sensation of cold in a room is generally due to the

radiation of heat from the body to the colder walls and to the floor, and also to the roof of the building, unless there is a ceiling. This cold is especially liable to be felt in a one-storey building with a large surface of outer wall and a floor raised above the ground, with circulation of air underneath.

In proportion as the temperature of the floor and walls is raised, so will the sensation of cold be less felt. It is therefore desirable that in hospital wards of this construction the floors and walls should be so formed as to be able to be warmed. For the floor it is probable that it would suffice to warm that portion on each side of the ward extending from the wall a certain distance under the beds, for which purpose this part should be of cement or tiles; the central part of the ward floor might be of wood as heretofore. It might suffice to arrange for warming the walls up to the level of the heads of the occupants of the wards. A warmed floor and warmed walls would tend to prevent the sensation of draught, and would enable the temperature of the fresh air admitted for ventilation to be reduced.

Experience seems to be conclusive that the one-storey building admits of the best treatment for surgical cases, it is also admittedly preferable for fever cases; the one-storey ward has been adopted in the most improved French and American hospitals, and where the space admits it may be predicted that the future unit of hospital construction will consist of one large ward with subsidiary small wards, and with the necessary ward appurtenances in detached single-storey buildings.

If it be really true, as alleged in the Report of the Commission on Small-pox and Fever Hospitals, that the aggregation of this class of patients intensifies the poison,

and admits of its spread to the neighbourhood, the aggregation must also be unfavourable to the patients themselves. The French have termed our fever hospitals "Foyers d'Infection." The logical conclusion would be not to collect infectious cases (that is, small-pox and fever patients) all together, but to separate them as much as possible—that is to say, in the first place, if necessary, to separate the individual patients by lodging them each in a small separate ward. If an epidemic arises, and if there are more cases than can be so accommodated, resort must be had to temporary hut hospitals; but certainly the number of the sick in any one such hospital should be limited to very few in each, instead of collecting large numbers in one or more central positions.

Upon this question the Royal Commission say:—

"If we determine, as has been suggested by some witnesses, that each parish shall bear its own burden, we necessitate the sudden establishment on occasion of every great epidemic of thirty or forty institutions, in a great measure extemporised, each of which will be extremely expensive, both in construction and management, in proportion to its number of patients, some of which will certainly be ill-managed, and all of which, in proportion to their defects or mismanagement, will be effective foci of infection."

If, however, the management of these hospitals in London is placed under one Asylum Board, as proposed by the Commission, and if the members of this Board are qualified for their work, there appears to be no reason why these separate hospitals should not be established on permanent sites; and with adequate supervision by the Board there ought to be no difficulty in ensuring that they are properly managed.

Whatever may be the case so far as London is concerned, it would seem advisable in other places, that Fever

Hospitals and Small-pox Hospitals should invariably be limited in size to a very few, say eight or ten beds each,—placed in quite separate localities,—the wards to be of temporary materials, to be burned or destroyed every year after use and replaced to be in readiness for the next emergency. The material selected for the walls and roof should in preference be such as would check the loss of heat by radiation. A double roof of Willesden paper, and a double wall of the same material with an intermediate layer of felt, or a double wall of canvas, might suffice. The floor might be permanent and of cement, raised 5 feet or 6 feet from the ground, and warmed underneath on the Roman plan. Such buildings for the sick would be temporary and cheap. There should be a permanent cottage adjacent for the habitation of a nurse and attendant; and a kitchen, a disinfecting-chamber, and other necessary appurtenances should be provided.

The conclusion to which these various considerations would lead us is, that for Fever and Small-pox Hospitals temporary structures, to be renewed at frequent intervals, are desirable for the reception of the sick, the only permanent buildings being those for administrative purposes, and for the use of the hospital attendants. It would also be desirable that every part of the ground attached to such hospitals should be paved or asphalted except where covered with vegetation.

In general hospitals the unit of construction for the part of a hospital devoted to the sick is one general ward and the necessary attached subsidiary small wards, with

the adjacent ward offices and appurtenances; there can be no question that the considerations which have led to the adoption of single-storey buildings for surgical wards on the Continent should apply wherever sufficient space is available not only to surgical and infectious wards, but to all the wards of a hospital.

But the wards should be raised 8 feet or 10 feet off the ground, and communications for administrative purposes could be carried on, if desired, in covered corridors under open terraces connecting the wards.

It is questionable whether it would not be preferable for some, at least, of the surgical wards to be temporary structures so far as the walls and roof are concerned. But permanent structures would be necessary in all cases where uniformity of temperature must be maintained; and they should be so constructed as to check the loss of heat by radiation.

It seems probable that some modification of the Tollet form of construction, combined with the use of floors partially or entirely warmed underneath on the old Roman system, and with walls capable of being warmed, may be found to be the most convenient description of ward for the immediate future.

I have endeavoured in these remarks to bring to your notice the chief points in hospital construction which have been developed by the experience of the last few years. Whatever may be the discoveries of science in respect to the origin and propagation of disease, the experience of the whole civilised world in the matter of hospital construction appears to point with unerring

certainly to the fact that just as pure air is the best safeguard against disease, so does a free atmosphere produce the conditions most favourable to the cure of disease, and to the healing of injuries.

The patient should be surrounded with pure air, which can only be obtained by free circulation of air. This is not compatible with complicated buildings, and therefore in proportion as we progress in sanitary knowledge, so do we revert to simpler forms of hospital construction. We first abandoned the Palatial Hospital; we are now abandoning the Pavilion Hospital of many stories, and we are adopting Single-storey Pavilions, or what may be termed the Hut Hospital.

With simplicity in the form of hospital building we shall do well to combine shortness of duration, for if the aggregation of sick is in any degree injurious, the hospital building must partake of that injury in an enhanced degree.

The longer I study this question of hospital construction the more firmly do I become convinced that hospitals should not be built for a long futurity.

In these remarks I have left many points of hospital construction untouched, and I feel I have dealt very inefficiently with the subject; but I think that the questions which I have raised will at least have the effect of drawing attention to this very important subject.

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