DESIGN

—FOR—

A CITY HOSPITAL

—BY—

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It is not the purpose of this paper to deal exhaustively with the subject of hospitals in general, but to record the data obtained for use in designing a hospital of the double pavilion type for a small city. The problem for design did not include isolation wards, boiler house, laundry, or morgue, which in this case are to be in buildings entirely separated from the main portion of the hospital. However, their requirements will be considered to some length.

In the construction of a hospital the first thing to be considered is the site, i.e. the nature of the soil and the area in relation to the number of beds. Also the convenience of access for the patients and the medical officers.

Nature of soil.

The healthiness or unhealthiness of a site depends to a great extent upon the depth at which the ground water level is found, as well as upon the composition of the soil itself. "Mud soil" being usually very bad on account of the great amount of organic matter in it. A high water level is unhealthful on account of its...
keeping the soil and the air above it moist and damp. The water level can be controlled to some extent by means of drains.

Area in Relation to Number of Beds.

It is difficult to lay down any definite rule for the proportion between the two as practice varies greatly. The mean, 1000 to 1800 square feet per bed, of a number of examples, seems to be about right. Johns Hopkins, one of the best modern hospitals, has 1673 square feet per bed.

Convenience of Access

As the object of a hospital is the treatment of disease it is of importance that the site should be convenient of access for the people to be benefitted. Dr. Oppen states that there should be 4 beds for every 1000 inhabitants and that the hospital should be placed as near the center of the city as possible.

Foundations.

They should of course be strong enough to prevent any danger of collapse. It is also very important that means
should be provided to prevent moisture being drawn up into the walls by capillary attraction. This can be prevented by interposing a layer of asphalt, slate, or other impervious substance along the whole length and breadth of the wall at the ground level. The best authorities state that it is essential to have as high a basement as possible in order that the air which enters the windows may not be in close contact with the earth and emanations there from.

Walls.

Enclosing walls in addition to their duties of support are usually assumed to be to keep out the air. In reality walls built in the ordinary way of brick or stone and plastered on the inside perform this latter function only to a limited extent. The porosity of brick and plaster is very great, and that of stone is not much less. That is, the air passes quite freely through the walls and plaster leaving the impurities in them. These impurities in rooms occupied by patients will consist largely of organic particles, pus cells, etc. An analysis made of the plaster of a hospital wall
showed it to contain 46% of organic matter. The ideal wall then would be one which presents an absolutely impervious surface capable of being washed down and thoroughly cleaned. Such a wall has however not yet been attained. Glazed brick or tile are impervious but do not make a satisfactory wall on account of the numerous joints which have to be made with a more or less absorbent cement. Whatever kind of wall is adopted it is best to avoid all angles where the air may stagnate. For this reason it is usual to round all angles.

Floors.

The main consideration of those for the administrative building is that they are fireproof. For the floors of the wards, the out-patients' department, and the operating theatre it is important to secure a solid and impervious floor as well as a fireproof one. With floor boards laid in the best way it is impossible to avoid shrinkage and in the crevices thus formed a large amount of dust and dirt collects. Ward floors are best formed of a solid oak or teak parquet laid on a surface of cement concrete and washed.
polished or paraffined. The floors of the waiting room of the outpatient department and the surgery, and the corridors of the laundry and kitchen departments are best made of "terrazzo," a mixture of marble chips and cement. In the operating room a better form of the same kind of flooring called "mischaiti" is desirable. This is formed of cubes of marble laid closely together, but without any attempt at regularity of pattern. In any case the angle between the floor and wall should be rounded to a radius of not less than 2". In wards where the floor is of wood a hollowed field of oak best answers the purpose. Where a marble or cement floor joins a plastered wall the hollow can best be formed in the material of which the floor is made.

Drainage.

A very important point and one which has so far received too little attention in hospital work is drainage. Drains should only be of sufficient size to carry off the waste rapidly, and should have as great a fall as possible. Salt-glazed tile laid on a bed of concrete should be used; the joints being formed with neat-
Portland cement. Where it is necessary to run the drains under buildings they should be of cast-iron pipe. Manholes must be provided at suitable points, such as junctions or where one or more trunk drains join the main drain. Where the drains pass through the manholes they should be formed of half pipes or of channels in the concrete bottom of the manhole.

Planning.

Administration Building.

This building should contain the offices for the transaction of business, the residences of the officers and servants, kitchen offices, stores, and, where there is no separate nurses' home, the quarters for the nurses. In a large clinical hospital to which is attached a medical school, the residential portion will include rooms for numerous house physicians, surgeons, dressers, clinical clerks, etc.

The business portion of the hospital consists of board room, office for secretary (two rooms), stewards office, and maids' office.
The stewards office should be easy of access to tradesmen, and there should also be a receiving and weighing room.

A linen room must be provided large enough for the storage of linen and the accommodation of at least one sewing woman.

In some convenient part of the administration building a consultation room with a lavatory and water closet adjoining should be provided for the use of the medical staff.

Bath rooms must be provided for the matron, medical officers, nurse, servants, etc. Water closets in the same proportion.

The bed rooms of the servants should be on the top floor. There should also be a trunk room of ample size to hold all boxes and trunks.

The kitchen offices comprise scullery, larder, kitchen, and servants hall. The proper place for these is on the top floor. The scullery must necessarily adjoin the kitchen and need need not be separated from it by a wall or partition. In large hospitals there should be a separate larder for cooked and uncooked food. When the kitchen
is on the top floor the ladder for cooked food should be there, and the ladder for uncooked food in the basement. The flooring of the mullery and also of the kitchen should be of some impervious material as tiles, marble mosaics, asphalt, cement, etc.

Wards.

There are several kinds of wards which may be classed as follows:

1. Corridor wards; ventilated at one side only.
2. Long wards; ventilated at ends only, or at one side and ends.
3. The double ward.
4. The cross-ventilated ward.
5. The circular ward.
6. The octagonal ward.
7. Irregular forms.

Classes 1, 2, 3, and 7 are found only in old hospitals or a few isolated examples of the present times, and will
not be discussed. Classes 5 and 6 are rare but are very much better than those just mentioned. Class 4, the cross ventilated ward, is the most perfect form of ward. In it the windows face each other on opposite sides of the ward, and there are but two rows of beds. In laying down a rule for the size of wards in relation to the number of beds three things must be considered. (1) The wall space or the distance from center to center of beds. (2) The floor area. (3) The cubic space.

Wall Space.

The amount of wall space varies in different cases from 7.2 to 9'. However it is generally conceded that a less distance than 8' is undesirable.

Floor Area.

This also varies greatly, running from 69 sq. ft. in the Moabit Hospital at Berlin to 149 sq. ft. at Antwerp and Edinburgh. 100 sq. ft. is usually considered as the minimum amount. It will be found best to make wards for 20 or more beds 28' wide, while those for
a less number may be but 22 to 24 wide.

Cubic Contents.

Having determined the floor area it is necessary to fix upon the height of ceiling needed to obtain sufficient cubic space per bed. Here again great difference is found to exist. The cubic space varying, in existing examples, from 864 to 2544 cu. ft. per bed. Dr. Monat gives 1000 as the minimum for ordinary wards, while Barkus and de Chaumont place the limit at 1500 to 2000. However in large wards of about 100 in length the ceilings may have to be placed high enough for the sake of appearance to considerably increase this amount.

Ventilation.

There is much written upon this subject but no two writers seem to agree upon the amount of air to be introduced or the manner of introducing it. Berlin hospitals supply 2200 to 2500 cu. ft. of air per patient per hour and the best French examples supply 2100 to 2500 cu. ft. Dr. Billings recommends 3000
In any case the system should be so arranged that the supply may be doubled for a time so as to thoroughly flush the ward.

In the U. S. it is deemed best to use mechanical means for forcing air into the wards, but in other countries this is not considered necessary. Ventilation is then divided into two classes:

1. Natural.
2. Forced.

In the first system the efficiency depends upon windows, smoke flakes, etc. In the second system air may be either forced into the wards or the impure air in the wards may be drawn out. The first of these two methods is the better but the cost of running is much greater.

Heating and Ventilating of American Hospitals.

The greater majority of the hospitals in the large northern cities are heated by steam or the system usually known as that of indirect radiation, so far as the wards are concerned. In this system the radiators, receiving the steam from a central boiler plant, are placed in the basement, being usually encased in tin
lined or galvanized iron boxes placed near the ceiling against the pins between the windows. The air is admitted to these radiating boxes either through the basement windows or by means of special wood, tin, or galvanized ducts constructed for the purpose. The top of the radiator box communicates with flues built in the outer walls and leading up to the wards. These ducts may be of terra-cotta pipe built into the wall, but they are usually made of tin.

In the majority of cases steam heating apparatus does not give good results as regards ventilation when the temperature of the external air ranges from 40° to 50°, because the rooms become overheated if sufficient air is admitted. The reason of this is that the air admitted has just passed over coils having a temperature of at least 212°, and has a temperature of 100° to 150°. When steam is used the radiators should be so arranged that the incoming air may be taken either through or around them.

Hot water seems to be greatly preferable to steam as the temperature of the radiators can then be kept at the precise degree necessary
to warn all the incoming air just enough and not more than enough. This is effected by regulating the temperature of the water in the boilers and large mains, and by regulating the velocity of flow through a particular set of radiators or even one radiator, thus securing a local control. The disadvantage of a hot water system is that it is much more expensive to install than one for steam, and occupies more space. However it is much more economical to operate.

In small wards and private wards the open fireplace is sometimes relied upon for ventilation.

In the wards of the Johns Hopkins hospital the foul air registers are placed in the floor under the beds; horizontal galvanized iron pipes running in the floor from these to a main duct which is in turn carried into a large shaft provided with steam accelerating coils. In most other hospitals these ducts run to flues built in the outer walls.

Windows.

Probably the best form of ward window in
she double hung sash either with or without a transom light. Each bed should have a window on each side of it; the sills being at such a height from the floor that a patient sitting up in bed or sitting on a chair can easily see out. The top should be as near the ceiling as possible. Dr. Thomas Thorne states that the window area should be about 1 sq. ft.; 60 to 80 cu. ft. of space.

Ward closets.

It is necessary that they should be placed near the ward, but they should be separated from it by a well ventilated passage way. The doors through this passage way should be wide enough to allow a cot to be wheeled through. All fixtures should be of the simplest form possible.

Ward kitchen.

As only light cooking is done in the ward kitchen it need only be large enough to permit two or three persons working in it at the same time. It should contain a sink with both hot and cold water, a dresser for dishes, and a range.
Nurse Room.

The nurse room should be next to the ward with an observation window in the wall. It should never be used as a bed room for the nurse.

Isolation Ward.

The isolation ward should be entirely separated from the rest of the hospital and should have a disinfecting room and bath; a separate water closet and room for the nurse in charge; and a ward in which patients suspected of having contagious diseases may be placed until it develops.

Cupboards adjoining wards.

It is too often the case that insufficient closet and cupboard room is provided. Cupboards are needed for:

1. Patients' clothes
2. Ward linen
3. Food
4. Medicine and poisons

Lighting.

Electric lighting is much the best form as it is clean and does not consume the oxygen in the air.
Operating Rooms.

In all hospitals where surgical cases are received and operations performed a special room or rooms will be required. In large hospitals two or three such rooms are provided with accommodations for a considerable number of students.

The operating room must be convenient to the wards, while being as far as possible removed from aerial contact with them. It should be lighted from the north and also by a skylight. Within the operating room itself every detail should be devised with special view to its aseptic nature. If the room is for operations only and not for the accommodation of students this is easily accomplished.

Possibly the best means of describing an operating room would be to give the requirements for an ideal one. These can then be followed as closely in practice as circumstances will permit.

An ideal operating theatre should be a small room, say
20' x 30' x 15'. It would have no provision for spectators. The light would be furnished by a single window from 8' to 12' wide and extending from 4' above the floor to the ceiling; this window should have a north aspect. In addition there should be a skylight 12' square. The floor should be of marble tiles, the walls of enameled brick or covered with sheets of glass, or of enameled slate. However, well painted plaster walls and well laid hardwood floors covered with wax or paraffin gives practically as good results.

The room should have two 100 C.P. electric lights with reflectors which can be turned to any angle; also two portable incandescent lamps with flexible connections. Electrical connections should also be furnished on each side of the room for wires for galvanic, carbonic instruments, electrolytic work, and ordinary galvanic and paradic currents.

The furniture should consist of one operating table, shelves, racks, sinks and traps. The table may be of iron or of wood well saturated with paraffin. The shelves should be of glass or slate, and
the basins and trays of glass or porcelain; the racks of iron. The operating table should not be fixed. The bowls and sinks should waste into vessels which may be removed.

The room may be heated either by direct or indirect radiation from steam coils. The fresh air should be filtered through a layer of cotton batting before entering the room. About 10 cu.ft. will be required per second for a room of the size mentioned above.

There should be the following rooms in addition:

1. An anteroom for the medical staff. 2. An instrument-room, or the instruments may be kept in a glass case in the surgeron's room or the operating room. 3. An anaesthetic room. 4. Also possibly a waiting room.

Laundry.

The laundry should be a detached building. In its simplest form it will consist of a wash house and an ironing room, to which may be added if possible an
open air drying ground. In large establishments there should be a room for the collecting and sorting of soiled linens, and another one for the sorting and delivery of clean linens. A separate wash house and ironing room for infected linens is sometimes required.

The construction of the laundry throughout should be simple in character with light and readily cleansed surfaces. For walls white glazed bricks, and for floors cement or artificial stone should be used. The floors of the wash house should be laid to a regular fall and the whole drainage whether from the floor or the apparatus should be received in open channels covered with perforated iron gratings and running out to an open trap or traps outside the external wall.

The apparatus needed will be a washing machine, hydro-extractor, steeping tank, boiling copper, washing troughs, soap boiler, and a rinsing and blanching machine. The drying chamber should be placed between the wash house and the laundry, and should be provided
with horses fitted with galvanized iron rods and moving on wheels or over head tracks. The room should be heated with steam coils and should be well ventilated. In large laundries it is desirable to have an additional room for airing linen after it is ironed. The ironing room should contain besides the necessary benches, a wringer with the rolling in table.

Boiler and Engine House.

This building should be placed close to the laundry. The best machinery should be obtained and should all be concentrated as far as possible in the one building for economy in running. Where steam is used for heating it can be carried in tunnels to the different buildings. Where hot water is used it can be heated by steam from the central plant.

Disinfecting House.

In all hospitals a disinfecting apparatus of some kind is needed, both for the purpose of destroying vermin in clothes and for disinfecting bedding, etc., after cases of infections.
disease. It is supposed that the only trustworthy process is the application of steam under pressure.

The temperature required to destroy the contagion of ordinary diseases is found to be 220° with an exposure of one hour for dry heat, or 212° with an exposure of five minutes for steam. In any case it is not advisable to exceed a temperature of 250°. An efficient apparatus should be provided to subject the articles to be disinfected to actual contact with high pressure steam. It should have an automatic means of shutting off the steam if the temperature becomes too high. Whatever form of apparatus is used it should be provided with two doors. The one for ingress being in one room, and the one for egress in another room with a solid wall between.

Institute and Post Mortem Rooms.

There can be no question of the necessity for completely isolating these rooms. The building containing them should not even be connected to others by a covered way. However when, for lack of room, it becomes absolutely necessary to place
shin in one of the buildings, they should be on a top floor and be reached by a lift and stairway from the outer air only.

The morgue should consist of two rooms. One a general dead house where bodies are received, washed, and prepared for burial; the other a smaller room in which one body may be placed for friends to see. This latter room may take the form of a small mortuary chapel.

The general dead house should have its walls lined with white glazed tiles or bricks, and its floor should be of cement or tiles. It should be fitted with marble or slate slabs on which to place the bodies. There should be an entrance into this room from both the mortuary chapel and the post-mortem room.

The post-mortem room should be lighted with both sky-light and vertical windows unless it has to be used as a theatre for sealing students, in which case one central sky-light will have to be made large enough to supply the necessary light. The walls should be made of glazed tile or brick and the floor of cement, marble mosaics, mica habitats or terrazzo. Under each table if there
is more than one, there should be formed an open channel of white eartheware, and covered with an iron grating, to take water from the table and also from the floor. The channel should be carried outside of the building and thence delivered into open traps.

The post mortem room fittings should consist of the following:

1. The table, which should be made of polished marble properly dished out and formed to carry all the water to the center of one end where a grating should be fixed and a copper pipe carried down to the channel in the floor.
2. Sinks of glazed porcelain provided with a funnel to fit into the waste so that the sink can be filled and the water allowed to run without overflowing the sides.
3. A marble shelf on which organs or parts of the body needed for examination may be placed.
5. An instrument-case.
6. A blackboard. Hot and cold water should be laid to both sink and lavatory, and to a hose pipe suspended over the center of the table. The latter should have a rinsing chamber on the wall.

In addition to the rooms above described the pathological
department is sometimes included. In Johns Hopkins Hospital it consists of an autopsy theatre, a room for private research, two rooms for bacteriological work, a director's laboratory; a laboratory for pathological histology; one for experimental pathology; a pathological museum, and a photographic room.

But Patients' department.

This is a very important part of every hospital, although but very little attention has been bestowed upon it by modern writers. It is important because of the enormous number of patients who attend there for advice; because it is the channel through which a great number of the in-patients enter the hospital wards; and because in it are treated a large number of cases not requiring treatment as in-patients. It should be isolated as completely as possible from the rest of the hospital. The reason for this is that hundreds of people pass through it with practically no check save an observant nurse to detect signs of contagious diseases. In an
isolated building a contagious case could be promptly taken care of with practically no danger except possibly to one or two persons in the waiting room.

There should be the following rooms in addition: 1. Waiting room; either one large room or two smaller ones, one for each key. 2. Consulting rooms; these will vary in number according to the size of the hospital. To each consulting room should be attached a separate smaller room for examination of patients. There should be doors between each consulting room so that the medical officers may pass from the one to the other without having to go through the waiting room. Patients on leaving the consulting room should not re-enter the waiting room but should pass out through a separate hall to the dispensary, where having obtained their medicine they leave by a separate door.

Nurses' Home.

The necessary arrangement does not vary much with the number of nurses. The only important difference
depending upon whether they take their meals in the home or not. If in the home suitable arrangements must be made for kitchen offices. In some cases there is two homes, one for nurses on active duty, the other for nurses who are suit to outside cases.

At least one room with two beds must be allotted as a ward for sick nurses. Provision must also be made for a sitting room and bed room for a house keeper.

The bed rooms should be separate rooms and should contain but one bed, with a fire place in each case.

Bath rooms should be provided in the proportion of not less than one for each ten nurses. Water closets and house maids closets are needed on each floor.