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Hospital Engineering

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Telecommunications in hospitals

by R. G. JONES

Electronics can add another dimension to communication in human relations, one of the most important factors in a hospital. Electronics, communication and information is each a subject on its own. This article shows how they can be combined to produce a better and more efficient hospital environment, both for patients and staff.

In the late 1960s, electronics became an important part of every communication system. At the same time, the first generation of hospitals with new electronic medical equipment became operational. Major advances have been made in the detection and treatment of illness. There seems to be no limit to the advances health care can make. Electronics has played a major part in this progress, and there are few departments in the hospital where we do not find electronic equipment, boiler house controls, lift controls, complex X ray and patient-monitoring equipment, to mention only a few. Yet the potential of electronics has still to be realised in telecommunication, as applied to the hospital. Why has there been this delay?

One of the reasons must be the effect of phased planning. In many hospital projects, this has prevented the development of a comprehensive telecommunication policy. The design of a new X ray or intensive-care department in an existing hospital gives scope for the introduction of the latest equipment available.

However, the only way to update the telecommunication facilities is to extend whatever facilities that are available in the other parts of the hospital, although these may well not be adequate. This limits the operation of the new departments, resulting in the new and expensive equipment not being fully used. What are the communication requirements of a modern hospital? They are endless, and, in the space available, I will not be able to detail them all.

Every department has a communication requirement, I am not only referring to the spoken word. Communication embraces listings, alarms etc.

Are we making the best use of communication technology in health care?—I am sure that you will not hesitate to agree that the answer to this question under present circumstances must be no. The second question asks—are communication technologists fully aware of the real needs of potential users in the field of health care? Again, the answer must be no; but I believe it can be a qualified no.

A number of communication requirements in hospitals have been identified and I will be touching on these later. Without a doubt, however, there are a large number of areas where the communication needs still have to be identified, with a view to increasing efficiency and creating savings.

Are nurses, doctors, administrators and other disciplines aware of what can be achieved economically with modern technology? I believe the answer must be negative. There has, so far, been a lack of opportunity for hospital designers and staff to be kept informed of progress in telecommunication—another communication problem. The tendency has been for every department to look at its own problems, but not in the context of the whole hospital.

The effectiveness of any communication and information system is totally dependent on the attitude and philosophy of management, not the technical processes. The effective use requires management by exception and delegation; it can only make this contribution, if it has the full understanding and backing of the staff. These techniques will prevent the

This article is based on a paper given at the Institute's seminar 'Telecommunications in hospitals' on the 15th October 1975.

Mr. Jones is a director Cass Electronics Ltd., Crabtree Road, Thorpe, Surrey.

manufacturer saying that you must run the hospital to fit the system. How the system is used will depend on the requirements of the different specialists that make up the staff of the hospital.

The telecommunication needs of hospitals at present are based solely on the telephone. The telephone's role as a communication system from the hospital to the outside world is clearly defined; it is not the most suitable system for communicating within the hospital. Telephones are part of a world-wide network and cannot be as efficient as an in-house communication system. I do not visualise a hospital without telephones, but see their use only in the areas where they are most effective: communication outside the hospital and person to person communication within the hospital.

The first step forward to meet the communication needs of the modern hospital has been the concept of the centralised communication system. The advantages of centralised communication facilities within a hospital have been clearly demonstrated in recent installations. For anyone not familiar with the operation and facilities of centralised communication, I will give some of the important features.

Two-way speech is provided from every patient's bedside and all nurse duty areas in the wards to the communication centre, not a nurse's station. All departments, e.g. laboratories, out-patients, accident centre, c.s.s.d., porters, transport, engineers etc., are also provided with a link to the central station. A patient's call is answered instantly by voice and the urgency of the call is established.

The ' centralist ', a term used for the operator, will pass on the information to a nurse or sister who will reach the patient prepared to meet the patient's needs.

In practice, it has been found that the communication link is used more by the staff than by the patients. This is because it is much faster and more efficient than the telephone. It is also more convenient, because on a ward you have 40 communication points instead of one or two telephones. Surveys on a number of centralised hospital communication systems have shown that approximately 123 different requests or informations can be identified.

Checks on the centralised communication system at Charing Cross Hospital have shown that it deals with over 4000 communications in a 24 h period. These calls are from patients and staff, from wards and other areas. In fact from anywhere in the hospital. 60% of the calls are from staff asking for information, giving information, or requesting assistance through the centralist. 30% of the calls are from patients. In 70% of these cases, a nurse or sister was sent to the patient knowing why they were going there. The rest of the calls were answered completely by the centralist without requiring nursing assistance. The other calls were originated by the centralist to staff or patients, to pass on information or obtain answers to the questions asked by various departments.

The centralists also deal with communication to porters associated with the out-patient's department, and control of lifts for use by the theatre, X ray and supply departments, among many other services. A recent survey analysis as to the benefits of the centralised communication system at the hospital has shown that a staff saving of more than 60 can be identified. On this basis the system has been paid for by revenue savings in less than a year.

The radio staff-location system, bleeps for short, is already standard equipment in our hospitals. The use of pocket receivers in locating and contacting staff instantly make them a vital part of the communication system.

In addition to the usual role of the telephone operator for calling people to the telephone, they can play a vital role in improving patients' care and reducing the nursing workload. Nurses planning on a ward by the use of pocket receivers results in better patient care and better use of staff. A recent survey by *Which* has shown that 25% of beds in hospitals are occupied by patients that do not require qualified nursing care.

How does nursing planning operate?

With nursing planning, the ward sister can allocate individual pocket receivers to members of her staff according to their responsibilities and patients' needs. A call from a patient who is in hospital for a test only can therefore be answered by an orderly rather than a trained nurse. A call from a patient just returned from the theatre is directed to the responsible trained nurse, automatically.

The aim of this article is to show how, by the use of advanced electronics, the benefits of centralised communication can be used to even greater advantage. The use of digital techniques allows not only the identification of a patient's call from the bedside, but the same unit can provide the nurse with an assistance call facility and, if there is a medical equipment in use at the bedside, an alarm call from this equipment will also be identified.

So from each bedside three separate sets of information can be originated. At the communication centre, this information is displayed on the centralist's television display unit instead of just a light. Stored in the memory of the system will be the name, ward and bed number of the patient.

The information available can be collected, listed and made available to departments that require it. The programs used will depend on these requirements. Computer techniques simplify installation and make the system readily adaptable in phased developments with new or existing hospitals.

Let us look at a typical hospital using a computer centralised communication and information system based on the latest techniques. The communication and

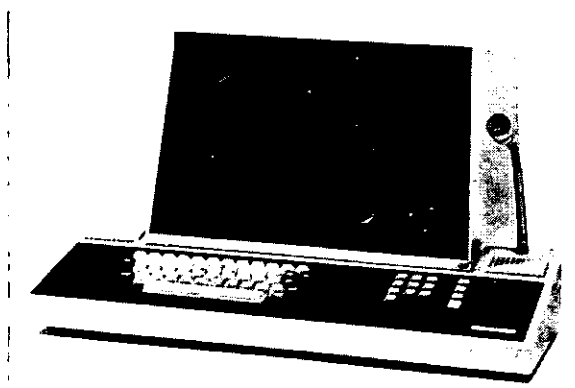


Fig. 1 Video display unit with keyboard, speaker and microphone

information centre consists of a video-screen display unit with keyboard, similar to that of a typewriter, for entering information into the system. The unit also includes a speaker/microphone for two-way speech communication and a 12-button panel with separate digital display for the operation of the pocket-paging bleep system. Depending on the size of the hospital, more than one of these units can be installed in parallel.

In addition, it would be desirable to have an input unit at the admission office to relieve the centralist from the initial input work. Other satellite display or input units can of course be added to the system if required.

System operation

A patient reaches the hospital, and, in the admission department, the initial information is fed into the system by using the keyboard. The questions that need

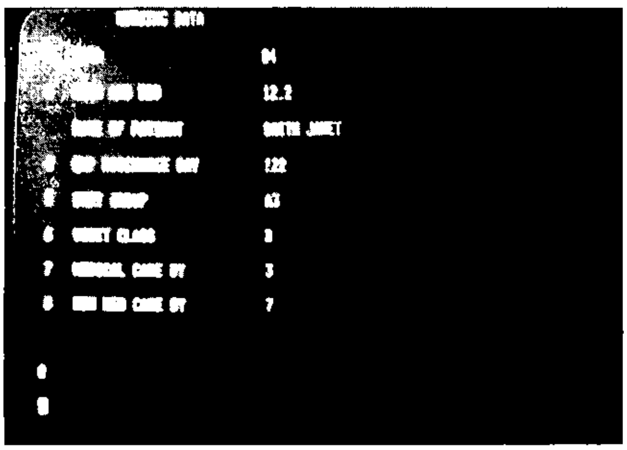


Fig. 2 Questions to be asked are displayed to get the admission data

to be asked appear on the screen. The operator enters answers to these questions as far as the information is available. The initial information required is:

- the patient's name
- age
- religion
- patient's number
- number of pocket receiver for doctor responsible for the patient
- ward number to which the patient will proceed.

Fig. 3 Nurse calling centralist to pass on information

If the hospital wishes to use an addressograph-type card system, for the patient's documents, this can be produced at the same time.

The patient is then taken to the ward and the sister can advise the centralist, using an intercom station, of the additional information as it becomes available. This

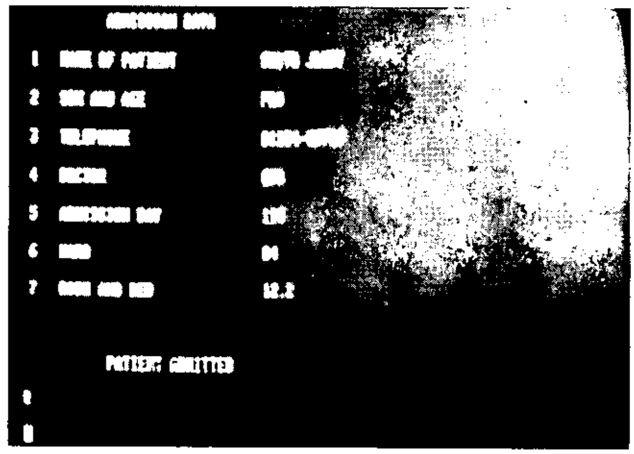


Fig. 4 Additional data entered as it becomes available from nurse

includes the patient's sex, bed number, patient's meal or dietary requirements, and the approximate date on which the patient will be discharged.

The sister can also specify the patient's level of nursing care. For example, does the patient require intensive nursing or, if she has come in only for a test, minimum professional attention. As I mentioned

Fig. 5 Pocket receiver

earlier, this will then automatically relate the patient to the pocket receiver carried by the responsible nurse.

From the information so far entered into the system, the following printed lists can be obtained:

- a list of patients admitted today
- an updated alphabetical list of patients in the hospital
- a list of patients per ward
- a list of free beds
- a list of beds expected to be available during the next three days.

PROGRAMME SP 2Ø4Ø

DAY 125 ADMISSION - TRANSFER - DISCHARGE INFORMATION

WRD	R	B	CL	NAME	PAT NU	S	AGE	REL	TELEPHONE	HS	DR	ADM	DIS
	PATIENTS ADMITTED TODAY												
Ø1	Ø2	3	A	EDMUNDS N.D.	798778	F	21	HV	59ØØ 26283	IND	Ø41	125	132
Ø2	1Ø	2	A	FRANKS M.	381521	M	72		59ØØ 62817	OPR	Ø41	125	142
Ø2	Ø4	1	A	HOUSEMAN K.L.	6Ø2856	M	4Ø	PK	59ØØ 21321	OPR	Ø39	125	136
Ø1	Ø2	1	A	WILLIS P.	723561	F	28		59ØØ 425Ø1	IND	Ø39	125	138
	PATIENTS TRANSFERRED TODAY												
Ø1	Ø3	1	A	GALE P.	623483	M	38	PK	5932 358	IND	Ø39	112	126
Ø2	Ø9	1	A	HEBENTON H.	731219	F	27	GP	5915 326	OPR	Ø43	1Ø2	135
Ø1	Ø7	2	A	NEWTON J.	58892Ø	F	42		59ØØ 23913	IND	Ø41	1Ø8	135
Ø2	Ø7	1	A	TANNER J.	547855	F	46	HV	59ØØ 64231	OPR	Ø38	115	132
	PATIENTS DISCHARGED TODAY												
Ø1	Ø3	3	A	HOLLIMAN D.	6Ø1827	M	4Ø	HV	59ØØ 35233	IND	Ø4Ø	1Ø3	125
Ø2	Ø7	3	A	POPLIN J.	6529Ø7	F	35	GP	5915 412	OPR	Ø39	118	125
Ø1	11	1	A	RATLEDGE M.	473662	F	53	GP	59ØØ 42816	IND	Ø42	1Ø7	125
Ø2	Ø8	2	A	SHANNON D.	387349	M	62	RK	59ØØ 46125	OPR	Ø41	1Ø5	125

Fig. 6

PROGRAMME SP 2Ø2Ø

DAY 125 PATIENTS ALPHABETIC

WRD	R	B	CL	NAME	PAT NU	S	TELEPHONE	HS	DR	VIS
Ø2	11	1	B	ABINGTON M.	751324	M	591Ø 5432	OPR	Ø4Ø	A
Ø2	Ø5	2	B	ACKROYD R.	622869	F	59Ø7 232	OPR	Ø43	N
Ø2	Ø3	2	A	AMBROSE K.	683619	M	59ØØ 6266Ø	OPR	Ø43	N
Ø2	Ø8	2	A	APPLEBY D.	614287	M	592Ø 8324	OPR	Ø42	A
Ø1	Ø9	2	A	BAKER J.W.	656853	F	59ØØ 23468	IND	Ø38	A
Ø2	Ø1	1	A	BAYLEY J.	7781Ø5	F	59ØØ 34621	OPR	Ø38	A
Ø1	Ø6	1	C	BELL A.G.	3255Ø7	M	593Ø 2321	IND	Ø38	A
Ø1	Ø1	1	A	BOYCE P.	392432	M	59ØØ 1225Ø	IND	Ø39	A

Fig. 7

PROGRAMME SP 2Ø1Ø

DAY 125 INFORMATION OF WARD Ø1 .

R	B	CL	NAME	PAT NU	S	AGE	REL	TELEPHONE	HS	DR.	VIS	DIET	NURSE		ADM	DIS
Ø1	1	A	BOYCE P.	392432	M	61	PK	59ØØ 1225Ø	IND	Ø38	A	A1	4	8	124	131
Ø1	2	A	SEARLE V.	58636Ø	M	42	GP	5915 632	IND	Ø41	A	B1	4	8	1Ø9	127
Ø1	3	A	CAHY A.	448417	M	56	RK	59ØØ 64298	IND	Ø38	A	A1	2	6	115	128
Ø2	1	A	WILLIS P.	723561	F	28	GP	59ØØ 425Ø1	IND	Ø39	A	B1	2	6	125	138
Ø2	2	A	DAVIES G.J.	585216	F	42	RK	592Ø 5172	IND	Ø41	A	A1	2	6	123	135
Ø2	3	A	EDMUNDS N.D.	798778	F	21	HV	59ØØ 26283	IND	Ø41	A	A1	4	8	125	132
Ø3	1	A	GALE P.	623483	M	38	PK	5932 358	IND	Ø39	A1	A1	4	8	112	126
Ø3	2	A	WALTERS G.K.	587899	M	42	RK	59Ø2 732	IND	Ø38	A	B2	2	6	118	129
Ø3	3	A														
Ø4	1	A	ROURKE S.	45Ø3Ø7	F	55	GP	59ØØ 15863	IND	Ø39	B	A1	2	6	114	138
Ø4	2	A														
Ø4	3	A	BLACKBURN F.M.	324434	F	68	HV	59ØØ 24691	IND	Ø4Ø	A	C1	4	8	111	128
Ø5	1	B	SMITH B.R.	287418	M	72	RK	59Ø5 5893	IND	Ø39	N	A2	2	2	1Ø8	132
Ø5	2	B	JOHNSON I.	416294	M	59	GP	5912 621	IND	Ø41	N	A2	2	2	121	13Ø
Ø6	1	C	BELL A.G.	3255Ø7	M	68		593Ø 2321	IND	Ø38	A	A3	2	6	124	131
Ø7	1	A	VAUGHAN W.E.	643826	F	36		59ØØ 14692	IND	Ø41	A	A1	3	7	1Ø5	128
Ø7	2	A	NEWTON J.	58892Ø	F	42		59ØØ 23913	IND	Ø41	A	C1	3	7	1Ø8	135
Ø7	3	A	DENHAM M.G.	515Ø32	F	49	HV	5931 21Ø1	IND	Ø42	A	B1	3	7	113	14Ø
Ø8	1	A	BERKELEY P.	671237	M	33	GP	59ØØ 14215	IND	Ø4Ø	B	B1	1	3	122	129
Ø8	2	A	KEATS W.B.	444242	M	56	RK	59ØØ 3Ø1Ø6	IND	Ø39	A	D1	1	5	112	131
Ø8	3	A	BURTON R.L.	4963Ø7	M	51		59Ø5 211	IND	Ø39	B	C1	1	3	116	142
Ø9	1	A	WELLESLEY C.	629188	F	38		5923 283	IND	Ø38	A	C1	1	5	117	125
Ø9	2	A	BAKER J.W.	656853	F	35		59ØØ 23468	IND	Ø38	A	A1	3	7	12Ø	13Ø
Ø9	3	A	COX G.J.	741421	F	26	HV	591Ø 9276	IND	Ø42	A	A1	3	7	112	126
1Ø	1	A														
1Ø	2	A	BROWN J.	715893	M	29	RK	59ØØ 34567	IND	Ø4Ø	A	A1	3	7	122	134
1Ø	3	A	LONG W.	52425Ø	M	48	GP	59ØØ 45678	IND	Ø4Ø	A	D1	3	7	1Ø7	136
11	1	B														
11	2	B	WOBURN J.	412250	F	59		593Ø 3921	IND	Ø39	A	B2	1	5	114	126
12	1	C	DURRANT F.	571682	F	43	PK	59ØØ 52Ø62	IND	Ø41	B	B3	1	11	118	139

Fig. 8

PROGRAMME SP 2Ø3Ø

DAY 125 FREE BEDS INFORMATION

WRD	R	B	CL	S
Ø1	Ø3	3	A	M
Ø1	Ø4	2	A	F
Ø1	1Ø	1	A	M
Ø1	11	1	B	F
Ø2	Ø2	3	A	M
Ø2	Ø4	2	A	M
Ø2	Ø5	1	B	F

Fig. 9

```
DAY 125     BEDS BECOMING AVAILABLE INFORMATION UNTILL DAY 127              PROGRAMME
                                                                            SP 2Ø5Ø
WRD R  B CL NAME           S
Ø1

TO BE FREE DAY 125
Ø9 1     A  WELLESLEY C.   F

TO BE FREE DAY 126
Ø3 1     A  GALE P.        M
Ø9 3     A  COX G.J.       F
11 2     B  WOBURN J.      F

TO BE FREE DAY 127
Ø1 2     A  SEARLE V.      M
```

Fig. 10

The lists are always up to date and can be printed as required. One or other of these lists will be invaluable to the reception, telephone exchange, the bed bureau and other departments that have to be informed as soon as the patient has entered the hospital.

The housekeeping department for example can receive, at regular intervals, information as to which rooms have become free or beds that are ready for preparing for the next patient. It will not be necessary for telephone calls, trips to nursing stations or admission offices to ascertain the current position. The bed-state information is of vital importance. In most hospitals at present this information is 24 h out of date, resulting in empty beds and under-employed staff and facilities.

Recent studies recommended the introduction of a patient 'enabling office' to plan the discharge of a patient prior to the actual moment of discharge. The information available from the bed-state programme will give advanced warning of expected discharges over the next three days or more.

It is now possible for the responsible person to check, in advance on the social problems involved. For example, will the patient travel home on his own? Is an ambulance required? Are some preparations required at home before the expatient's arrival, and who has to be advised etc. If these inquiries are delayed until the final decision that the patient can go home, he may well have stayed in hospital for another 24 h, or more, while the necessary arrangements are made.

The bed-state program, therefore, can create an increase in beds available to the health service of 15% with consequent decrease in overhead costs. A report published some time ago on this subject gives a case of a patient who had been kept in hospital for eighteen days because of what we may call, lack of communication and information.

The fact that information is available on the expected future bed state can also assist in an emergency. If a number of beds are required urgently, this list will provide information on the patients it may be possible to discharge earlier. In addition, the central station will receive, during its normal contact with patients or staff within the hospital, details of patients that are being discharged or are moved. In a 500-bed hospital, these changes can reach up to 100 a day. One problem that this movement of patients causes concerns the distribution of meals. The kitchen is preparing meals for every one of these patients and the result of the movements is that as many as 100 meals are being distributed incorrectly. With the computer system, the meals and dietary program from the information system are kept up to date automatically as patients are moved or diets are changed. The kitchen can therefore obtain up-to-date information up to the last minute of distribution, from the readout.

The result is a substantial reduction in wastage of food and an elimination of extra deliveries from the kitchen—a saving of labour.

Now let us return to the patient settled comfortably in her bed. She is in an unfamiliar environment, surrounded by new faces and, while waiting for her medical care, would like to read a book. She presses the call button on the bedside unit. At the communication and information centre, the patient's name, together with other relevant information, e.g. ward and bed number and the receiver number of the doctor responsible for the patient, will appear. The centralist, by pressing the communication button, can establish two-way contact.

The patient will hear the question, 'Can I help you? Miss Smith?' The patient will inquire how she can obtain her book; the centralist will in turn give the necessary information. The patient's query has been dealt with without interrupting the nursing staff.

Let us look at another situation. The nurse has put the patient to bed and wishes to advise the doctor that the patient is ready for examination. The nurse presses

```
DAY 125     KITCHEN INFORMATION                                   PROGRAMME
                                                                  SP 2Ø8Ø
WRD R  B CL NAME              PAT NU S AGE REL

       DIETETIC GRP B1
Ø1  Ø2 1 A  WILLIS P.         723561 F 28  GR
Ø1  Ø9 2 A  MASTERS P.L.      759614 F 25
Ø2  Ø2 2 A  KIND G.S.         5ØØ378 F 5Ø  GR
Ø3  Ø9 2 A  MUTTON P.         624826 F 38  RK

       DIETETIC GRP B2
Ø1  Ø3 2 A  SEARLE V.         587899 M 42  RK
Ø1  11 2 B  WOBURN J.         41225Ø F 59
Ø2  Ø5 2 B  NORTHCOTE C.      196815 F 81  GR
Ø3  Ø5 1 B  LEAHY C.D.        462324 F 54  RK

       DIETETIC GRP B3
Ø1  12 1 C  DUPPANT F.        571682 F 43  RK
```

Fig. 11

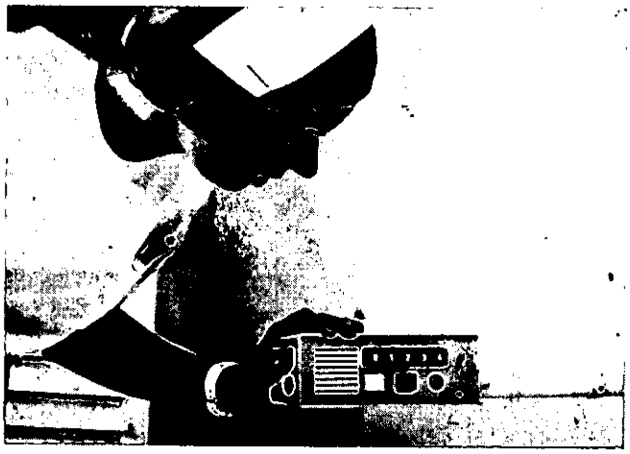


Fig. 12 Nurse pressing staff button on a swivel arm unit, which gives her call priority

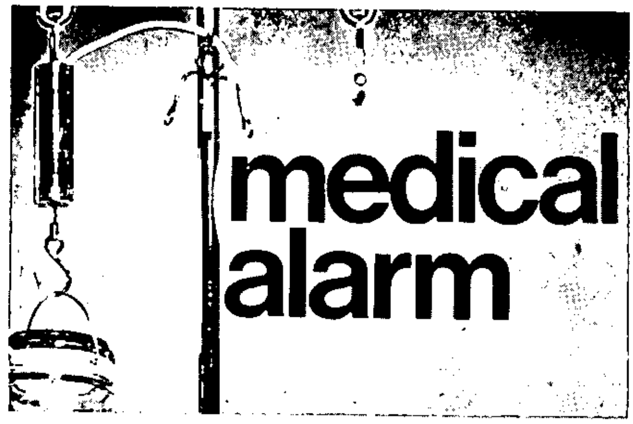


Fig. 13 Drip bottle liquid reaches a danger level and sets off an alarm. The nurse's pocket receiver is bleeped and an alarm at the communication centre is registered

the staff button on the swivel arm unit. This call appears on the centralist's screen as a staff call, and will receive priority.

The nurse asks the centralist to call the doctor and give the information to him, thus relieving the nurse of any further action. In an emergency, e.g. cardiac arrest, this facility allows the nurse to summon all the assistance required, without leaving the patient. This results in speed and reduced anxiety for staff and patient.

Now let us look at a medical alarm. Take a drip bottle as an example. As the liquid reaches a danger level, an automatic alarm signal is originated; the nurse allocated to the patient receives a special bleep signal on her pocket receiver, and, at the communication centre, a medical alarm is registered. The nurse calling the centralist will be advised of the problem, without delay.

All alarms and also technical information can be linked to the system, whether it be a blood-bank alarm, a security alarm or a gas alarm; and there is certainty of 24 h manning. The system can also provide control

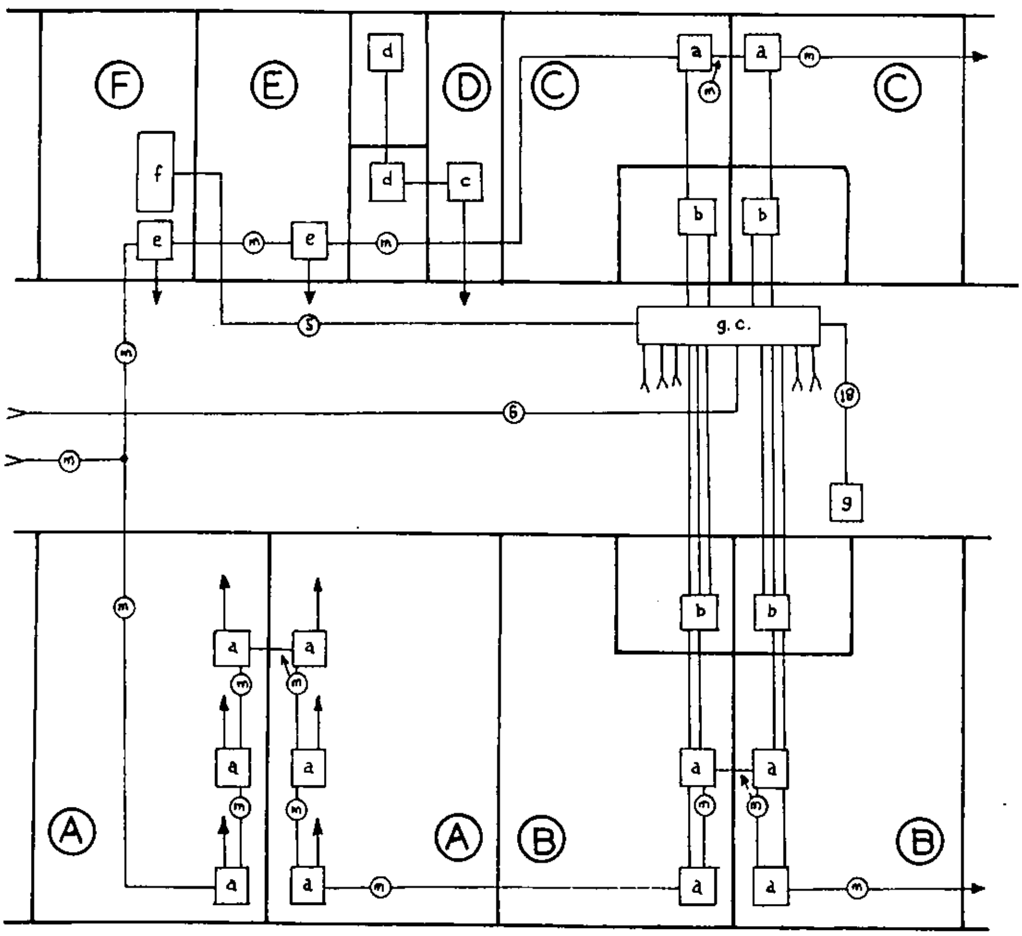


Fig. 14 Typical arrangement of calling requirements

of equipment, automatically or manually. Collation of requests for engineering services can form part of the central station's benefits.

Engineering

The *central processing unit (c.p.u.)* of the communication and information system, is a minicomputer. There would be no difficulty in interfacing it with a hospital's computer if one has been installed.

Cabling, of course, can be very simple. A single coaxial cable joining all points is not the answer in a hospital environment. However effective the communication system, there is a requirement for signal lamps, chimes, buzzers, assurance lamps, patient's bedlight control etc. There is, therefore, a low voltage requirement. For economy, low voltage is best distributed separately.

To meet all requirements for an installation having the facilities I have mentioned, a 2-pair cable from all points to a local supply and terminal unit will be required, which takes the electronics out of patient areas to a readily accessible location. Take a ward area for example: information from a patient's bedside call button, a medical alarm from a drip bottle and an engineering alarm from a refrigerator or a security alarm from a drug cupboard can all be connected on the same cable. If this is taken a little further, a new piece of equipment installed in the same area at a later date can also be connected to the nearest terminal unit. In time, fire alarms and detectors may also follow the common path instead of requiring separate cabling.

How much?

What about the cost of a communication and information system? The total cost would depend on which of the programs are required. Each program will produce a cost benefit. Although the capital costs will, no doubt, be a factor, the contribution an effective communication and information system can make in the management and running of a modern hospital will be substantial.

What are the financial advantages of a centralised communication and information system? This is a difficult question to answer, and I will stick to generalisations, although I believe these claims can be proved.

The bed-state information program can produce an increase in bed occupancy of more than 15% or allow the reduction of beds available without reducing facilities. The ability of programming nursing staff to the patient, in line with the patient's care requirements, will reduce wastage of trained staff; remember that 25% of patients in acute hospitals do not require qualified nursing care. The dietary and meals program saves wastage of food and staff time. In fact on figures quoted previously, the program can save approximately 100 meals a day.

The telephone exchange and reception, post room and porters will benefit from the alphabetical list program saving unnecessary investigations as to where a patient is located.

In fulfilling its purpose of patient care, a hospital can be viewed as a complete and complex information system that collects, transmits, records, retrieves, summarises all patients and administrative data. By linking key hospital functional areas using a computer-based central hospital information system, a method is provided to achieve better administration of patient care and engineering services.

Inflation has made substantial increases in productivity necessary to help maintain the standards we already have. These vital increases in productivity will come not only from working harder, but also from working more cleverly. Only through improved management of our resources, human, natural and financial, will we be able to maintain and improve the hospital service.

HE Product news

Chart recorder

The Series 320 multipen continuous-trace recorder offers independent pen-crossover ability, covering the chart width of 250 mm, with each trace in a contrasting colour. The instrument is of modular construction and has a choice of from one to six channels, a single- or 10-speed electronic chart drive and high/low individual channel alarm facilities. There is a range of plug-in signal-conditioning units available to accept almost any input signal, each unit incorporates isolation and electronic linearisation, a facility to handle nonlinear input signals and present them as a linear trace. The chart used may be roll or Z-fold; individual channel event markers may be incorporated and remote control enables many recorders to be operated from a single console.

Chessell Ltd., Broadwater Trading Estate, Southdownview Road, Worthing, Sussex BN14 8NL

Shower blender

The Sensoft shower-blender unit consists of two bottles and a dispenser. One squeeze on either of the bottles releases a small amount of concentrated liquid into the unit, which blends with the water in the shower. The effect lasts for a few minutes, before the water runs clear again. The unit does not affect the normal working of the shower and can easily be fitted to new or existing units of rigid or flexible types. The bottles can hold any substance from a fragrance to a medicinal rinse. The third container is a handy dispenser which will hold any concentrated liquid such as shampoo, for simple and safe use in the shower. Rinsing treatments can take place under a shower, obviating the problems that traditional bathing causes with certain types of patient.

Scentrose Ltd. (Sensoft Shower Blender Units), PO Box 58, Park Place, Leeds LS1 1TP

Handbook

Thermalite Ltd. has introduced a handbook setting out the functional performance, specification, application details, working characteristics and instructions for the company's range of autoclaved aerated concrete building material.

Thermalite Ltd., Station Road, Coleshill, Birmingham B46 1HP

See also page 26.

A management-services approach to evaluating communications in hospitals*

G. L. HUGHES

In the past, the Central Management Services Branch of the DHSS has undertaken several studies in the communications field to assist in the planning of new hospitals. Although no research has been carried out in recent years, the results of these studies still have some applications today.

Introduction

One of the major functions of the Central Management Services Branch is to undertake wide-ranging national studies on behalf of DHSS, the results of which are hopefully of value both to the NHS and to DHSS, operationally and in formulating and reviewing policies.

Some 10 years ago, the branch had a general remit to undertake studies in the communications field which could assist in planning new hospitals and from then until 1971 the results of this work were published in the *Building Bulletin*, the *Technical Memorandum* and finally, and more appropriately, in our own *Management Services (NHS)* series. I say 'more appropriately' simply because, although most of the studies were of communication devices, they were concerned primarily with the needs and reactions of patients, staff and the hospital organisation itself and only marginally and very broadly with any technical aspects.

This article is based on a paper given at the Institute's seminar 'Telecommunications in hospitals' on the 15th October 1975.

Mr. Hughes is with the Central Management Services Branch, Department of Health & Social Security, 6 St. Andrew Street, London EC4A 3AD.

Technological advances coupled with the changing needs of the hospital organisation make it unlikely that all the conclusions then reached would be reached today and there would be little point now in indulging in a detailed historical review. Nevertheless, the studies do appear to have been reasonably successful, in that the NHS generally took note of them and manufacturers reacted responsibly—and on occasion strongly!

The day after one of these publications hit the bookstalls, I received a plaintive telephone call, from a director of a well-known firm: 'My Chairman' he said, 'is very upset by your report'. But nobody threatened any legal proceedings and indeed we have letters on file acknowledging that there had been on their part a lack of market research in depth, accepting the validity of such comments as had been made about the incompatibility of their product with the objectives of a hospital and, of course, promising to work towards producing a device which would more nearly satisfy the need.

So it might be useful just to look back very briefly at the approach adopted to each of these studies and to explore whether, seen together, they provide any sort of guidance on the way in which we might tackle studies today.

At the outset we had the firm conviction that it was not sufficient merely to study the effects of, or the uses for, an individual device and that it was essential to attempt to understand and to quantify the communications needs of a hospital as a whole in terms of infra- and interdepartmental communications traffic and its connections with the outside world.

The whole-hospital concept

At that time, two major initiatives embodying this whole-hospital concept were in progress and both are still continuing and growing in strength today.

Interrelation of departments in hospitals

The first was aimed at helping to find an answer to the question which faces all planners: where should each department in a hospital be sited in relation to all the others?

Fig. 1

Whole hospital concept (1)

Interrelation of departments in hospitals

—Building Bulletin 5—

- *Question:* Where should departments be sited in relation to each other?
- Organisational model of a 600-bed hospital constructed: efficiency assumed
- 18 major departments/activities (including 'outside the hospital') identified and for each of these, *necessary* direct and reciprocal communication links with the other 17 calculated and weighted
- Matrix constructed: flexible and infinitely variable to take account of adding or substracting departments; joining together or splitting departments; introducing communications aids which affect the relative needs of departments to be closely related; and any variation in communication needs generally
- System can be used to guide siting of extensions
- Further work on finding optimum solutions to the matrices has been undertaken in this and other countries

- Computer-aided design based in first instance on criterion of optimising communication facility now feasible

This study provided a striking example of the rewarding marriage of two Management Services disciplines: 'organisation and methods' and 'operational research'.

The original concept and the many organisational studies which were indispensable to the construction of a realistic matrix were produced by organisation and methods, whereas the new mathematics needed to attempt the derivation of solutions from that matrix were evolved by operational research.

Management survey

The second was not so much a study as the long-term evolvement of a management-review technique called 'management survey' which again involved a 'whole-hospital' approach.

Fig. 2

Whole hospital concept (2)

Management survey

- A 'whole-hospital' management review technique developed by CMS for use in the NHS
- Designed to assess effectiveness of organisation/practices of a hospital by means of a *rapid survey* based on accumulated knowledge derived from detailed studies at other hospitals
- Several MS officers work together, each surveying a particular department/activity of which he has previous knowledge and experience
- Comprehensive picture built up of all departments and their interrelationships within a short time
- *Current situation:*
  - . recognised function of MS divisions of RHAs
  - . more than 300 practitioners trained
  - . beneficial redirection of at least 5% of revenue
- *Byproduct:* improved communications and greater awareness of each other's objectives and problems

The crux of the management-survey technique is to bring together for a series of final discussion meetings, members of all disciplines who have an interest in any of the activities surveyed. Although improved communications amongst staff was never a major objective of management survey, nevertheless the staff of many hospitals where surveys have been provided have told us that one lasting effect is the habit, introduced or re-emphasised by the Survey, of meeting together regularly to discuss common problems.

I am sure readers will agree that, in a hospital, there is no known mechanical or electronic substitute, however sophisticated, for the catalyst of effective interpersonal communications.

Studies of individual devices

The remainder of the studies were of individual devices and the most venerable of these was of:

Pneumatic tubes

Fig. 3

Pneumatic-tube communication systems
—Hospital Technical Memorandum 9—
Approach to study

- ☐ Two hospitals with pneumatic tube systems were studied
- ☐ Two factors considered
  - practical—usage/speed/cost
  - psychological—impression of efficiency
- ☐ Practical aspects compared with alternative method—messenger service
- ☐ Wide range of equipment, goods, materials and communications examined for suitability for tube transmission
- ☐ Comparisons were made of transmission times for same object conveyed by both methods
- ☐ Installation and revenue costs were examined

Fig. 4

Pneumatic tube communication systems
Conclusions

- ☐ The use of these systems is limited
- ☐ Their virtue of speed is overrated
- ☐ They are expensive to install
- ☐ A well organised messenger service is
  - often as fast
  - 50% more effective in eliminating errands
  - costs virtually nothing to install
  - operates at about one-third the cost
- ☐ *But*—simple point-to-point installations may be useful

The final conclusion of the study was that although comprehensive systems could not be recommended, a single point-to-point system was sometimes justifiable when two departments, between which there was a necessarily large but unpredictable flow of paper or small items, were physically separated. There are two or three of these point-to-point systems operating today that have successfully overcome an architectural or spatial layout difficulty.

Patient/nurse call systems

Fig. 5

Patient/nurse call systems
—Hospital Technical Memorandum 15—
Approach to study

- ☐ It was found in the preliminary study that most nonauditory systems were installed in open wards
- ☐ Main study concentrated on small groups and single rooms
- ☐ Six wards selected
  - two nonauditory
  - two single reply point
  - two multiple reply point
- ☐ Wards were under continuous observation
  - number of calls made by patients and staff
  - purpose of calls
  - time taken by nursing staff to answer calls
  - results of calls made
  - walking distance/time saved or lost attributable to auditory systems
  - other factors affecting usage

Fig. 6

Patient/nurse call systems

Conclusions

- ☐ There is a need for call facilities in all types of ward irrespective of layout
- ☐ Best system: nonauditory with call button and reassurance light

Points on auditory systems:
enable an earlier indication to be given to patients that calls will be answered *but*

- ● do not enable nurses to reach patients sooner
- ● the saving of nursing time is negligible

A subsequent study of an existing auditory system was undertaken by a Regional Health Authority, the results of which tended to support the conclusion that any saving of nursing time was largely illusory.

Facsimile telegraphy

Fig. 7

Facsimile telegraphy

—Hospital Technical Memoranda 18 and 19—

Approach to studies

- ☐ Trials were mounted in two hospitals planned for development as district general hospitals
- ☐ Document and telephonic traffic were observed, recorded and analysed
- ☐ Traffic between pathology departments and wards was examined in detail
- ☐ *Dual system*, both facsimile telegraphy and messenger service, was introduced and results compared
- ☐ All document traffic was sent by both systems and the following were observed:
  - ● transmission times
  - ● reception procedures
  - ● action times

Fig. 8

Facsimile telegraphy

Conclusions (Gen.)

- ☐ A number of documents in common use in hospitals are suitable for interdepartmental transmission by facsimile telegraphy but the advantages are too tenuous to justify increased cost over messenger service
- ☐ compared with telephone, facsimile telegraphy
  - ● costs more
  - ● is *slower*
  - ● has no feedback from recipient

Conclusions (Path.)

- ☐ Little identifiable benefit to patients
- ☐ Heavy traffic could cause delay because of slow transmission rate
- ☐ Likely/possible benefits where laboratory serves two or more hospitals

A further conclusion of the study of the transmission of pathology reports was that when considered as one element of a total operation affecting the patient, including clinical action and changes of treatment, the transmission time itself was relatively unimportant whatever means of transmission was employed.

Closed-circuit television

Fig. 9

Closed-circuit television

—Management Service (NHS) Report 4—

Approach to study

- ☐ Visits by nurses to selected wards were recorded and classified
- ☐ Results were analysed on the basis of
  - ● type of patient
  - ● type of visit
  - ● time of visit
- ☐ An assessment was made of which visits could be replaced by c.c.t.v. and the savings in time that would result
- ☐ Special uses were examined:
  - ● teaching
  - ● data transmission
  - ● general activity observation

Fig. 10

Closed-circuit television

Conclusions

Purposes studied:

- ● Instructional aid—successfully used for:
  student teaching
  postgraduate study
  research
- ● Patient monitoring—little savings on cost and time
  can never *replace* the professional nursing eye
  improves staff safety in radiotherapy units
- ● Document and information relay: costly to install
  requires a demontrable need
- ● Transmission of films and charts: little advantage in speed
- ● Security: other methods often have advantages
- ● Control of vehicles: detailed study needed first
- ● Control of pedestrians: unjustifiable expenditure
- ● Centralised meter reading: uneconomic

Prime questions

Looking back at those studies there seemed to emerge a list of prime questions, answers to all of which were indispensable to the formulation of any sort of judgement about the evaluation of a particular device to the hospital service. The questions are so simple that at first sight they might appear to be naive. Nevertheless, the answers are not always easy to find and it certainly is not unknown for equipment to be installed before they have all been satisfactorily explored (Fig. 11).

Fig. 11

Evaluation (1)

Prime questions

Developed from studies

- ☐ What does it achieve?
- ☐ Does it satisfy a real need?
- ☐ What is the best manual or other mechanical alternative?
- ☐ What are the nonfinancial advantages?
- ☐ What are the nonfinancial disadvantages?
- ☐ What are the comparative costs?

The financial element can never be ignored, for the cost of even a moderately priced device when multiplied throughout the service can easily amount to millions of pounds. Further, in a service that operates on a finite budget, management, on consideration of all the available options, must in the end establish the priorities and make the decisions.

Development of an evaluation methodology

In more recent times, a specialist section within Central Management Services was given the task of developing an evaluation methodology. Although a primary objective was to produce a practical system of evaluating computer applications in the NHS, the job was deliberately allocated to a study team, members of which had no direct interest in computers. Consequently what they were studying was evaluation *per se*—evaluation as an art—and the principles that have been evolved can be used not only in relation to computer applications but for the assessment of almost any innovation involving radical change in an organisational structure or in the equipment it uses. The system has evaluation tools from which to select the most appropriate for a particular purpose. Although these tools may have to be adapted in the light of experience in using them, there seems little doubt that they could be of considerable value in the communication field.

Fig. 12 shows the three main stages in the methodology.

Fig. 12

Evaluation (2)

Computer evaluation methodology

Stage 1

- Analysis of problems envisaged
- Assessment of other solutions to problems
- Recommendation of computer if best solution

Stage 2

- Preliminary study of potential benefits and costs
- Full study on identification of specific application improvement objectives with predicted changes and estimated costs
- If possible, an assessment of the likely return on investment of proposed applications

Stage 3

- Production of final evaluation reports: information on the measured benefits of the operational system compared with cost

The full report of the study is currently in draft and was recently sent in the first instance to regional health authorities for comment.

Current work

Apart from an imminent study of central dictation systems, no major studies in the communications field have been contemplated by Central Management Services within the past few years. But management services divisions of regional health authorities continue, when invited to do so, to carry out reviews of the uses made of existing installations of telephone, paging and patient/nurse-call systems. Most of these reviews examine how patients and staff react to the facilities provided and have usually resulted in a range of suggestions for increasing the benefits available.

Recent reports have included the following suggestions and comments.

Paging systems

These on the whole seem to work very well but occasional criticisms of the equipment or of its use appear in the reports: e.g. repair times of pocket receivers should be shorter to avoid the cost of having to increase reserve stocks; all areas covered should be tested for fading or disappearing bleeps; the basis of issue of pocket sets should be solely that of need; the system should not be used simply to replace the telephone; and the receivers should be robust enough to withstand jumping on when they break down for the second time that week!

Patient/nurse-call systems

Here again, there have appeared more criticisms of the use being made of the systems than of the design of the equipment itself: e.g. complex combination control units issued to elderly/incapacitated patients who cannot use them and which are sometimes out of reach; lack of instructions to patients on the use of the equipment; badly sited call buttons in lavatories and day rooms; lack of maintenance, particularly of the radio facility. These are hopefully isolated instances but there was one sad case which I like to think was unique. In a hospital for elderly patients three quarters of the earphones tested were either broken or missing, call buttons in day rooms were unmarked and their existence was unknown to the patients and indeed unknown to some of the staff; in some lavatories, the call button was some distance from the seat, so the patient had to take two paces forward and then stretch upwards.

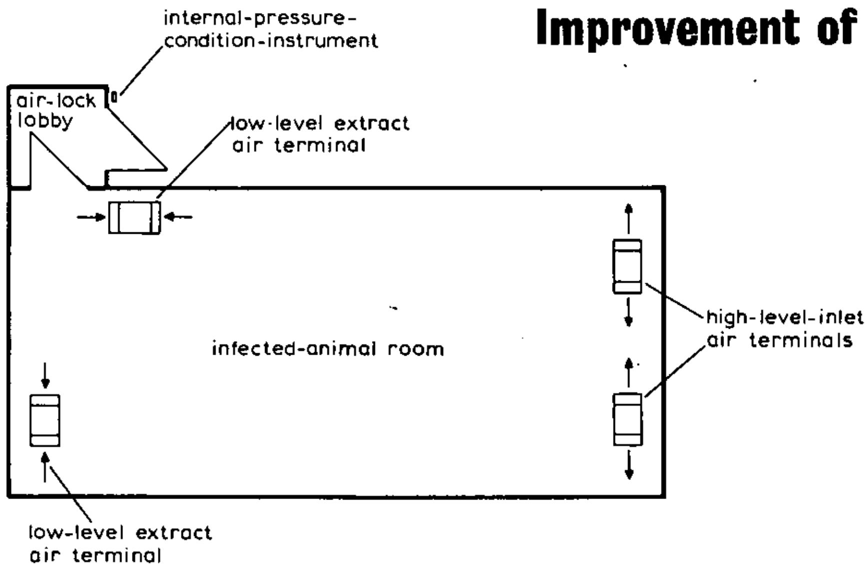
Future work

It has been suggested from time to time that CMS should resume studies of the needs of the hospital service, and now of course of the community, for communication aids. After all, there are always new ideas and concepts to be explored. For example the 'whole-hospital' centralised call system would seem to have attractions but has never yet to my knowledge been comprehensively evaluated in this country. In Germany, pilot studies have shown that it is not as effective in saving nursing time as has been claimed. In the same field there is the problem, which may never be fully resolved, of how to enable patients who unexpectedly become too ill to use a conventional call system, to contact nursing staff.

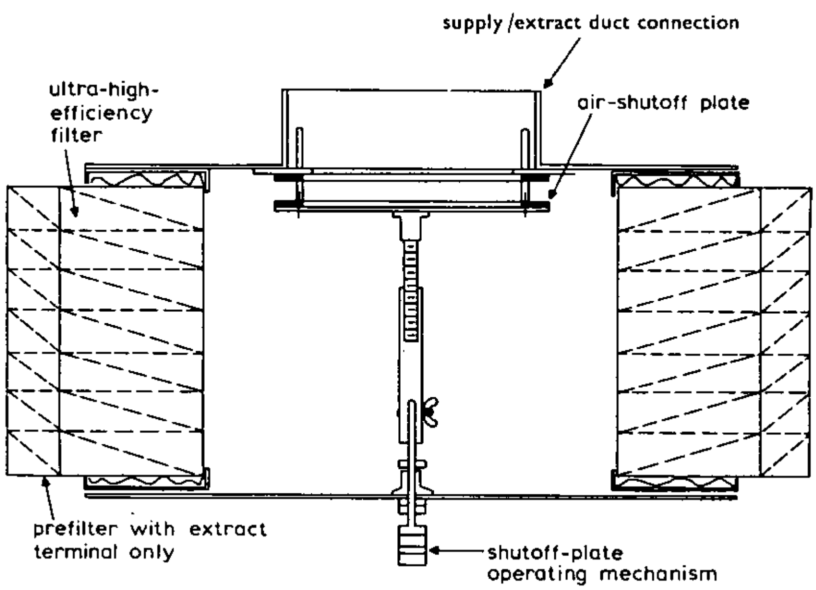
Whereas, in the past, CMS has relied upon its own resources, consulting as necessary with other disciplines, we would hope that any future studies in this important field are undertaken in closer collaboration with all the disciplines involved.

There are clearly engineering, nursing, medical, supplies and policy interests and we in CMS would see our role as participating in the work of a small representative group or, since management services must accept the priorities laid upon it by management, and must always have a sponsor, undertaking studies on its behalf.

Improvement of infected-animal suite



Layout of infected-animal room



Detail of air-filter terminal

The infected-animal suite of the Medical Research Council's Demyelinating Diseases Unit at Newcastle General Hospital is at present being upgraded. An interesting aspect of the project, designed by engineers R. W. Gregory & Partners, is the air-terminal filter housing.

These terminals are provided on both the inlet and extract ventilation positions and are designed so that the filter replacements can easily take place when the system continues to operate. The filters are the ultra-high-efficiency type and the procedure adopted for changing a filter is:

(*a*) The terminal shut-off mechanism to the ducted ventilation system is closed.

(*b*) The dirty filters are then removed and autoclaved to kill possible infection. The prefilters, located only on the extract systems, are then washed and cleaned for reuse and the main filter is disposed of.

(*c*) Before the replacement filters are fitted, the housing is fumigated or sprayed with a disinfectant to eliminate the possibility of infected carry-over due to the filters being disturbed.

(*d*) The filter media are replaced and the terminal shut-off mechanism is opened.

The airflow pattern in the animal rooms is negative to the surroundings and access to the suite is through an airlock lobby. An instrument measuring the ventilation pressure condition inside the infected room is located on the clean side of the access door, which enables staff to check the system prior to entering the room.

The Institute Library

The following additions to the library have recently been purchased and are now available for loan in the normal way:

DRUCKER: *Future of industrial man*
KOONTZ: *Principles of management: an analysis of managerial functions*
OSCHINSKY: *Walter of Henley and other treatise*
MCKAY: *Building construction metric Vol 1*
MCKAY: *Building construction metric Vol 2*
WOOD: *Costing matters for managers*
SAYLES: *Managing large systems*
DRUCKER: *The effective executive*
TWORT: *Water supply*
THORNCROFT: *Principles of estate management*
CHAPMAN: *Walmsley rural estate management*
LEACH: *Urban estate management, Vol 2*
ROCKLEY: *Finance for the non accountant*

Further information can be obtained from the Institute Honorary Librarian, R. G. Smith, 'Kewstoke', Primrose Lane, Oversley Green, Alcester, War. B49 6LG.

HE News

Progress at York

The first phase of the new 1000-bed York District Hospital, being built by Shepherd Construction Ltd., under contracts worth £7 million, has been handed over to Yorkshire Regional Health Authority for equipping and commissioning.

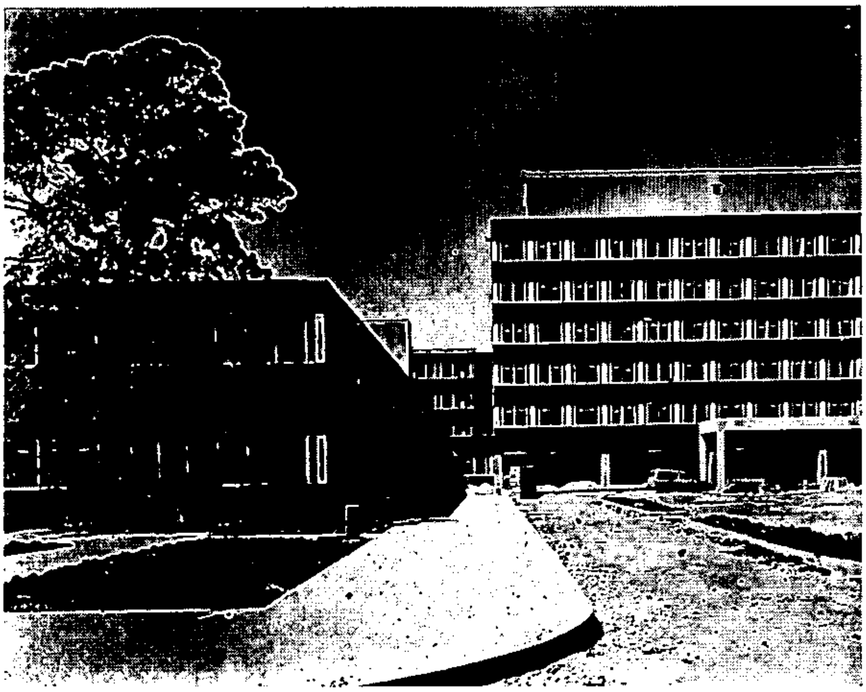
Work completed by Shepherd, valued at £1·5m, includes the boiler house and workshops, kitchens and staff dining rooms, general stores, physiotherapy and rehabilitation blocks, X-ray department, sewage pumping and electricity sub-stations, car parks, roads and landscaping.

United display

14 British manufacturers of hospital equipment have formed a consortium to establish the British Hospital Equipment Display Centre at 22 Newman Street, London W1P 3HP. The centre will provide a permanent display of equipment needed for the new hospitals being built in many parts of the world, such as the newly affluent oil producing countries.

The marketing objective of the centre, which was officially opened by D. A. Owen, Minister of State (Health), is to enable busy overseas buyers to see a comprehensive range of equipment in one centralised location in London without having to spend valuable time travelling to individual company headquarters in different parts of the country.

James Lloyd, Managing Director of Hoskins Ltd. of Birmingham, who initiated and organised the consortium, comments 'British medicine and medical equipment have traditionally enjoyed a high reputation overseas, and the members of our consortium are in the ideal position of being able to help overseas countries developing their hospital services while at the same time benefiting Britain's balance of payments substantially'.



Water therapy in Bath

A multithousand pound complex at the Royal United Hospital, Bath, was opened recently by Kingsley Williams, Chairman of the Wessex Regional Health Authority.

The building of the physiotherapy and hydrotherapy department, which cost £417 000, is the latest in a series of developments at the hospital. Schemes totalling over £2 million have been completed in Bath this year.

Separate departments

The new single-storey department replaces two old departments which served different parts of the hospital. It has been designed in separate departments for hydrotherapy and physiotherapy, with ancillary tooms, such as a patients' room, reception and waiting areas, changing rooms with showers, staff rooms and laundry facilities.

The hydrotherapy part has a heated 6500 gal exercise pool fitted with horizontal parallel bars and with a hydraulic hoist for lifting patients in and out of the water.

The department also includes a stainless-steel tank with hoist for exercising individual patients, water-jet system for spray massage and heated towel cupboard. Surfaces are tiled or lined in stainless steel, chrome plate, or p.v.c., to counteract corrosion from the chlorinated atmosphere.

The physiotherapy department has a large room with curtains to divide it into cubicles, several sound-insulated rooms with metal grids for exercising equipment, and a wax treatment room, ultra-violet light and ultra-sound equipment and traction couches.

Stay cool

The need for optimisation and conservation of energy in heating and cooling systems has led to the development of the N-9000 enthalpy logic centre.

The unit is designed to overcome the common problem of overuse of refrigeration plant when outside air could be used for 'free' cooling.

By recognising energy which the inhabitants of a building cannot feel, the N-9000 decides if air for cooling can be brought in from outside by comparing the total heat of the outside air with that of the inside return air.

The equipment provides a true economiser cycle to regulate total heat between any two psychometric conditions with accurate, proportional pneumatic control.

Further details can be obtained from Johnson Control Systems Ltd., 41–45 Kingston Road, Commerce Estate, Leatherhead, Surrey.

Three very special beds

by F. H. HOWORTH
President, Institute of Hospital Engineering

On the 13th February 1974, a new burns unit was opened at the Mount Vernon Hospital, London. This was the first burns unit in the world to use a bed that floated the patient on air. These and other advanced forms of medical air technology and contamination control have been used to assist survival and accelerate the recovery of patients who have severe burns of the body.

A severely burned patient is without skin in the burned areas and consequently is in pain and very tender. He is losing heat and water at a high rate, is wet with his own serum on which airborne bacteria will multiply, and is in a state of shock. In addition, there may be other adverse factors, either directly or indirectly, resulting from the burned condition. In any one of these conditions, the patient's metabolic rate may become violent and therefore fatal, if he is not kept in a suitably controlled and contamination-free environment during the early recovery stages. Furthermore,

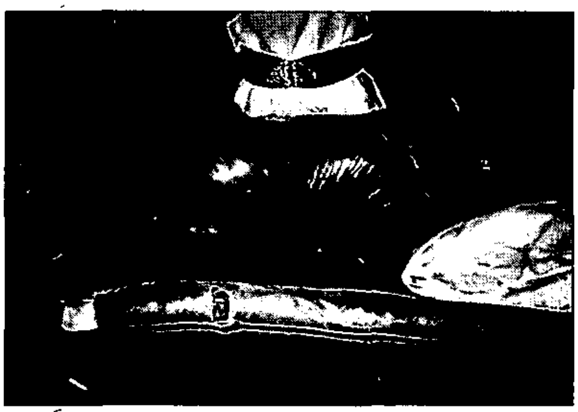


Fig. 1

once the patient is no longer in danger of death, all surgical operations, e.g. desloughing and skin grafting etc., should be carried out in a contamination-free environment.

Mr. Howorth is chairman and managing director with Howorth Air Conditioning Ltd., Lorne Street, Farnworth, Bolton BL4 7LZ, Lancs. This article is based on a paper presented at the International Biomed 75 BES Conference at Edinburgh on the 17th–22nd August 1975.

During the necessarily long period of convalescence, continuous care must be taken to prevent infection of the burned area. In the first 48–52 h of recovery, the environmental requirements for the patient are[1]:

- ambient air which is free from contamination
- ambient air of suitably high temperature to prevent loss of heat and to help form an eschar. (An eschar is rather like the skin on hot milk when it has been allowed to cool. This is the barrier between the flesh and the environment.)
- ambient air of suitable relative humidity to prevent loss of water and to help to form a pliable eschar.
- air to lie on in either a prone or supine position, so that there is nothing to stick to and there are no pressure points: this minimises aggravation and therefore pain.

The requirements for the surgical and nursing team are:

- ease of access to the patient for servicing and monitoring
- a firm support for the torso, so that violent massage in case of cardiac arrest may be sustained
- a reasonably comfortable working temperature and humidity
- good observation facilities

Since the badly burned patient may require a dry-bulb temperature of up to 40 °C with 70% relative humidity

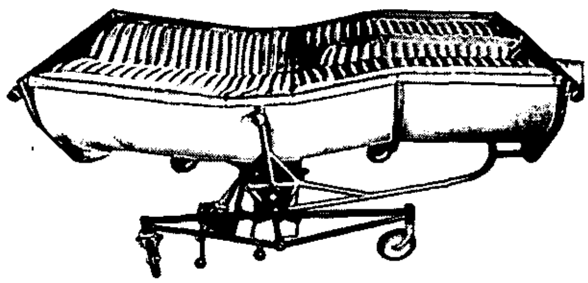


Fig. 2

and is only free from pain when he is not in contact with anything, it will be seen that the two groups of requirements are in some conflict.

A variation of the hovercraft principle was seen to be a solution to levitation of the human body. In order to have accurate but variable following of the perimeter of the human body, special textile flexibles were developed. Where the weight of the body downwards equals the pressure of air upwards, the flexibles fall away and only air supports the body. Because the air escapes all round the perimeter of the body, there is little or no contact between the body and the flexibles; the patient is floating on air.

It was also necessary to have an air-supply system

Fig. 3

that could easily be regulated to suit the weight/area ratio of any given patient, and, at the same time, have an automatic compensation system to allow for movement by the patient as well as for nursing activity, without the possibility of the patient sinking owing to the consequent disruption of the levitation air system.

Because the patient must be completely within a controlled environment, air of similar conditions and free from contaminants must also be supplied above the air bed. This is achieved by placing it under a downward-unidirectional-flow operating enclosure.

When a panel is removed to service the patient, air escapes from the patient's microclimate towards the nurse servicing him. This reduces the possibility of infection of the patient by the nursing staff as long as they do not actually lean over him. If close attention to the burn by the nursing staff is necessary, they should wear the total-body exhaust system to prevent their emissions infecting the burned area.

Each air-bed unit is in a room that has a double-glazed window large enough for the nurse on duty at the control console to see each of the patients from their control position. Most of the air from the rooms is ducted away. All the zones have automatic pressure control systems to establish balance and a correct air pattern. Each zone has its own air system with individual control of relative humidity and temperature as well as bacteria filtration. Access to the rooms is via the nurses' station, and access to the nurses' station is by a ventilated air lock from the corridor. There is a temperature gradient down from the rooms to the nurses' station, and down again from there to the corridor. Layout details depend on whether the suite is being applied to a new or existing hospital.

Since the completion of the Mount Vernon burns

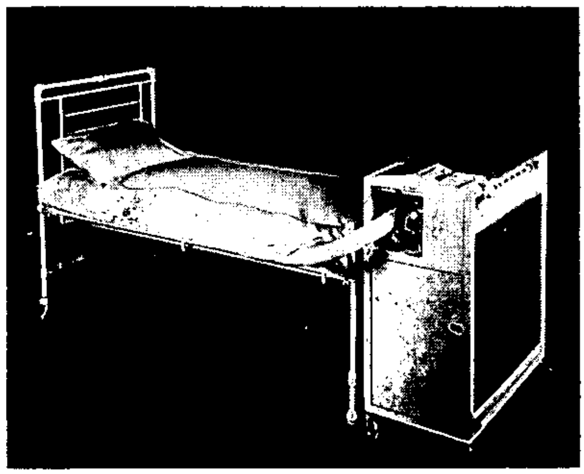


Fig. 5

unit, various clinical factors have emerged which necessitated design change. It has been found that in exceptionally badly burned cases, for instance, where over 70% of the skin is damaged, a short period of high temperature with low humidity is beneficial to 'flash dry' the body surface to form an eschar even more rapidly.

An environment of this very high temperature, 45–50 deg C, is uncomfortable for the medical staff, although they are only in it intermittently. Also it has a bad effect on the eyes and respiratory system of the patient. To overcome these problems and still keep the burned area free from airborne contaminants, a movable environmental cover has been designed. This is on casters and is plugged into a normal 13 A electric supply socket. This movable cover acts as a miniature downward flow enclosure. It is fitted with clipon drapes on all four sides, so that only the head of the burned patient is outside it. The air escaping from all around the patient on the air-bed is recycled by the cover, and at the same time, is reheated to automatically-controlled preset temperature, passed through a bacteria filter and then discharged vertically downwards over the patient's body. His body therefore is dried rapidly

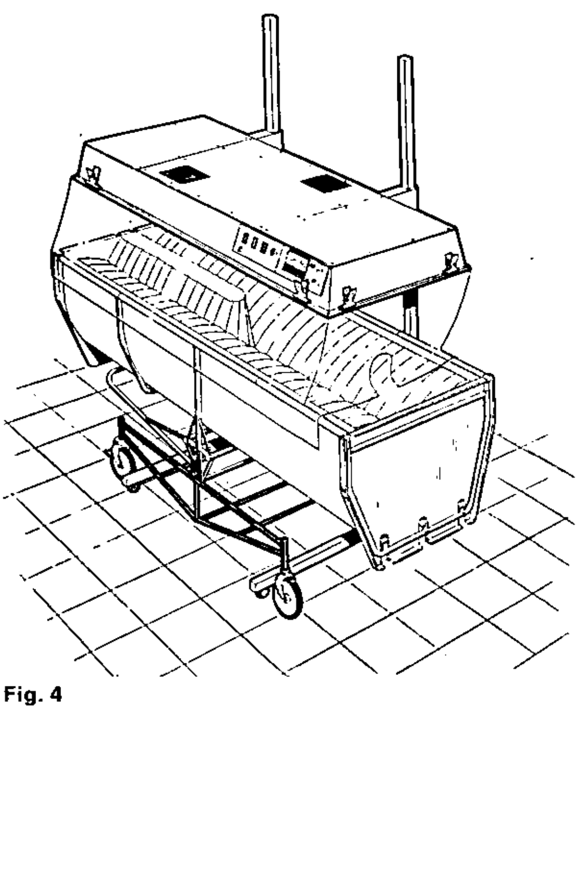


Fig. 4

from above and below, in a contamination-free environment. Lights are incorporated in the cover to aid inspection of the burned area.

With this system, the total air volume which has to be handled, and therefore heated to these high temperatures, has been reduced from 4000 cfm to 900 cfm. This obviously saves fuel and considerably reduces the thermal insulation requirements. Also, it has enabled the entire air-bed system to be packaged, thus reducing the cost still further.

The climator and mattress for intensive care

After a patient has undergone extensive surgery or is recovering from severe burns, following the formation of a dry eschar, any device which can accelerate his recovery, either in an intensive-care unit or a hospital ward, is of immense value to the patient, the nursing staff and the hospital economy. Approximately 70% of the work done by the heart is used to control the body temperature. Consequently, if this load can be largely removed, there is an immense potential available for acceleration of recovery.

One of the great problems of a patient who is in bed for a long time is bed sores. These are caused by pressure points occurring between the protrusions of the body and the bed. At a pressure point, blood flow is restricted and air movement is almost eliminated, because of this, sweating commences and the moist skin will not slip easily on the bed sheets. This causes shear which breaks down the skin surface, and, owing to the absence of air as well as the restricted blood flow, no oxygen can reach the skin at that point, consequently, deterioration accelerates and a bed sore is formed.

To overcome these problems, a low air loss, ventilated mattress which can be used on any type of hospital bed was developed.

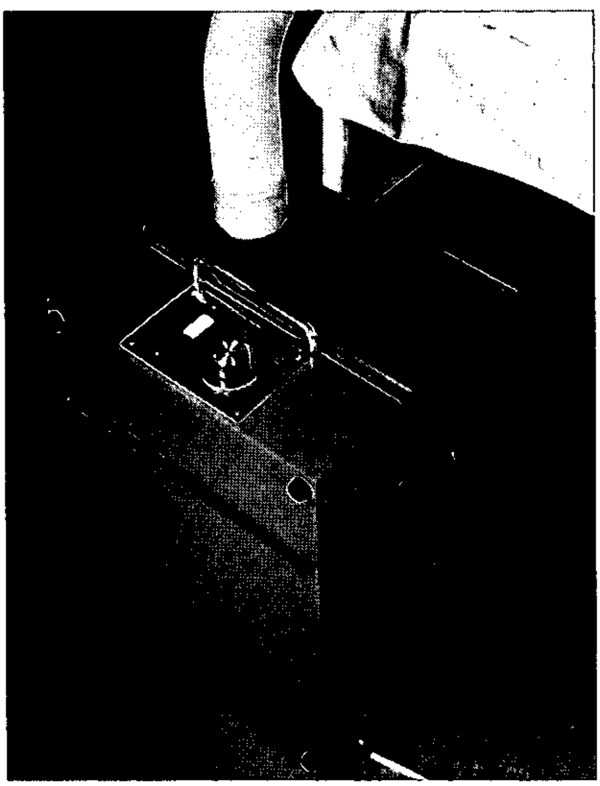


Fig. 6

The mattress is made up of galleries of foam plastics contained in a textile cover. The air is fed into a manifold across one end of the mattress and then into the galleries which run longitudinally. The air is also fed along both sides of the mattress to a similar manifold arrangement in the opposite end, so that under no circumstances can the even air distributed be restricted. Contamination-free, conditioned air is supplied to the mattress from a specially developed console, which has facilities for heating, cooling, humidifying, drying and bacteria filtration. The instrumention for patient monitoring is a 5-channel electronic thermocouple unit. Power is from a normal 13 A supply.

With the patient covered only with a sheet and a temperature sensor fixed to his leg, clinical trials have shown that this equipment holds the patient at the set-point temperature and prevents his body temperature from rising seriously (hyperpyrexia) or falling (hypothermia). Either of these conditions can prove fatal[2].

With a plastics tent placed over the upper quarter of the bed, enclosing the patient's head and shoulders, the mattress, which is supplying contamination-free air with controlled temperature and humidity, also serves to isolate the patient from his surroundings and thereby eliminates airborne crossinfection.

The same mattress as the intensive-care version, but with simpler-to-operate air conditioning, is used in a system designed for ward and home-care use. It takes in room air which is filtered; cooling is achieved by the flow of ambient air over the patient; warming is automatically controlled by using the appropriate setting on the dial[3].

References

1 MUIR, I. F. K., SCALES, J. T., and SANDERS R.: 'Levitation in treatment of large-area burns', *Lancet*, 1970

2 'Observations based on the use of the Howorth ICU type Climator', Guy's Hospital internal publication

3 'Control of body temperature in i.c.u.s'. BBC film available from Howorth

1976 Annual Conference

The 1976 Annual Conference will be held at the Royal Hotel, Norwich, on the 28th–30th April.

Conference delegates and their ladies, will receive official hospitality on the first evening and the Conference Dinner Dance will be held on the 29th April. A full ladies programme, probably including a visit to Sandringham and a trip on the Broads, is being arranged.

Full details of the Conference programme, the ladies programme, and the Annual General Meeting of the Institute (which will be held on the final morning) will be distributed to members in due course.

Institute news

SOUTHERN BRANCH

On the 13th September members of the branch visited *HMS Apollo* in Portsmouth dockyard. *HMS Apollo* is a Leander-class frigate which is used as a training ship.

Members were shown the bridge with the control panels together with the radar and other navigation equipment. Following this the after deck equipment was seen which included armament and the helicopter flight deck together with its hangar.

Following a refreshing cup of naval tea members were taken below to see the engine room and the boiler room together with the control room.

EAST ANGLIAN BRANCH

The Branch Meeting held at Addenbrooke's Hospital, Cambridge, on the 27th September was attended by the President of the Institute, F. H. Howorth, J. Furness, the Institute Secretary R. G. Kidsley, the Vice Chairman of the Branch was in the chair and R. G. Freestone was there in his usual capacity as Branch Secretary.

Mr. Howorth spoke to the meeting about the beginning of his company which was started by his grandfather in 1858 and originally provided ventilation for the Lancashire Cotton Mills. In approximately 1920, the brewing trade was losing a considerable amount of beer owing to mould growths in the fermenting rooms and his company was able to perfect a filtration system which completely eliminated this problem and plants have since been installed in many countries. This was the first breakthrough in air filtration where bacteria could be filtered out by the use of air filters as this is usually carried on particles of approximately 4 μm. Mr. Howorth was brought into the health field mainly by John Charnley, who was then engaged in hip replacements and was worried by his 9% infection rate. The outcome of this meeting was the Charnley/Howorth Laminar Flow System and ventilated clothing for the surgeons which reduced this risk to approximately 0·3%. The hoverbed was taken over in a semi-developed state and was not producing satisfactory results but with his expertise in this field Mr. Howorth was able to perfect this item giving good results on burns cases.

Following a discussion on Mr. Howorth's paper, Mr. Furness raised the question of conference facilities for the 1976 conference to be held at Norwich in April 1976. He reported that in company with Mr. Parker and Mr. Freestone the Royal Hotel was visited and facilities offered were acceptable and an early booking has been made. Mr. Furness stated that the council's education committee will take full responsibility for the lectures, leaving the branch to arrange a programme for the ladies and to forward a suggested list of guests and others who may be interested in the lectures.

LONDON BRANCH

An attendance exceeding 60 in number was attracted to the Wolfson Lecture Theatre, National Hospital, London, on Tuesday, 30th September to listen to four distinguished speakers on 'Art in Hospitals' under the Chairmanship of R. T. W. Doubleday, Branch Chairman.

The first speaker F. H. Howorth, the Institute President and Chairman and Managing Director of Howorth Air Conditioning Ltd. gave a short introduction to air technology in hospitals and spoke of the contribution made by Prof. J. Charnley. Mr. Howorth illustrated his talk with a 16 mm colour sound film using the Schlieren motion-picture photography technique. This technique makes use of the fact that changes in air density produce changes in refractive index, so that the flash from an electric spark light source enables the existence and movement of a pressure wave to be photographed. The importance of air pattern movement in operating theatres, body convection currents and the prevention of airborne infection were clearly demonstrated in the film.

The second speaker R. Manser, Institute Past President and Assistant Chief Engineer DHSS, considered the future role of ventilation and air conditioning, including ultraclean air in hospitals. Important considerations in any air-conditioning system includes pressure, temperature and comfort conditions. Post War buildings, in general, were appalling, with near impossible solar gains. Several research commissions were at present investigating the feasibility of integral buildings against a full air-conditioned building. The importance of a reliable and economical fuel source must also be seriously considered at national and international levels, and Mr. Manser was of the opinion that an electric heat source offered the best answer to the future of air conditioning in hospitals. Mr. Manser considered that heat pumps may also have a role to play in small to medium size buildings. Heat-recovery systems if proved successful, may also provide small buildings with cheap air conditioning. Both systems if properly designed were capable of achieving considerable energy savings. The importance of ultraclean air was essential in operating-theatre suites and extensive-burn recovery units. Laminar flow pattern found applications in the healing of arm and leg stumps, chest operation and radiation recovery.

The third speaker J. E. Firman, Consulting Engineer, J. E. Firman and Associates, spoke on the mechanics of submicron filtration and recommended the use of ultrahigh-efficiency filters with a penetration level of 0·003% against BS 3928. The importance of establishing a particle count before filters were actually placed into service was paramount. Viruses had a particle size of 0·01–0·4 μm while bacteria had a particle size of between 0·4 to 9·0 μm.

The last speaker S. W. B. Newson, Consultant Pathologist, Papworth Hospital, was concerned with the microbiological aspects of air in the hospital, and referred to some 6 000 known recorded cases of laboratory infections throughout the world, of which 15% were related to known accidents but of the remaining 85% there were apparently no known cause, and were assumed to be of airborne origin.

Obviously it was essential to have an effective laboratory safety cabinet and he illustrated his remarks with a number of slides. Correct installation was vital. It was not unknown for filter media to 'block up' and not be serviced, and under these conditions the unit cabinet would be totally useless. Dr. Newson recommended that each laboratory should be equipped with an electrical or thermal anemometer for measuring the airflow, and was of the opinion that the electrical anemometer was a 'good buy' at around £100.

In the general discussion that followed, a speaker inquired as to the minimum safety distance for extracting air from safety laboratory cabinets and was informed that it was vital to site the cabinet extract trunking in such a manner that the air was carried sufficiently well away and could not return by wind change or through an adjacent open window. Dr. Newson considered that the best answer was by roof extraction with an outside pixie hood. To a further inquiry Dr. Newson replied that, with laminar flow cabinets, it was essentially a device for providing protection not only to the operator but also for the product. Mr. Howorth also stressed the importance of changing soiled filters and strongly recommended the use of a warning-light system. On a question concerning the future role of ventilation Mr. Manser replied that, in his view, heat exchangers were going to be very important. He was also very apprehensive about the general maintenance problem in the hospital health service and expressed concern that filters may not be installed or serviced when dirty. The question of energy conservation was in everyone's mind.

In concluding the meeting Mr. Doubleday warmly thanked the speakers for their most interesting informative and challenging papers.

Institute news

Provisional Programme 1976–1977

1976

27th January	'Engineering aspects of pathology' P. C. Vedast
30th March	Annual General Meeting and 'Objectives and future role of the IHE Council Members Panel'
27th April	'Total energy—will it fit into the hospital complex?'
29th June	'Health & Safety at Work Act' W. Askew
28th September	'Water—basic to our survival' W. Lawrence
30th November	'Engineering functions in hospital architecture' G. Bushill

1977

25th January	'Infrastructure—disciplines and relationships in the NHS' L. Davies
29th March	Annual General Meeting and 'The changing face of hospital engineering'

New members

Applications for membership have resulted in the following elections:

Fellows

Crowther, M.	Oxford	*Oxford RHA*
Dixon, A. S.	Kenilworth	*Warwickshire AHA*
Howard, P. B.	London	*Ealing, Hammersmith & Hounslow AHA*
Howorth, F. H.	Bolton	*J. Howorth & Co. Ltd (Holdings)*
May, T. H.	Tripoli	*The Oil Industry Medical Society*
Parker, P. H.	Sheffield	*Trent RHA*
Silver, D.	Sutton	*Kingston & Richmond AHA*
Turner, L. F.	Wolverhampton	*Static Switching Ltd.*

Members

Abel, R.	Aberdate	*Mid Glamorgan AHA*
Adams, D.	Bolton	*Bradshaw, Gass & Hope*
Anderson, B.	London	*Redbridge & Waltham Forest AHA*
Arnott, J. R.	Edinburgh	*Scottish Home & Health Department*
Bowers, F. J.	Kirkintilloch	*Greater Glasgow Health Board*
Bray, D. J.	Bideford	*Devon AHA*
Brown, P.	Ashford	*Kent AHA*
Clark, A. A.	Amersham	*E. A. Pearce & Partners*
Coe, P. J.	Cambridge	*Cambridge AHA (T)*
Cooper, B. J.	St. Albans	*Hertfordshire AHA*
Cruickshank, M. L.	Ghana	*Ministry of Health*
Doole, J. A.	Newry	*Southern Health and Social Services Board*
Heald, B. D.	Huddersfield	*Kirklees AHA*
Jackson, C. H.	Bodmin	*Cornwall & Isles of Scilly AHA*
King, A. T.	St. Albans	*Hertfordshire AHA*
King, I. K.	Oxford	*Oxfordshire AHA*
Mackenzie, M.	Birmingham	*Birmingham AHA (T)*
Matheson, D. J.	Reading	*Berkshire AHA*
Morris, W.	Manchester	*R. W. Gregory & Partners*
Newbury, J.	Abergavenny	*Gwent AHA*
Nicholls, C. T.	Stafford	*Staffordshire AHA*
Oliver, R. W.	Bury St. Edmunds	*Suffolk AHA*
Osmond, R. J.	Birmingham	*Birmingham AHA (T)*
Pye, F.	Liverpool	*Liverpool AHA (T)*
Roberts, I.	Pewsey	*Wiltshire AHA*
Robinson, M. A.	Hastings	*East Sussex AHA*
Skinner, R. H.	Chichester	*West Sussex AHA*
Smith, T. H.	Chigwell	*The City and East London AHA (T)*
Stoneham, H. G.	Sutton	*Merton, Sutton & Wandsworth AHA*
Watkins, N. J.	Edgware	*Barnet AHA*
Wilson, D. A.	Peterborough	*Cambridgeshire AHA (T)*
Woods, J. L.	Tullamore	*Midland Health Board*

Graduates

Hodgson, P.	Croydon	*Croydon AHA*
Lees, S. A.	Sheffield	*Sheffield AHA (T)*
Limbrick, K. A.	London	*Camden & Islington AHA (T)*
Loughton, D. C.	Harrow	*Hillingdon AHA*
Rex, C. G.	Birmingham	*Birmingham AHA (T)*
Trendell, B.	St. Albans	*Hertfordshire AHA*
Vernon, M. A.	Cardiff	*W. S. Atkins & Partners*
Woolard, S. J.	Thornton Heath	*Croydon AHA*

Students

Heath, S.	Birmingham	*West Midlands RHA*

Associates

Butler, T.	Eastwood	*National Coal Board*
Diprose, D. B.	London	*Electricity Council*
Fuller, A. C.	Cape Town	*Ninham Shand & Partners*
Hall, J. D.	Ilminster	*Powrmatic Ltd.*
Jones, A. F. M.	Shrewsbury	*Percy Thomas Partnership*

Affiliates

Sovex Marshall Ltd. Nottingham

Use of low temperature steam in the sterilisation of nonporous loads

At subatmospheric pressure and with low concentrations of formaldehyde

by C. WEYMES, T.D., M.D., M.Sc., F.R.C.P., F.F.C.M., D.P.H.

Items and materials that withstand a temperature of 134°C present no particular sterilisation problem. Alternate pulses of vacuum and steam remove the air, and steam at 2·2 kgf/cm² sterilises bacteria and spores in 3·5 min. Disposable heat-sensitive items are normally supplied sterile by manufacturers. They are sterilised by irradiation or ethylene oxide. Heat-sensitive non-disposable items present greater problems in hospitals.

In-hospital irradiation is unacceptable because of the cost and because irradiation degrades materials and is unsuitable for other than disposable items. Ethylene oxide has been used for several years in hospitals and when properly used it gives excellent results. It is still the method of choice in hospitals but has the major disadvantage that certain materials such as rubber and plastics absorb ethylene oxide. The safe clearance time for total gas removal is 5–7 days. Chemical disinfectants are no longer acceptable as sterilising agents.

The deficiencies of the present methods have been recognised for some years and in 1966 Alder* developed the use of steam at subatmospheric pressure with formaldehyde to sterilise items at between 70–80°C. It had long been known that formaldehyde in a concentration of about 1500 mg/litre was bactericidal and sporicidal but the new system, by adding steam under vacuum, allowed a reduction in formaldehyde concentration to around 50 mg/litre. This method is currently used in a few centres in the United Kingdom but has not received the recognition and consequent development it deserves. The standard cycle employed is

(*a*) Vacuum with limited steam entry to below 100 mm Hg a.b.s. This level is held for about 10 min.

(*b*) Steam entry to a vacuum level which gives the required temperature. At the beginning of the steam pulse 75 ml of 40% formalin is mixed with the steam.

(*c*) Vacuum to around 40 mm Hg a.b.s.

(*b*) and (*c*) are repeated to a total of four pulses.

(*d*) The temperature is balanced at the required level (usually 72°C) by small steam pulses for 20–30 min.

(*e*) A steam flush under vacuum at about 40 mm Hg a.b.s. for 10–15 min helps to wash off absorbed formaldehyde.

(*f*) Alternating vacuum and air admission between 100–600 mm Hg a.b.s. for 15 min removes formaldehyde and dries the load.

It was felt that this cycle was too long, the temperature was a little high and the concentration of formaldehyde was too high. Preliminary experiment showed that, if the formaldehyde was omitted in a cycle following a cycle in which a concentration of 50 mg/litre was used, there was sufficient residual formaldehyde to give reliable sterilisation in the second cycle. This indicated an excess of formaldehyde in the first cycle which was bound to cause a build up in the machine.

It was from this baseline that we started our studies which aimed

(*a*) to relate the volume of formalin to formaldehyde concentrations within the chamber

(*b*) to study the effect of temperature with a view to using the lowest temperature compatible with reliable sterilisation.

(*c*) to study the effect of formaldehyde concentration with a view to using the lowest concentration compatible with reliable sterilisation

(*d*) to determine the minimum safe overall time for reliable sterilisation

(*e*) to study how variations in the cycle can affect load penetration.

The investigation covered 1000 cycles and the method and results are detailed in *Greater Glasgow Health Board Sterilisation Research Centre Note 4*.†

The study was restricted to the sterilisation of heat-sensitive nonporous loads. Our recommendations cannot be applied to porous loads such as blankets or mattresses.

The machine used was a standard 600 litre British Sterilizer SLTF–LT–A machine which allows most cycle parameters to be easily altered. A few modifications were made. The standard machine starts from cold and takes about 20 min for 'warm up'. A Rotatherm controller was added to keep a probe fitted to the jacket drain, at a preselected minimum temperature. This is set at about 5°C below the cycle operating temperature. The steriliser controller was modified to allow the initial vacuum to fall to 200 mm Hg a.b.s. before steam is introduced with vacuum. This modification greatly reduces condensation and the consequent

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*Alder, V. G., Brown, A. M. and Gillespie, W. A.: *J. Clin.Path.*, 1966, **19**, p.83.

†Available free from Dr. Weymes.

wetting and loss of formaldehyde by solution in condense. A 3 h vacuum-chamber recorder was fitted and the relationship between temperature and vacuum can be accurately studied. Small quantities of 40% formaldehyde W/vol. in water were used and a fine jet was introduced to the formalin line to slow entry to the steam/formaldehyde mixer.

The investigation showed that

(*a*) 65°C was as effective a temperature as 70°C or higher.

(*b*) The holding of 'sterilising' period was valueless. Sterilising occurs during the 'pulsing' period.

(*c*) The amount of formaldehyde required varied according to the size and porosity of the load and the method of introduction. With the standard machine, vapourisation of the formaldehyde is poor and the measured chamber concentration is only 50% of the calculated concentration. This is partly due to condensation of formaldehyde on the cool load, door, and back wall.

(*d*) Load penetration can be monitored using a standard or modified helix. The standard helix was devised by Line and Pickerill* to provide a severe test. It is 455 cm long with a bore 3 mm giving a length to bore ratio of 1500:1. The terminal reservoir into which the spore challenge is sealed has a capacity of 1 ml. The severity of the test can be reduced by increasing the volume of the terminal reservoir.

The following cycle is recommended:

(*a*) Prevacuum without steam entry to 200 mm Hg a.b.s., followed by vacuum with limited steam entry to below 100 mm Hg a.b.s. This takes about 7 min.

(*b*) Eight steam pulses with formaldehyde admission from a level of between 20 and 30 mm Hg a.b.s. to a vacuum level where 65°C is achieved. With each of the eight pulses 6 ml formalin should be admitted.

(*c*) A postvacuum flush at between 20 to 40 mm Hg a.b.s. for 5 min.

(*d*) Air wash for 15 min with a vacuum fluctuating between 50 and 500 mm Hg a.b.s.

With this cycle the chamber formaldehyde concentration during the 20 min sterilising varies between 0 and 3·3 mg/litre. Improved vapourisation would give better formalin utilisation levels. With this cycle residual formaldehyde levels vary between 0 and 12 parts in 10^6, depending on the material.

These studies have improved our knowledge and have indicated the lines along which further research could usefully be channelled. Steam in this process (as in the positive-pressure steam process) kills by giving up its latent heat to the organism. The organism is scalded by intense local heat which kills it but does not raise the temperature of the sterilised article.

If one has a holding period of say 65°C± 1°C very little killing is achieved. Little condensation occurs at this period as the chamber walls and the load have reached this temperature. Little additional steam is called for and little latent heat is produced. The sensible heat of 65°C is of no sterilising value.

Steam can only give up its maximum latent heat when it is at phase boundary. Superheated steam is useless as it will not condense to provide latent heat. Wet steam will wet the load, dilute the formaldehyde and produce less latent heat. This poses a difficult engineering problem. How do we know we are providing high-quality steam? In a full-pressure porous-load steam steriliser a combination of high steam flow rates and good separation and trapping ensures dry sterile loads even when the steam dryness fraction is 80%. It is unlikely that the low-pressure system will tolerate steam of such poor quality.

In this low-temperature system it is usual to have jacket and chamber at the same temperature. Thermocouples placed on the chamber roof, walls, doors and base show that with a 65°C setting the initial readings are roof 85°C, base 60°C, door 45°C. These fluctuations do not appear to be harmful and may in fact be helpful. It is clear that the jacket temperature recorder which is set in the drain does not reflect the temperature changes in the chamber walls.

When the process is used without formaldehyde, vegetative bacteria are killed and spores survive. With formaldehyde concentrations of 0·08 mg/litre, stearthermophilus and globigii spores can be killed inside a standard helix. A very low concentration of formaldehyde allows the spores to be killed. We postulate the unproved theory that perhaps the very active aldehyde alters the hard shell of the spore and allows the latent heat to penetrate and kill. We know that the spore shell can resist boiling for 1–3 h. We know that steam will not readily penetrate heavy plastic layers. When a trace of ethylene oxide or formaldehyde is added to steam, penetration occurs probably as a result of restructuring of the polymers. Perhaps formaldehyde acts on the spore wall in the same way. For reliable sterilisation we probably require to cover all exposed surfaces with a layer of formaldehyde one molecule thick.

The effect of varying relative humidity in the chamber has not been studied in detail. When the formaldehyde concentration is 40 mg/litre the relative humidity is 85%. With the low concentration of formaldehyde used in the new process (2–10 mg/litre) the relative humidity is almost 100%.

Where do we go from here? The system has the great advantages that it can sterilise heat-sensitive nonabsorbent loads in less than an hour and the goods can be used immediately. We require to make the system reliable in ordinary hospital practice. We can improve methods of vapourising and mixing the formaldehyde probably by using a fine spray within the steam pipe close to the chamber entry point. Further study is needed on jacket heating methods. We must try to reliably supply steam at the phase boundary. We have to develop a tape indicator to show that the load has been exposed to a low-concentration formaldehyde/steam mixture for a specified time.

If the system is to be of real value we will have to rely on engineering tests of sterilisation. At present we rely on spore culture tests. These take one week and this time lag is unacceptable for most of the items we wish to sterilise in hospital. I feel sure that if engineers and doctors discuss and research these problems they will prove to be surmountable.

*LINE, S. J. and PICKERILL, J. K.: Testing a Steam/Formaldehyde Steriliser for Gas Penetration Efficiency', *J.Clin. Path.*, 1973, **26**, 716.

High-alumina cement – an appraisal

by L. R. CREASEY, C.B., O.B.E., B.Sc., C.Eng., F.I.C.E., F.I.Struct.E.

This article is concerned with a brief Department of the Environment appraisal of the Report BRAC P40, issued in August 1975, together with the Building Research Station Paper CP 34/75, issued in April 1975, with which it is closely linked. There is common agreement in principle between the recommendations of these two documents and the past and current practice of Alan Marshall & Partners. But in some respects, it has been necessary to both simplify and develop our techniques to deal more effectively with the problems encountered in the field, and these adjustments are indicated where appropriate.

Scope of the reports

The two reports are primarily concerned with floor and roof slabs which are formed with proprietary precast units manufactured from high-alumina cement (h.a.c.) concrete.

In this form of construction there are two relatively distinct characteristics of potential weakness:

(*a*) strength of the concrete
(*b*) a liability to chemical corrosion.

These two factors are interrelated but in practice they can be effectively treated as separate problems.

The DoE report has confirmed generally the need to appraise the structural condition of h.a.c. floors and roofs and the importance of judgement in weighing up the relative value of the many imprecise factors involved.

A sole exception is made in the case of floors in low-rise domestic accommodation. The floors are 'exempt' from appraisal but there are some qualifications to this in respect of h.a.c. roofs.

Concrete strength

It has been generally found that the strength of the h.a.c. concrete when fully converted is relatively low. Fortunately, the induced stresses under working load are also quite low, except with long-span units of relatively shallow depth.

The report confirms the advantages of using non-destructive tests for the concrete strength, but it also records the difficulties found in current nondestructive field methods; e.g. core tests are unreliable and full scale load tests are expensive.

The BRS refers to the relatively good results that have been obtained from the use in the laboratory of ultrasonic pulse tests (u.p.v.).

We have found that with skilful use and interpretation a satisfactory guide of concrete strength can also be obtained in the field, with this test.

In all sensitive situations, it is necessary to make an assessment of the current strength of the concrete. The latter, when combined with the corresponding level of current conversion, will provide an indication of the probable long-term or 'residual' strength of the concrete.

The u.p.v. tests are always included in our appraisal where appropriate, and recorded in the appendix to the report.

Strength of section

The two factors of 'induced stress' and 'strength of the concrete' are connected by a factor of safety. The BRS method of assessing this factor is somewhat complex, but the result is broadly consistent with the value of 1·4, as suggested by the earlier report of the Institution of Structural Engineers, and this value is used by us in making an initial assessment.

Likewise, the BRS method of calculating the strength of the section is based on more detailed information of the units than is commonly available, e.g. the number of prestressing tendons in the unit section.

For convenience of rapid identification we have developed a technique which connects the various relevant factors into permissible or 'target values' of the span/depth ratio of the units for different types of floor use. This procedure has been described in our brochure of June 1975.

In a particular case, the actual span/depth ratio can be easily checked against the target value. Allowance can then be made as necessary by a simple percentage addition or subtraction for the many other factors which contribute to the strength of the unit. The latter are referred to as 'enhancement' or plus values.

The new reports refer to many tests which provide guidance on appropriate values for these plus values, e.g. floor screeds and other semicomposite effects.

In a particularly sensitive case, it may be necessary to undertake a detailed calculation and in the limit to initiate further tests.

Chemical corrosion

These lower-strength h.a.c. concretes are vulnerable to chemical attack. But this can only occur where the h.a.c. concrete is exposed to:

(*a*) persistent water seepage or condensation
(*b*) an aggressive agent such as Portland cement or gypsum in the adjacent screeds, or plasters, or roof boarding.

It is therefore very important to seal off water seepage through a roof or floor and persistent leakage from plant or service pipes.

In this respect one of the most sensitive forms of construction is composed of widely spaced units supporting a roof covering of felt on chipboard decking.

The onset of the chemical attack can sometimes be deduced from external evidence or detected in the DTA thermal tests.

Domestic accommodation

In the floors of low-rise housing of up to four storeys the span/depth ratio is relatively low and the environmental conditions are favourable. The DoE report considers that in such cases, the h.a.c. floor is removed from the h.a.c. hazard.

For roof slabs, the report emphasises the importance of avoiding water seepage through the roof covering, particularly with widely spaced structural units supporting a lightweight decking. There is also a limitation on the span.

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12 months' review

In many cases, Alan Marshall & Partners have recommended a reappraisal of the structural and environmental conditions in approximately twelve months from the time of the initial inspection.

As the review date for such projects falls due, the opportunity has been taken to reappraise the data in the light of these new reports and other relevant experience.

Wherever possible, the cases are classified as being removed from the h.a.c. hazard and no further inspections are then required. In more sensitive cases, a limited inspection and retest is carried out.

Summary

The effect of the new DoE and BRS reports is as follows:

(*a*) The reports are concerned with proprietary joist-type precast concrete floor and roof units.

(*b*) The recommendations from these reports are consistent generally with our practice, but we have found it necessary to develop modifications to suit field appraisals for the particular type of work on which we are engaged.

(*c*) The DoE report confirms the need generally for an appraisal of h.a.c. structures, but the floors in low-rise domestic accommodation are now exempt from the h.a.c. hazard and some reservations still apply to the roof slab.

(*d*) There are two relatively distinct problems:
(i) The strength of the concrete is generally lower than expected, but in most cases is till satisfactory.
(ii) The potential liability of the weakened concrete to chemical attack.

(*e*) There is a great need for a simple nondestructive test of the concrete strength. For this purpose, the BRS has been able to take satisfactory pulse tests (u.p.v.) in the laboratory. We have found that with skill and care, these pulse tests can also provide a satisfactory indication of strength when taken on site.

(*f*) The strength of the whole floor or roof structure is complex. We have found an advantage in developing a concept of target span/depth ratios, as a means of rapidly identifying favourable conditions of use.

(*g*) In this procedure, allowance can be quite easily made by enhancement or plus values for the many subsidiary effects which contribute to the overall strength of the concrete floor.

(*h*) To avoid chemical conversion in the h.a.c. concrete particular care is required to eliminate the seepage of water through defective roof coverings, or from plant or service pipes.

(*i*) In this respect, isolated and widely spaced units supporting thin decking panels are particularly vulnerable to this hazard.

(*j*) Alan Marshall & Partners are reassessing all cases at the twelve months' review and wherever possible suitable cases are being classified as outside the h.a.c. hazard.

Product news

E.C.G. electrode

Constructed of sensitive foil strips bonded to treated board, the Cardiomat e.c.g. electrode transmits patient heart electrical energy to the cardioscope where the signals are converted to an e.c.g. reading. The Cardiomat is placed under the patient and connected to the cardioscope by a spring clamp. Prepping of the electrode sites is eliminated and no conductive gel is needed. The electrode is disposable, compatible with electrosurgery, and reduces the possibility of patient burns caused by faulty diathermy because of its large contact area. X ray translucent, the Cardiomat can be used with all recognised makes of cardioscope.

Intel (UK) Ltd., 88 Brewery Road, London N7 9ND

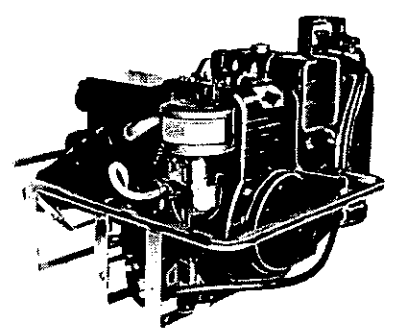
Blood cabinet

The Foster blood cabinet has twin refrigeration systems and if one system fails the other can be engaged immediately by pressing a switch. Either system will maintain a storage temperature of 3°C to 6°C in ambient temperatures up to 40°C. Immediate alarm of temperature deviation is given by a buzzer and light on the console (which can be linked to a central point). The cabinet has a capacity of 0·5 m^3. The blood bottles or bags are stored on shelves or sliding drawers. A stream of fan-assisted air flows over the items in storage, keeping them at the correct temperature.

Foster Refrigerator UK Ltd., Oldmedow Road, King's Lynn, Norfolk PE30 4JU

Power generator

The PBS40 4 kW, 240 V generator can be run on natural gas, low-pressure gas or petrol. Designed for both industrial and domestic use, the unit is equipped with a patented high-voltage magneto ignition system. Push-button starting is provided through a 12 V battery. The alternator is of all-steel construction and is of the 2-pole



revolving armature self-exciting type. It is self regulating and can be supplied for operation with a different voltage. The basic price is £420 exclusive of v.a.t.

L. E. Phillips & Co. Ltd., Little Kingshill, Great Missenden, Bucks. HP16 0DX

See also page 10

Classified Advertisements

OFFICIAL APPOINTMENTS
SITUATIONS VACANT
COURSES, EQUIPMENT ETC.

To place an advertisement in this section, please write or telephone:
Classified Advertisement Department, *HOSPITAL ENGINEERING*
Peter Peregrinus Ltd.
Station House, Nightingale Road,
Hitchin, Herts. SG5 1RJ, England
Telephone: Hitchin (s.t.d. 0462) 53331, ext. 276

APPOINTMENTS AND SITUATIONS VACANT

HERTFORDSHIRE AREA HEALTH AUTHORITY

Hertfordshire
Area Health Authority

NORTH WEST DISTRICT

Assistant Hospital Engineer

St Albans City Hospital, Normandy Road, St Albans

Salary: £3,063-£3,507 plus £141 p.a. Outer London Allowance.

The successful applicant will be responsible to the Hospital Engineer for the efficient operation and maintenance of all engineering plant and services including steam raising plant. Applicants should have completed an apprenticeship in mechanical or electrical engineering and possess an Ordinary National Certificate or an equivalent approved qualification.

The successful applicant will be expected to reside within easy reach of the Hospital. A flat may be available if required.

***Applications in writing, naming two referees to the District* Works Officer, St. Albans City Hospital, Normandy Road, St. Albans, Herts.**

Oxfordshire AREA HEALTH AUTHORITY (TEACHING)

SECTION ENGINEER

BANBURY £4371 - £5262

to be responsible for the maintenance operation and minor new works schemes for this group of Hospitals, and to provide specialist technical knowledge on an Area basis.

Candidates should be experienced in the operation and maintenance of complex engineering services. Experience in fuel economy measures; communication systems, Design of M. & E. Services for Minor Capital Schemes, will be an advantage.

Minimum qualifications HNC in Engineering plus endorsements.

Job description and application form from:

Elizabeth J. Morton, Recruitment Officer, Oxfordshire AHA (T)., Manor House, off Headley Way, Headington, Oxford OX3 9DZ

Closing date: 31st December, 1975

Preference may be given to existing N.H.S. personnel

Hospital Engineer

Salary scale £3615–£4140 p.a. plus £183 p.a. Special Responsibilty Allowance and £312 London Weighting Allowance.

Primarily responsible to the District Engineer for the operation and maintenance of all engineering and electrical services at Epsom District Hospital.

Applicants must be in possession of a Higher National Certificate in Mechanical or Electrical Engineering, an equivalent City and Guilds Certificate or other qualifications acceptable to the Department of Social Security as an alternative.

Application forms are available from: The Personnel Officer, Epsom District Hospital, Dorking Road, Epsom, Surrey Tel.: Epsom 26100 Ext. 327.

Mid Surrey Health District

SEFTON AREA HEALTH AUTHORITY

DISTRICT WORKS OFFICER

Salary Scale £6405–£7716 p.a.

Owing to the promotion of the present holder, a vacancy has occurred for this post in our Southern District, based at Walton Hospital, Liverpool.

Applications are invited from Officers currently employed in the National Health Service. In the case of transferred Officers there are no stipulations regarding qualifications.

Job descriptions and application forms available from Area Personnel Officer, Merton House, Stanley Road, Bootle, Merseyside, L20 3BA, to whom they should be returned by January 5th, 1976.

HOSPITAL ENGINEER—SOUTH BIRMINGHAM

£3615–£4140 p.a. plus

Responsible for Selly Oak Hospital, the Head Injuries Rehabilitation Centre and the Artificial Limb and Appliance Centre the successful candidate will have wide responsibilities. For example the building of a £3 million New Ward Block and four additional operating theatres commenced earlier this year which is due to be completed by 1977.

The successful applicant should hold H.N.C. in Mechanical or Electrical Engineering or an equivalent qualification and on top of his annual salary a special responsibility allowance is paid.

South Birmingham as a place to live and work has much to offer so please apply for application forms and further information to Mike Clitheroe, District Personnel Officer, South Birmingham Health District, Oak Tree Lane, Birmingham B29 6JF. Persons interested in viewing the site are welcome to contact the Administrator, Selly Oak Hospital. Telephone 021 472 5313.

Closing date is the 17th December 1975. Please quote ref. HE.

CLASSIFIED ADVERTISEMENTS *continued from previous page*

APPOINTMENTS AND SITUATIONS VACANT

Hertfordshire
Area Health Authority

NORTH WEST DISTRICT

Assistant Hospital Engineers

required at:

CELL BARNES HOSPITAL
Highfield Lane, St Albans
Salary: £3063–£3507 plus
£141 p.a. Outer London Allowance

HARPERBURY HOSPITAL
Harper Lane, Radlett, Near St Albans
Salary: £3063–£3507 plus
£312 p.a. London Weighting

The successful applicants will be responsible to the Hospital Engineer for the efficient operation and maintenance of all engineering plant and services including steam raising plant and a hospital laundry. Applicants should have completed an apprenticeship in mechanical or electrical engineering and possess an Ordinary National Certificate or an equivalent approved qualification.

The successful applicant will be expected to reside within easy reach of the Hospital. A house will be available if required.

Applications in writing, naming two referees to the: District Works Officer, St Albans City Hospital, Normandy Road, St Albans, Herts.

ENERGY CONSERVATION

TECHNICAL ASSISTANT ENGINEER

(Salary scale £3906–£4692 +£312 London Weighting)

The Technical Assistant will be expected to improve existing 'housekeeping' measures to conserve energy within the three Districts of this Area, also to assess the economic viability of medium/long term Capital Investment proposals.

H.N.C. or equivalent, consideration will be given to persons with specialist knowledge in energy conservation.

Application form and further details from: Area Personnel Officer, Merton, Sutton & Wandsworth Area Health Authority (Teaching), "Homewood", 14 Atkins Road, London, SW12 0AD. Tel.: 01-673 8881 Ext. 12. Closing date for receipt of applications is the 6th January 1976.

Merton, Sutton and Wandsworth A.H.A (Teaching)

NORTH TEES HEALTH DISTRICT

Top Flight Hospital Engineering Opportunity

North Tees . . . a progressive Health District containing one of the largest and most modern hospitals in Europe, need a Hospital Engineer preferably with hospital experience to use flair and initiative in an important and responsible post.

You should possess a qualification at HNC level or equivalent in mechanical or electrical engineering, plus the ability to organise the work of a skilled maintenance team.

Main responsibilities include maintaining high standards of technical servicing to medical departments and units. And ensuring that technical manpower resources are deployed effectively throughout the District.

In addition you will carry out surveys and prepare plans with a view to improving the engineering services, assist in the design specification and execution of minor capital works, and represent the Works Department at meetings.

In the more important aspects of the job, the Hospital Engineer is accountable to the District Engineer.

Salary is £3615–£4140 plus £183 special responsibility allowance. Benefits include payment of removal and settling in expenses in approved cases, a car user allowance and a superannuation scheme.

Write with full career details, to the Personnel Manager, North Tees Health District, North Tees General Hospital, Hardwick, Stockton, Cleveland TS19 8PE, or telephone Stockton (0642) 62122 for further details, extension 545. Please quote reference/852. Closing date 2nd January, 1976.

Hertfordshire
AREA HEALTH AUTHORITY
EAST DISTRICT

HOSPITAL ENGINEER

To cover engineering services at the Hertford County Hospital plus two other hospitals and community properties.
Applicants must be in possession of HNC in Mechanical or Electrical Engineering or a City and Guilds Certificate in Plant Engineering.
Salary scale £3351 to £3942 plus responsibility allowance and outer fringe weighting of £141 per annum.

Full particulars of the post with job specification can be obtained from the District Works Officer, The Mansion, Ware Park Hospital, Nr. Ware, Herts.

Closing date 29th December, 1975.

CLASSIFIED ADVERTISEMENTS
continued from previous page

Nottinghamshire Area Health Authority (Teaching)

WORKSOP & RETFORD DISTRICT

ASSISTANT ENGINEER

based at Kilton Hospital, Worksop, and responsible to the District Works Officer for assisting in the design, specification and supervision of a wide range of engineering projects, and for the preparation and documentation of Planned Preventive Maintenance Systems on plant and equipment in the District.

The successful applicant will have served a recognised apprenticeship, possess O.N.C. (or approved equivalent) in electrical or mechanical engineering and, ideally, have experience of Electrical and/or Mechanical Services.

Salary on scale £3063–£3507

Application forms available from Personnel Officer, Worksop and Retford Health District, 30 Watson Road, Worksop, Notts., S80 2BN. ('phone Worksop 2831).

Closing date for applications December 22nd, 1975

Classified advertisements for the next issue of

HOSPITAL ENGINEERING

published 6th February should be received not later than Monday, 23rd January

MISCELLANEOUS

CIRCULATING PUMPS and Steam Turbines. Complete units, electric and steam, spares and service. TURNEY TURBINES Ltd., 67 Station Road, Harrow. Tel.: 01-427 1355 and 01-427 3449

Pipe flanges; Imperial, American, metric: many sizes from stock. Small orders accepted. Earl Street Ironworks, London Office, 77 New Bond Street, London W1Y 9DB. 01-493 3321.

REGULATIONS FOR THE ELECTRICAL EQUIPMENT FOR BUILDINGS

These regulations (formerly the 'Wiring rules'), which have been published by the IEE since 1882, are effectively the UK national code for the safety of electrical installations, specially from fire and shock, in and around building generally.

They are recognised in the statutory Electricity Supply Regulations 1937, as fulfilling the requirements of these regulations for consumers' installations. They supplement these and other statutory regulations by prescribing, in detail, methods (not necessarily the only methods) of complying with the statutory regulations.

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Publication Sales Department, IEE, Station House, Nightingale Road, Hitchin, Herts. SG5 1RJ, England

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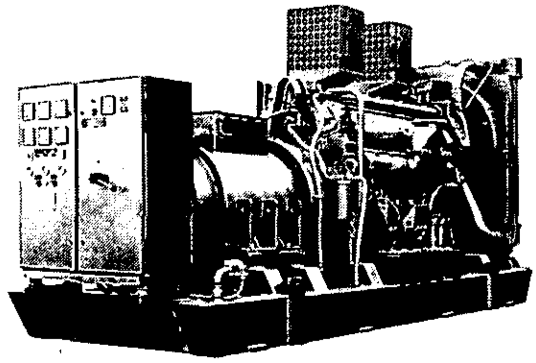

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