A King's Fund Report

Design of Hospital Bedsteads

King Edward's Hospital Fund for London

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The report of an enquiry carried out by a King's Fund Working Party into the design of hospital bedsteads which has resulted in a specification of a bedstead suitable for general purposes

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Chairman's Foreword

The summary of the enquiry which follows this note explains why the working party came into being. The summary and the specification give the essence of the report and supporting evidence is supplied in the appendices.

The aim has been to provide a specification of a bedstead suitable for general purposes which will be of maximum benefit to the patient and at the same time will facilitate the work of nurses and other staff. The main concern of the working party has been to evolve a specification; the interpretation is left to the manufacturers in so far as materials and mechanism are concerned.

The ultimate purpose of the enquiry will only be achieved when bedsteads made to the specification are supplied to hospitals. While the method adopted for production and supply is the responsibility of the Ministry of Health, the fact that Mr Hunt has been a member of the working party means that he is well aware of the suggestions which have been received on this question. This close consultation with the Ministry has also been strengthened by Mr F R Howes of the Supply Division who has given considerable help.

The specification calls for a bedstead which will be considerably more elaborate than many of those in use in hospitals at the present time; but it is expected that rational methods of production will bring the cost down to acceptable levels. Even the slightest deviations from a standard article of equipment can double the cost of manufacture. The working party trusts that the weight of evidence for the specification will forestall requests for departures from it.

In a study of this scale and complexity it is not possible to thank by name all those who have helped us in our deliberations, some of whom have in any case submitted evidence in confidence, but they have played an indispensable part and we are most grateful.

The Industrial Design (Engineering) Research Unit of the Royal College of Art under the able leadership of Mr L Bruce Archer deserve special mention for undertaking much of the work in connection with the specification and for producing the prototype. So do Mr S E Harrison and his team who, armed with this prototype, reached the same high standards in preparing and conducting the trials in a hospital ward.

Finally, the working party would like to pay a tribute to their secretary, Mr Irfon Roberts, who has had the task of sifting the evidence, drafting the documents, and co-ordinating the activities of the many groups who participated in the project.

Angela Campbell-Preston
Chairman February 1967

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1 Stages of the Enquiry

This is no more than the briefest sketch of the enquiry. Separate reports with details of the various stages are available from the King's Fund Hospital Centre. The form at the end of this report may be used for enquiries and comments.

In 1963 King Edward's Hospital Fund, in consultation with the Ministry of Health, formed a working party to study the design of hospital bedsteads. The enquiry had been prompted by the lack of good designs and by the wasteful methods of supply prevalent throughout hospitals. The working party decided to concentrate on the design of hospital bedsteads for general purposes, to be presented in the form of a specification.

The purpose of the working party has been to give a guiding hand, generally directing the course of the enquiry and weighing the evidence collected and sifted on its behalf. The way in which it has conducted the study from the King's Fund Hospital Centre is shown in the diagram on page 11, to which these notes form a commentary.

Gathering Information
The first step was to find out what had been done already, in order to avoid duplication and to build up ways of exchanging information both within this country and abroad. After making sure that the ground had not previously been covered the working party decided first of all to analyse the needs and to determine the characteristics required of a general purpose hospital bedstead. At the same time a separate analysis was made by the Industrial Design (Engineering) Research Unit* of the Royal College of Art which was already sponsored by the Fund to study the choice and design of hospital equipment. The two analyses were then compared and it was decided that more evidence was needed before a specification could be prepared.

The research unit suggested the use of television to gather some of this evidence and prepared the material for this purpose. About twenty thousand members of hospital staffs invited to take part made special arrangements to view the feature which appeared in the BBC programme *Panorama* in February, 1964, and although the transmission was sadly mutilated an admirable response was obtained and valid answers were given to nine of the twelve questions asked.

Drafting a Specification
This evidence was supplemented by other means of enquiry and the research unit prepared a specification of the users' requirements which was approved by the working party and issued in June, 1964.

Designing a Prototype
The next step was to put the specification to the test. Designers and manufacturers were invited to produce prototypes and several designs prepared for this purpose were shown to the working party. The first of these to be ready as a satisfactory prototype was produced by the research unit itself and approved in February, 1965.

Devising Methods of Assessing Prototypes and Making First Assessment
The working party could find no satisfactory methods of assessment ready-made, and it therefore had to arrange for these to be specially devised for the purpose.

In the summer of 1965 the prototype was put through a preliminary trial at the Wolfson School of Nursing of Westminster Hospital by a team led by Mr C R Chamberlain, Work Study Officer of the hospital. Nursing and other procedures to suit this pattern of bedstead were devised in time for the benefit of the staff taking part in the full-scale trials.

Manufacturing Bedsteads for Trials in a Ward and Conducting Trials
The Ministry of Health made a grant to pay for these trials and Scottish Aviation Limited, whose plant lent itself to the prompt manufacture of bedsteads made in this particular way, produced twenty identical prototypes for trial purposes.

Mr S E Harrison, Work Study Officer of the North East Metropolitan Regional Hospital Board, conducted the trials from September, 1965, to January, 1966, in a women's general surgical ward at Chase Farm Hospital, Enfield. The entire ward of eighteen beds was equipped throughout with identical prototypes to ensure that every patient admitted to the ward would be put into the same sort of bed; this made for a valid assessment.

During the trials a team of trained observers kept constant observation between 6.00 am and 10.00 pm daily for five months. First the existing bedsteads were observed for one month, then these were replaced for three months by the prototype and finally the existing bedsteads were put back and observation continued for a month. Mr Harrison also conducted a method study, and the professional staff of the hospital took

*Then known as the Hospital Equipment Group

part in assessing the performance of the prototype. Altogether no fewer than 1¾ million items of information were recorded. At the same time sociologists under the guidance of Miss Joan Woodward of Imperial College of Science and Technology were engaged to find out the opinions of patients and staff about the conventional and prototype bedsteads.

Analysing Evidence from Trials and Revising Specification

The data obtained at Chase Farm Hospital were analysed by the work study team and the research unit with the aid of a computer under the direction of Mr A J Willmott of the Department of Computation at the Manchester University Institute of Science and Technology. The results were used in the revision of the specification by the research unit with other evidence collected since it was first issued.

The working party received the revised specification in October, 1966, and after final revision in the light of discussion it was approved for publication in the form in which it appears in this report.

Production and Supply

The working party has created opportunities for questions of production and supply to be widely discussed since it considers that it is just as important to observe systematic methods in this respect as it is in devising specifications and designs, and that each is the absolute counterpart of the other.

As patterns of bedsteads are produced in answer to the specification, their merits will need to be judged. This could be achieved by an impartial assessment of each design point by point against the specification. Each design would then be approved as a satisfactory embodiment of the specification, approved subject to specific improvements, or not approved, and, of course, the specification itself will need to be reviewed from time to time. On the assumption that the Ministry of Health will approve the specification for application to the hospital service, it will then accept responsibility for seeing that these tasks are undertaken.

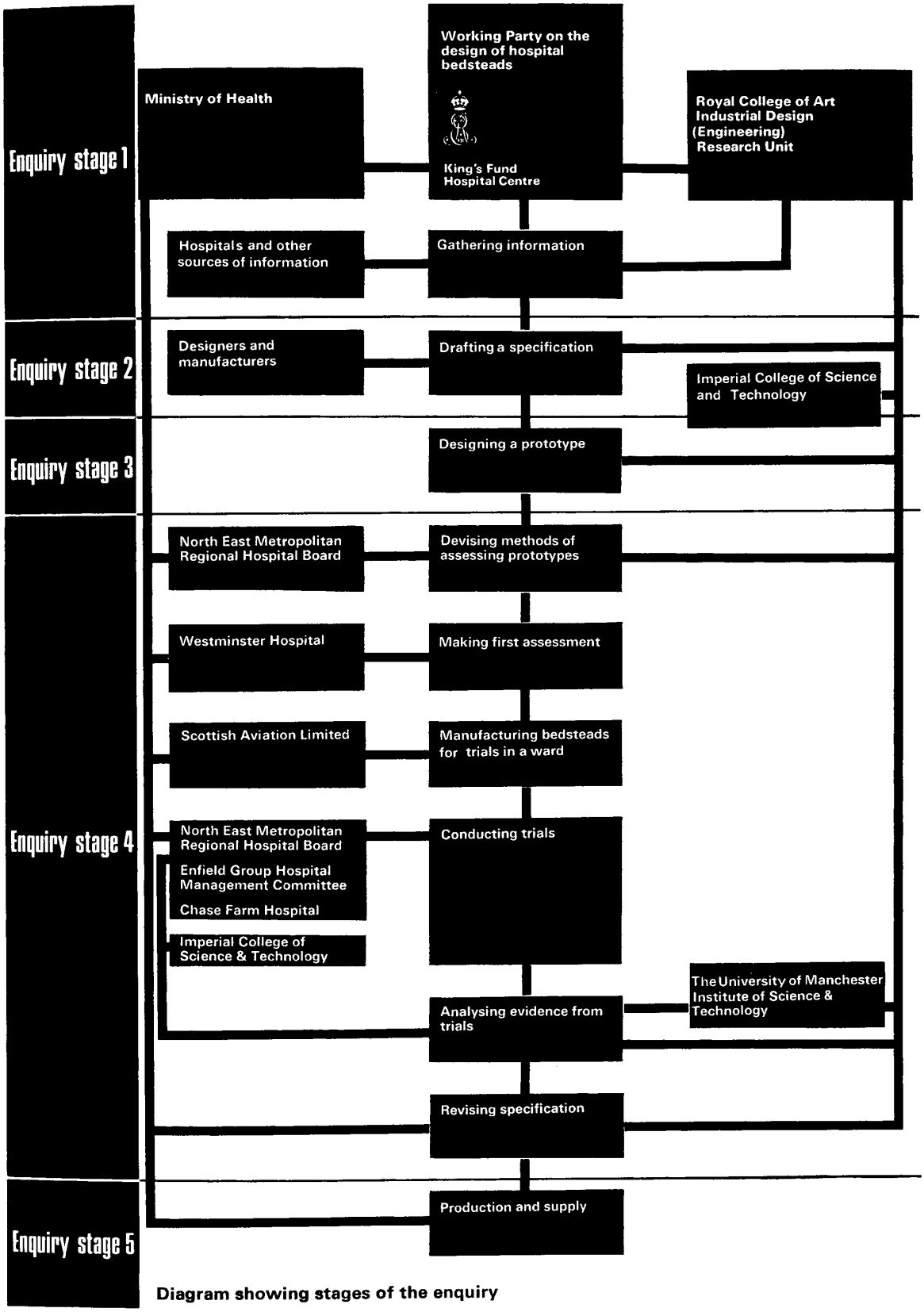


Diagram showing stages of the enquiry

2 Specification of Users' Requirements for General Purpose Hospital Bedstead

Introduction

The specification which follows describes the qualities which a bedstead is required to have if it is to be suitable for widespread use in general hospitals.

The specification does not describe a design. It is intended to give scope for ingenuity in manufacture, the use of new materials or the development of new constructional techniques. It is also intended to be used as a standard framework within which competing manufacturers' products may be assessed. Standardised acceptance tests and/or comparative evaluation procedures do not form a part of the specification itself. Such tests or procedures may be applied or recommended by testing or standards bodies from time to time.

In the text of the specification the use of the term 'shall' implies that a design which does *not* exhibit the quality described is *not* acceptable, whatever other qualities it may or may not have. The term 'should' implies that a design exhibiting the quality described is to be preferred over a design which does *not* exhibit that quality. The term 'may' implies that the additional qualities described can be offered by manufacturers at their discretion. General terms such as 'quick', 'easy', 'smooth', 'obvious', imply that an assessing or testing body must satisfy itself that these attributes are present to an acceptable degree. The term 'bedstead' refers to the structure, the term 'bed' refers to the structure plus the mattress and normal complement of bedclothes, with or without the occupant.

General

1 The bedstead shall conform with Ministry of Health requirements for electro-static safety as applying to equipment for use in the presence of flammable gases.
See Appendix A, page 20.

2 It shall be possible for all adjustments of the bedstead facilities to be made by one woman working alone, without the aid of tools or power sources, although in addition other sources of power may be provided or provided for.
See Appendix B, page 20.

3 It shall be possible for one woman working alone to remove, carry and where necessary stow, or replace on the bedstead, any part of the structure designed to detach for nursing purposes.
See Appendix B, page 20.

4 Adjustment, and/or movement of detachable parts, shall cause minimum unnecessary disturbance to the patient and minimum effort for the attendant.

5 All parts of the bedstead when positioned shall remain as positioned until further adjustment is desired.

6 Any part of the bedstead that a patient or attendant may reasonably grip or use as support, or may fall against, or may in any way come in contact with, shall not present a hazard.

7 It shall not be possible for any use or misuse of the bedstead and its adjustments to result in a sudden or uncontrolled movement.

8 Methods of use shall be either obvious or easily learned; the model number, month and year of manufacture, and manufacturer's name shall be on the bedstead; instructions for use, and directions covering assembly, maintenance, and the identification and rectification of minor faults, shall be provided.
See Appendix C, page 21.

Lying Surface/Work Surface

Support

9 The mattress together with the mattress support shall provide a posturally correct, comfortable and hygienic surface for the patient to lie or sit upon.
See Appendix D, page 21.

10 The mattress support shall be a flat and rigid surface with minimum interruptions consistent with ventilation of the mattress and drainage of spilled liquids.
See Appendix D, page 21.

11 The mattress selected shall be suitable for use on the mattress support.
See Appendix D, page 21.

12 Means shall be provided for retaining the mattress and bedclothes in position.
See Appendix E, page 23.

13 The surface of the mattress support shall not present a hazard to the hands of attendants or to the bedclothes.
See Appendix E, page 23.

Length

14 The length of the clear space above the mattress support between the headend and footend structures shall be 6ft 7in (201 cm). Preferably it should be capable of extension to 7ft 2in (218 cm).
See Appendix F, page 23.

15 The overall length of the mattress shall be 6ft 5in (196 cm).
See Appendix F, page 23.

16 Preferably it should not be necessary to use a different mattress when the inbed length is extended.
See Appendix F, page 23.

17 The overall length of the bedstead when unextended shall not exceed 6ft 10in (208 cm) and when extended shall not exceed 7ft 5in (226 cm).
See Appendix F, page 23.

Width

18 The overall width of the mattress shall be 2ft 10in (86 cm).
See Appendix G, page 25.

19 The mattress support shall be as narrow as possible but it shall not be less than the width of the mattress.
See Appendix G, page 25.

20 The overall width of the bedstead shall not exceed 3ft 2in (97 cm). Preferably the overall width should be less than 3ft 2in (97 cm).
See Appendix G, page 25.

Depth

21 There shall be a minimum depth of structure below the side edges of the mattress for a sufficient distance inwards to allow an attendant to adopt necessary postures requiring the knee and thigh to project under the mattress edge, or to sit without difficulty at the bed. Preferably the depth of structure should not exceed 2in (5 cm). Preferably there should be a similar clearance at the headend.
See Appendix H, page 26.

22 The uncompressed mattress shall be as thin as possible. Preferably it should not exceed 4in (10 cm) in depth.
See Appendix H, page 26.

Back Support

23 Means for supporting the head and trunk of the patient shall be provided for postures in addition to lying flat.
See Appendix I, page 27.

24 The angles of back support shall be at least from 0°–20° and from 50°–90° from the plane of the mattress support. Preferably angles of back support from 20°–50° should also be provided.
See Appendix J, page 28.

25 There shall be a positive means for retaining securely in position on the back support some of the pillows and padding necessary for the

patient's posture and comfort.
See Appendix K, page 28.

26 Use of back support shall cause minimum displacement of the patient's head and shoulders from the headend of the bed and shall, with mattress and footend on the bed, leave a clear length of at least 3ft 9in (114 cm) for the patient to sit in.
See Appendix L, page 29.

27 No form of back support when in use shall cause the mattress or the bedclothes to form ridges or folds beneath the patient.
See Appendix L, page 29.

28 The back support shall be easily positioned by one person and such positioning shall be possible from both sides of the bedstead or from the footend.
See Appendix M, page 30.

29 The action of the back support adjustment shall be light and smooth, and it shall not jam, even momentarily, under conditions of hospital use.
See Appendix M, page 30.

30 When adjusting the back support it shall be possible for the operator to adopt a correct posture and work without strain.
See Appendix M, page 30.

Height Variation Facility

31 There shall be on the bedstead means for positioning the mattress and mattress support at various heights.
See Appendix N, page 31.

32 There shall be a low position for the mattress and mattress support of less than 20in (51 cm) from floor to top of uncompressed mattress. Preferably there should be a low position of 18in (46 cm).
See Appendix O, page 31.

33 There shall be a high position for the mattress and mattress support of not less than 34in (86 cm) from floor to top of uncompressed mattress. Preferably there should be a high position of 36in (91 cm).
See Appendix P, page 32.

34 Intermediate heights shall be obtainable. Preferably all intermediate heights should be obtainable.
See Appendix Q, page 33.

35 The movement of height adjustment shall be smooth, and the rate of movement shall be acceptable.
See Appendix R, page 34.

36 Preferably height adjustment should be foot operated.
See Appendix R, page 34.

37 The operation of height adjustment shall not cause the mattress or the back support significantly to change its angle.
See Appendix S, page 35.

38 The adjustment of height shall not cause substantial horizontal movement of the perimeter of the bedstead. In any case, horizontal movement parallel to the length of the bed shall not exceed 2½in (6.4 cm). Preferably all such horizontal movement should be avoided.
See Appendix S, page 35.

Tilting Facility

39 It shall be possible to tilt the whole of the mattress support so that its footend is higher than its headend.
See Appendix T, page 35.

40 Foot-high tilt of between 5° and 7° shall be immediately obtainable, irrespective of the positions of other adjustable parts, and means for obtaining it shall be clearly indicated.
See Appendix T, page 35.

41 At least 12° of foot-high tilt shall be obtainable, although not necessarily over the full range of height adjustment.
See Appendix T, page 35.

42 Intermediate degrees of tilt shall be obtainable. Preferably all degrees of tilt from 0°–12° should be obtainable.
See Appendix T, page 35.

43 Changing the angle of tilt shall not change the angle of the back support relative to the mattress support.

44 It shall be possible to position the top of the uncompressed mattress, at the headend of the bed, between 26–28in (66–71 cm) from the floor, irrespective of the degree of tilt given, so that the patient's head and shoulders may be at nursing height when necessary.
See Appendix U, page 36.

45 A means for indicating the degree of tilt shall be provided.
See Appendix V, page 37.

Perimeter

46 There shall be a smooth perimeter to the mattress support and superstructure of the bedstead. No part of the lower structure shall protrude beyond this easily visible perimeter unless it is capable of being folded away.
See Appendix W, page 37.

47 Full all round access with no obstruction above the mattress surface at any point around the perimeter shall be obtainable.
See Appendix X, page 38.

48 It shall be possible to propel the bed without the attendant's view being unduly obscured by any structure.
See Appendix Y, page 39.

Headend

49 There shall be on the bedstead at the headend means for protecting the patient's head and for retaining pillows on the mattress. A filled panel may be incorporated.
See Appendix W, page 37.

50 It shall be possible quickly to obtain unobstructed access to the patient from behind the headend of the bed.
See Appendix X, page 38.

51 The structure at the headend of the bedstead shall be suitable for use by an attendant when propelling and manoeuvring the bed.
See Appendix Z, page 39.

Footend

52 There shall be on the bedstead at the footend means for protecting the patient's feet. A filled panel may be incorporated.
See Appendix W, page 37.

53 The structure at the footend of the bedstead shall be suitable for use by an attendant when propelling and manoeuvring the bed or by a patient when using it for support.
See Appendix Z, page 39.

54 The structure at the footend of the bedstead

shall not unduly obscure the patient's view.
See Appendix Y, page 39.

Bed Stripper

55 There shall be on the bedstead at the footend means for temporarily storing clear of the mattress surface and clear of the floor the pillows and folded bedclothes.
See Appendix AA, page 40.

56 Preferably the pillows and bedclothes when temporarily stored should remain in position even when the mattress support is tilted up to 7°.
See Appendix AA, page 40.

57 When in position the bed stripper shall present a suitable support for the bedclothes at a level permitting easy bedmaking and stripping with the normal hospital procedures.
See Appendix AA, page 40.

58 When the bed stripper is in position there shall be no hazard to the attendant's hands and arms or to the bedclothes.
See Appendix AA, page 40.

Attachments

Safety Sides

59 There shall be safety sides capable of attachment to the sides of the bedstead which, when in position, prevent the patient from accidentally rolling or slipping off the mattress.
See Appendix BB, page 41

60 The safety sides shall not be the full length of the mattress and, when in position, the unguarded length shall not be at the headend. Preferably the sides should be threequarter length.
See Appendix BB, page 41.

61 Preferably the height of the safety sides above the top of the uncompressed mattress should be 12in (30 cm). They shall not be less than 10in (25 cm), nor unacceptably high.
See Appendix BB, page 41.

62 The safety sides when in position shall not form a significant obstruction to vision.

63 The safety sides shall readily attach and detach, and they shall stow within the bedstead structure. Preferably they should not encroach on the dimensional and other requirements stated elsewhere in this specification.
See Appendix CC, page 42.

64 The safety sides shall be capable of being lowered without necessitating removal from the bedstead. When lowered they shall not hamper access to the patient. Preferably when lowered they should not hamper bedmaking. Preferably the lowering movement should require minimum clearance between the bed and its surroundings.
See Appendix CC, page 42.

65 Operation of the safety sides shall be quiet.
See Appendix CC, page 42.

66 It may not be necessary for each bedstead to have a pair of safety sides.
See Appendix DD, page 42.

Other Attachments

67 It shall be possible to attach various auxiliaries including a lifting pole to the bedstead, but

the means for mounting need not be part of the bedstead. The specification is not intended to satisfy the heavier orthopaedic requirements.
See Appendix EE, page 43.

Mobility/Stability

68 There shall be on the bedstead means for making the bed mobile or immobile.
See Appendix FF, page 43.

69 The state of mobility or immobility of the bed shall be easily seen, and the means for changing the state shall be readily discernible.
See Appendix GG, page 44.

70 The means of mobility shall permit easy smooth movement of the bed throughout the hospital including occasional travel over short stretches of paving or concrete.
See Appendix FF, page 43.

71 When mobile the bed shall be acceptably stable.
See Appendix GG, page 44.

72 When the bed is mobilised, it shall be possible to steer and control the bed, and there shall be clearance at the headend and at the footend of the bedstead for the legs and feet of the attendants moving it.
See Appendix Z, page 39.

73 When mobilised, the bed shall be capable of traversing small obstructions and floor discontinuities such as ramps and lift thresholds.
See Appendix FF, page 43.

74 When the bed is mobile or immobile, transmission of floor vibration and mild collision shock to the patient shall be dampened. Preferably they should be inhibited.

75 When immobile the bed shall be acceptably rigid and stable.
See Appendix GG, page 44.

76 Preferably, in any configuration, the mattress support should not deflect more than 1in (2·5 cm) when a downward load of 140 lb (64 kg) is applied at any place.
See Appendix GG, page 44.

Materials and Construction

77 All accessible details of construction and all mechanical movements shall be acceptably hazard free for attendants and patients, particularly with regard to finger and limb trapping, sharp projections, and unexpected changes in, for example, the height or tilt of the mattress support and back support.

78 All small parts shall be captive.

79 Materials or constructions that can support or harbour micro-organic life, can inhale or exhale airborne particles, or can permit moisture to accumulate or stand, shall be avoided.
See Appendix HH, page 44.

80 Materials and design of the bedstead shall be calculated to facilitate the cleaning of the bed and its immediate surroundings.
See Appendix II, page **45.**

81 The accessible surfaces of the bedstead shall be capable of disinfection by the methods in hospital use.

82 Materials and finishes shall be non-toxic.

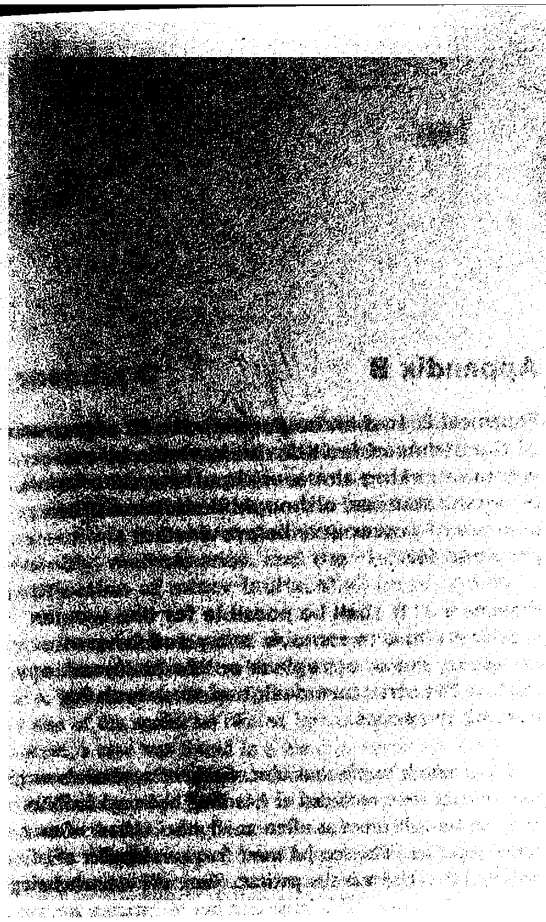
83 Surface finishes shall not be affected by or take permanent traces from urine, common medicaments and disinfectants, common anaesthetic and other gases; alcohol, fruit and vegetable juices and other food products; common toilet substances; water, soap and common cleaning materials; lubricants and mineral oils.

84 Surface finishes shall not permit permanent adhesion of dried body substances and organic fluids; dried food products; wax, plaster or adhesive tape.

85 Materials of construction and surface finishes shall not fracture or flake on impact with other equipment, nor erode or abrade too readily in use or cleaning.

86 Materials of construction and surface finishes shall not be affected by the heat of boiling water nor readily take a permanent trace from a cigarette burn.

87 Except where tolerances are specified, all dimensions and other requirements shall be achieved as closely as economically possible.



3 Appendices Giving Supporting Material for the Specification

Appendix A

Statement 1 : **The bedstead shall conform with Ministry of Health requirements for electro-static safety as applying to equipment for use in the presence of flammable gases.**

The use of certain flammable anaesthetic gases is widespread in British hospitals. Beds are occasionally taken into the operating theatre or the anaesthetic room, although this practice seems unlikely to become very common. In addition, there are occasions, admittedly rare, when an anaesthetic may have to be given on the bed, possibly even in the ward.

At the same time it has been argued in Ministry of Health *Technical Memorandum No.* 1 that, with increasing use of air conditioning equipment and its possible malfunction or misuse, the partial protection against electro-static charging normally afforded by the moist British atmosphere may be lost. In the USA at a conference on hospital safety held in Michigan in 1961 it was stated: 'The administration of anaesthetic gases is a source of potential accidents to personnel as well as patients. Every year, between 80 and 100 explosions of anaesthetic gases are touched off by electro-static discharges'.

Nothing points to a high degree of risk but early concern voiced by the nursing advisers was subsequently confirmed by 57 out of 60 anaesthetists, consulted in a television enquiry, who believed that anaesthetic gases might in some circumstances be given on or near the bed in their hospital. Where hospital staff returned group answers 68 per cent confirmed the risk.

As an additional minor hazard, a bedstead may at times accumulate a heavy electro-static charge which, if not otherwise earthed, may be discharged, painfully, by a person touching the bed.

The appropriate safety requirements, relating to electrical continuity and the characteristics of wheels and tyres are set out in, for example, British Standard 2057: 1953 regarding patients' trolleys, and British Standard 1938: 1960 regarding instrument tables.

General references: see lists of sources
Specific references: see 1.3, 1.7, 2.15, 2.21, 3.28, 3.41, 5.1, 6.2, 6.4, 7.33.

Appendix B

Statement 2 : **It shall be possible for all adjustments of the bedstead facilities to be made by one woman working alone, without the aid of tools or power sources, although in addition other sources of power may be provided or provided for.**

Statement 3 : **It shall be possible for one woman working alone to remove, carry and where necessary stow, or replace on the bedstead, any part of the structure designed to detach for nursing purposes.**

In a five month continuous observation of a women's surgical ward nurses were recorded as handling bedstead facilities three-and-a-half times as often as all other classes of user added together. The second most frequent handler of bedstead facilities was the patient. Since the overwhelming majority of nurses and a large number of patients are women and since many procedures have to be carried out by one person working alone, it is essential that all bedstead adjustments, attachments and detachments should be capable of being carried out by one woman working alone.

The motorisation of the heavier movements, such as height adjustments and back support adjustments, would ease the load on the nurse, and in suitable circumstances would make it possible for patients to adjust, for example, their own sitting positions with less frequent call on nurses' time. Evidence suggests that motorised bedsteads may become more common in hospitals in the course of time. This specification covers motorised as well as non-motorised bedsteads. However, a motorised bedstead must still be capable of use in emergency circumstances, for example, emergency tilt may be required while the bed is mobile or in a lift, and such circumstances may include momentary or prolonged local or general deprivation of access to an appropriate power source. Hence a motorised bedstead must be capable of operation independent of external power aids if required.

Evidence suggests that where a loose appliance, say a handle or key, is required for the operation of a bedstead or other facility, that facility is likely to be less used.

General references: see lists of sources
Specific references: see 1.3, 4.1, 6.5.

Appendix C

Statement 8: **Methods of use shall be either obvious or easily learned; the model number, month and year of manufacture, and manufacturer's name shall be on the bedstead; instructions for use, and directions covering assembly, maintenance, and the identification and rectification of minor faults, shall be provided.**

Enquiries revealed a number of instances where hospital equipment was recorded as having been wrongly handled due to ignorance not only of the correct method of use but also of the amenities offered by the equipment. For example, a case was found in a ward in which adjustable bedsteads had been regarded as non-adjustable for a considerable period. Difficulty in use had led to disuse, and disuse had led to ignorance that the facility was available. Cases were also found of equipment having been wrongly assessed by procurement or selection bodies in hospitals, or wrongly assembled on delivery.

In an ideal situation both the existence of a facility and its method of use would be self-evident. In reality, this is difficult to achieve completely in the design alone without adding substantially to its cost. The deficiency would be partially remedied by the manufacturers supplying adequate descriptions of their products. These would be in two parts – directions covering assembly, maintenance, and the identification and rectification of minor faults for the benefit of hospital supply, portering and maintenance departments; and instructions for use, presented in a form suitable for permanent display in ward offices.

The presence on the bedstead of the maker's name, model number and date of manufacture assists in the management of evaluation, procurement and maintenance, and makes it possible to associate the bedstead with the correct set of directions and instructions.

General references: see lists of sources
Specific references: see 1.3, 1.7, 5.6, 6.4, 6.5, 7.33.

Appendix D

Statement 9: **The mattress together with the mattress support shall provide a posturally correct, comfortable and hygienic surface for the patient to lie or sit upon.**

Statement 10: **The mattress support shall be a flat and rigid surface with minimum interruptions consistent with ventilation of the mattress and drainage of spilled liquids.**

In a study on spine displacement in bed it is stated that body alignment is dependent on 3 factors: height and weight of people + kind of mattress + kind of support. Heights and weights will vary; and the mattress alone cannot be expected to provide the total support necessary. Thus the form of support under the mattress is critical.

Too yielding a surface, whether through softness or sagging, will impede movement and the effort to move may disturb the sleeper. 'Whether he be normal or ill the bed must not resist nor handicap turning' (Sleep Research Foundation). 'A firm level surface permits good alignment of the body and promotes good physiological functions of the body system . . . alignment is poor when lying on a sagging bed' (Protective Body Mechanics). The disadvantages of a yielding surface become more critical for a hospital patient. The surface may 'wrap round', restricting body ventilation, and the bedclothes may wrinkle. With heavy patients greater resilience may be required of the mattress but a yielding support will only aggravate the disadvantages. Nursing opinion is in agreement that patients prefer a firm support, even if the bed feels harder than the one to which they are accustomed. A number of treatments have been quoted, including those for cardiac arrest, lumbar puncture and fractures, which require an extremely firm surface. When the support is not firm enough, fracture boards may be laid under the mattress; the patient may even in emergency be laid on the floor.

A flat rigid support for the mattress has been in use in hospitals abroad for several years, and although not yet the general practice in Great Britain, there is a significant trend in that direction. One manufacturer claims that a rigid base is requested in 30–40 per cent of the firm's sales. Another, who specialises in reconditioning hospital beds, reports 'an increasing demand' to replace bed springs with metal sheet. Those hospitals where rigid supports have been in use for periods of more than one year report

general satisfaction, and several Regional Hospital Boards have included the requirement in specifications.

The experimental prototype bedsteads observed in use for three months in a hospital ward had a flat, rigid support for the mattress and the following advantages were noted by the staff: 'a) beneficial to both the conscious and the unconscious patient, prevented mattress sag and provided greater comfort and freedom of movement; b) beneficial to medical and nursing staff in providing a firm surface on which to carry out patient examinations and treatments; c) suitable for spinal injuries and fracture cases; d) eliminated tearing of bedclothes and scratching of hands; e) facilitated cleaning'.

Only one objection was recorded: that a rigid surface was a contributory factor to pressure sores. In an attitude survey more patients using the prototype commented that the bed was hard than those using a conventional bed with a diamond wire mesh base. This was not reflected in general comments on comfort for the two designs. The work study team have pointed out that it was difficult to assess how much of this discomfort was due to the patient's physical condition, to the mattress, or to the mattress support.

Although hospital mattresses are frequently contained entirely in water- and vapour-proof envelopes this is not an invariable practice and in the future covers may be developed which are vapour permeable. It is desirable that humid air shall move freely away from beneath the patient's body, and mattresses are designed to allow this. The mattress itself therefore requires ventilation and any surface it rests on should permit ventilation of its lower surface. Similarly spilled liquids should not be permitted to drain down and remain beneath the mattress.

Statement 11 : The mattress selected shall be suitable for use on the mattress support.

Mattress materials and construction were not included in the bedstead study. (A Ministry of Health working party on the design of mattresses was sitting at the time of publication of this report.) Before, however, a flat and rigid support could be specified it was necessary to ascertain that mattresses suitable for use on it were available.

A survey of British manufacturers produced the names of seven who claimed that their product satisfied the requirements, that is, provided sufficient local softness and general resilience for use on a flat and rigid support, and retained their properties for a reasonable length of time under hospital conditions, including autoclaving. They were: 2 spring interior, 1 latex foam and 4 plastics foam. A foreign survey showed that those countries using flat and rigid mattress supports had no difficulty in obtaining suitable mattresses.

General references: see lists of sources
Specific references: see 1.7, 3.5, 3.9, 3.31, 4.1, 4.6, 4.11, 6.2, 6.3, 6.4, 6.13, 6.14, 6.15, 7.6, 7.7, 7.11, 7.13, 7.22, 7.23, 7.43.

Appendix E

Statement 12: **Means shall be provided for retaining the mattress and bedclothes in position.**

Statement 13: **The surface of the mattress support shall not present a hazard to the hands of attendants or to the bedclothes.**

Not only must the mattress be supported, but it must remain in position on the support under conditions such as bedmaking, movement of the bed, and height and tilt adjustments. Also it must be possible to tuck in the bedclothes so that they remain in position under the same conditions. A common criticism of the conventional wire mesh type of mattress support was that frequently it could cause injury to hands and damage to bedclothes.

On the experimental prototype bedsteads used in hospital ward trials the retention of the mattress was achieved by a small upstanding rim round the edge of the support. Although this was judged to retain the mattress satisfactorily, there were criticisms that dust could collect in the corners and that the rim bruised attendants' knuckles. This last became less of a hazard with use, when nurses were taught to withdraw their hands palm down. A minority of the staff commented that due to the slippery surface of the support the bedclothes were not always retained.

General references: see lists of sources
Specific references: see 4.1, 5.6, 6.2, 6.3, 6.4,

Appendix F

Statement 14: **The length of the clear space above the mattress support between the headend and footend structures shall be 6ft 7in (201 cm). Preferably it should be capable of extension to 7ft 2in (218 cm).**

Statement 15: **The overall length of the mattress shall be 6ft 5in (196 cm).**

Statement 17: **The overall length of the bedstead when unextended shall not exceed 6ft 10in (208 cm) and when extended shall not exceed 7ft 5in (226 cm).**

Ideally the 99 percentile man should be able to lie in bed in any posture. The longest posture is prone. Although the supine posture involves a shorter foot extension than the prone, it requires an additional allowance for the 'tenting' of the bedclothes over the feet and probably does not permit a materially shorter lying space, unless a 'tenting' device is incorporated in the bed configuration.

The frequency with which a 99 percentile man will occur who needs to lie prone for any length of time is not likely to be great, although any individual for satisfactory rest will need to be able to turn to the prone posture at times. However, tall people are accustomed to living in an environment primarily designed for people of lesser stature, and may be willing to accept reduced clearances. Therefore it may be postulated that the bed must be long enough to accommodate the 99 percentile man lying prone with at least the minimum clearance for rest.

Calculation

Standing height UK 99 percentile male, unshod	74 in	6ft 2½in
Possible increase in stature over 10 years	½in	
Increase in body length after 8 hours lying	1 in	
Foot extension, prone, 75 percentile	4 in	
Head clearance, prone, 25 percentile	2¾in	9¼in
Foot clearance, including thickness of bedclothes	1½in	
	83¾in	
Therefore: inbed length, say	84 in	7ft

Calculation continued overleaf

Maximum allowance for head and footpiece thickness	3 in	
Therefore: overall bed length	87 in	7ft 3in

But a bed 7ft 3in (221 cm) overall is too long for many existing hospitals and most projected architectural planning. Therefore, if the 99 percentile man is to be catered for, it must be by providing for extension on a shorter, standard length.

In determining a shorter bed length it could be postulated that, in order not to inconvenience ward staff, not more than, say, 25 per cent of beds should need to be used at any given time in an extended state. In this case obstruction to doorways, etc., in 4-bed, 6-bed and open wards can be avoided. With a higher proportion extended, obstruction is likely to occur. Thus it can be argued that the 75 percentile man should be able to lie in the unextended bed.

Since the demand for bed extension will arise from the 75 percentile onwards, the 75 percentile man should be accommodated at the minimum comfort clearance.

Calculation

Standing height UK 75 percentile male, unshod	69 in	5ft $9\frac{3}{4}$in
Possible increase in stature over 10 years	$\frac{3}{4}$ in	
Minimum clearance for rest (see above)	$9\frac{1}{4}$ in	
Therefore: inbed length	79 in	6ft 7 in
Maximum allowance for head and footpiece thickness	3 in	
Therefore:		
overall bed length, not more than	82 in	6ft 10 in
mattress length	77 in	6ft 5 in

The mattress length is calculated by deducting from the inbed length the thickness of the bedclothes at the foot of the bed + the thickness of a hand, say 2in (5 cm).

This inbed length calculation of 6ft 7in (201 cm) can be compared with the proposed new Swedish standard giving an inbed length of 6ft 9in (206 cm). An experiment conducted by the architects' division at the Ministry of Health indicated that beds 6ft 10in (208 cm) long could be used in cubicles conforming to their recommended dimensions. The manoeuvring of a bed of this length through ward doorways, recommended width 4ft 8in (142 cm), to and from corridors, recommended width 7ft (213 cm), though not easy, is possible even with a member of staff accompanying the bed at the side. The British Standard for electric hospital lifts requires inside dimensions of 7ft 9in × 5ft 1in (236 cm × 155 cm) with an entrance clearance of 3ft 10in (117 cm). If there is a handrail (maximum $1\frac{1}{2}$in, 3·8 cm) this area may be decreased to 7ft 6in × 4ft 10in (229 cm × 147 cm). Again, though not easy, it is possible to manoeuvre a bed of 6ft 10in in and out of this area. It is probable that an increase, at least in the length and entrance dimensions of lifts, will be recommended in the near future.

With regard to the requirements of the 99 percentile man, it can be argued that if extendibility is present at all the extended inbed length could be increased by 2in (5 cm) to provide normal rather than minimum comfort clearance.

Therefore:

inbed length extended	86in	7ft 2in
overall bed length extended, not more than	89in	7ft 5in

The actual proportion of beds used extended in a given ward at a given time will be determined by the interaction of patient comfort and staff convenience.

Statement 16: **Preferably it should not be necessary to use a different mattress when the inbed length is extended.**

There is little value in having a bed which can be extended in the ward for the taller patient, if a longer mattress has to be brought from a store. In this situation the taller patient will often simply be nursed in the unextended bed. The experimental prototype bedsteads extended at the headend, and were provided with a folding pillow rest beyond the end of the mattress, obviating the need for an extra piece of mattress. During three months use in a ward this was judged acceptable, but many other methods are possible.

General references: see lists of sources
Specific references: see 1.4, 2.8, 3.2, 4.1, 4.7, 4.14, 6.3, 6.10, 6.11, 7.33.

Appendix G

Statement 18: **The overall width of the mattress shall be 2ft 10in (86 cm).**

Evidence shows that limitation of the overall width of mattress and support is critical in the design of hospital beds. One authority in fact computes an ideal working width as narrow as 2ft 4½in (72 cm). At the same time it is difficult to prove that a traditional mattress and support will provide the comfort and permit the free movement, particularly turning, essential to healthy sleep at a width less than about 2ft 9in (84 cm). Moreover, the nursing problem of turning an obese patient becomes acute on a narrow mattress. The reconciliation of these requirements in present practice lies between 3ft (91 cm) and 2ft 9in (84 cm).

However, a well designed mattress on a firm flat base, and a bed which can be set at a low height whenever necessary and for which safety sides are readily available, undoubtedly permit easier and safer use of the full width of the mattress. On this basis a width of 2ft 10in (86 cm) overall was judged suitable and this width of mattress was used in the design of the experimental prototype bedstead.

For comparison it may be noted that the width of mattress in the proposed new Swedish standard is approximately 2ft 9½in (85 cm).

Statement 19: **The mattress support shall be as narrow as possible but it shall not be less than the width of the mattress.**

Statement 20: **The overall width of the bedstead shall not exceed 3ft 2in (97 cm). Preferably the overall width should be less than 3ft 2in (97 cm).**

A support slightly wider than the mattress is thought to assist tucking-in movements; and some dimensional freedom is needed to permit development of suitable ways of retaining lightweight mattresses and to permit innovation in the design and mounting of folding safety sides which are at present generally unsatisfactory. On the other hand, the greater the width of the bed the greater the strain on nurses reaching over the bed, especially in lifting. A further constraint is provided by the dimensions of doorways, corridors, rooms and lifts. (For relevant dimensions see Appendix F.) In the light of experiment an overall maximum of 3ft 2in (97 cm) has been adopted.

General references: see lists of sources
Specific references: see 1.4, 3.14, 4.7, 5.6, 6.2, 6.4, 7.24.

Appendix H

Statement 21 : **There shall be a minimum depth of structure below the side edges of the mattress for a sufficient distance inwards to allow an attendant to adopt necessary postures requiring the knee and thigh to project under the mattress edge, or to sit without difficulty at the bed. Preferably the depth of structure should not exceed 2in (5 cm). Preferably there should be a similar clearance at the headend.**

In order to facilitate certain nursing procedures, both standing and sitting at the bedside, and particularly those involving lifting the patient, it has been postulated that 'the mattress and platform elements should be sufficiently shallow to permit the knee to project under the plan'. An experiment conducted at a London teaching hospital showed that the 'ideal height beneath the side edge of the mattress support would be 34in (86 cm) but that 30½in (77 cm) would serve up to the 80 percentile nurse'. The top of the uncompressed mattress is not required to go higher than 34in (86 cm), although 36in (91 cm) is preferred (see Statement 33). Even with the mattress at 36in (91 cm) a clearance of 30½in (77 cm) below the support leaves a depth of only 5½in (14 cm) for both the mattress and its support. Assuming that the mattress is 4in (10 cm) deep, this leaves less than 2in (5 cm) for depth of structure if the tall nurse is to be accommodated.

Unfortunately it was not possible, during the ward observations, to use a mattress of the recommended depth on the experimental prototype bedsteads. The structural depth below the mattress at the sides was 1in (2·5 cm) but with the 7in (18 cm) mattress this gave a total of 8in (20·5 cm). Three-fifths of the ward staff did not consider that the clearance was sufficient when carrying out procedures at the bedside (but three-quarters of these mentioned the foot-pedal as the hindrance and so it was not possible to assess the depth independently). The work study team responsible for the trials commented that the 4in (10 cm) inwards clearance 'did not provide sufficient knee room for nurses sitting at the bedside feeding bedfast patients'. Although a number of constraints are involved in achieving a minimum depth of structure, it is critical for the well-being of hospital staff and must be achieved as closely as possible.

In Appendix X it is shown that patients will occasionally be attended from behind the headend of the bed. Often this attention will be given standing, but it is an obvious advantage to be able also to sit.

Statement 22 : **The uncompressed mattress shall be as thin as possible. Preferably it should not exceed 4in (10 cm) in depth.**

In the survey of British mattress manufacturers (to determine availability of mattresses suitable for use on a flat and rigid support) the requirement for the mattress to be no more than 4in (10 cm) thick was included. (For results of the survey see Appendix D.) One bedstead manufacturer, specialising in electrified double-breaking rigid-base beds for home use, and restricted by the configuration, has supplied 4in (10 cm) plastics foam mattresses for many years. A number of the British hospitals having rigid base beds use 4in (10 cm) mattresses. A disadvantage quoted is that, due to light weight, the mattress tends to move too easily on the mattress support. (See Statement 12.)

General references : see lists of sources
Specific references : see 1.7, 3.7, 3.15, 4.1, 6.2, 6.3, 6.4, 7.3, 7.6, 7.7.

Appendix I

Statement 23: **Means for supporting the head and trunk of the patient shall be provided for postures in addition to lying flat.**

Enquiry into the basic features required of a hospital bed quickly established the need for back support, so that a patient can rest in postures other than lying flat. Many methods of providing back support were in use, and each method had strong advocacy based on personal knowledge and experience. Conversely, attention was drawn to the disadvantages of each method. The consensus of opinion was twofold: adjustable back support is required; no existing solution is completely satisfactory.

Pillows will probably always be used, whether in conjunction with a structure or not, due to the wide range of body shapes to be accommodated and positions required. But where structure is incorporated as part of the support it should be an integral part of the bed. The reasons for this are the same as for other additions to the bed facilities such as bed strippers and safety sides: cross-infection, storage, wastage of nurse time and effort. The constraints are also the same: when not in use it must not obstruct any activities, must remain on the bed, must be easy to clean, quiet, and must not involve more than one attendant to adjust.

The two most common structural types in use are the 'pull-out' and the 'rising-base'. A question designed to discover if there were any significant preference between these two was included in a television enquiry. The explanatory film was cut and the answers therefore were not valid. Nevertheless, many hospital staff marked their preference, based on personal experience, and opinion was equally divided.

The provision of a 'knee-break' in the mattress support to allow a chair-like configuration was put forward to take account of the problem of the patient's slipping down the bed and the fact that a sitting position with straight legs is unnatural. But again opinion was so divided on the advantages and disadvantages that without a lengthy, medically controlled investigation no conclusion could be drawn. Its omission from the widely circulated preliminary specification elicited very few comments and these were based on personal experience rather than measured evidence. (In Appendix T attention is drawn to the fact that a small degree of foot-high tilt can be used to increase the comfort of the sitting or reclining patient.)

A more detailed investigation and analytical comparison of all methods advocated only emphasised the depth of division in opinion. Clearly it was not enough to state that back support must be provided; more data were needed before the requirements could be adequately identified. It was thought that extensive and detailed observation of actual use might provide such data. The experimental prototype bedstead permitted the use of several methods, and provided both 'pull-out' and 'rising-base' supports.

Daily, during the five months in which observations were recorded in a ward, six rounds were made at random times between 6.00 am and 10.00 pm when the position of each facility was noted. During the first and fifth months, when a conventional bed was in use, the 'pull-out' back support was recorded in use 49 per cent of the time. (This bed had no 'rising-base' facility.) During the middle three months, when the prototype was in use, the 'pull-out' back support was recorded in use 46 per cent of the time and the 'rising-base' 16 per cent. As the two structures were not used together, this represents a total of 62 per cent of the time. The observations were made during the autumn and early winter in a women's surgical ward, but there is no reason to think that the facilities would have been used less in many other kinds of wards. In the case of the 'rising-base' there is reason to think the reverse. Its use showed a steady increase through the three months (13 per cent, 16½ per cent, 17½ per cent) and may not have reached optimum usage. The work study team responsible for the trials have stated: 'The patients themselves learnt to use the 'rising-base' and many preferred to sleep with the 'rising-base' slightly raised instead of arranging 2–3 pillows'. It is felt that this usage could be higher in a medical ward and in late winter and early spring, particularly by patients with respiratory difficulties.

This evidence confirms that the back support facility is in use for a high percentage of the time, and the satisfactory provision of the facility is thus critical. It may also be concluded that methods of providing it complement rather than replace each other. (It must be remembered that any structure at the headend of the bed is governed by Statement 50.)

General references: see lists of sources
Specific references: see 1.5, 1.7, 4.1, 5.1, 6.2, 6.3, 6.4, 6.12, 7.14.

Appendix J

Statement 24: **The angles of back support shall be at least from 0°–20° and from 50°–90° from the plane of the mattress support. Preferably angles of back support from 20°–50° should also be provided.**

The selection from the full range of 0°–90° of two preferential areas for back support is based on two major kinds of evidence: first, the dichotomy of opinion concerning the two most common types of back support in use. It has been argued in Appendix I that these two types are complementary. If there were not a wide demand for each type there would not be such an equal division of preference. Second, observations of the use made of the angles provided by the experimental prototype bedstead during three months use in a ward. On the prototype the 'rising-base' provided angles from 0°–24° and the 'pull-out' provided angles from 40°–90°.

High angles. The 'pull-out' back support was in use for substantially the same amount of time on both types of bed (conventional 49 per cent, prototype 46 per cent). The prototype 'pull-out' was recorded in use half-extended (65°) for 78 per cent of the time and fully-extended (40°) for 22 per cent of the time. It is known that the prototype 'pull-out' tended to creep down the bed when only half-extended and the work study team have stated that towards the end of the period the staff preferred to extend it fully and sit the patient more upright, if required, by using extra pillows. The conventional 'pull-out' back support was recorded half-extended for 92 per cent of the time.

Low angles. The 'rising-base' on the prototype was recorded on average in use for 16 per cent of the time. This represents use of back support in addition to and not in place of the 'pull-out' type, and it has been argued in Appendix I that this may represent minimum usage. During the three month period of the trial the recordings of usage were equally divided between fully-raised (24°) and half-raised (12°). However, figures by the month reveal that use at the fully-raised position decreased (63 per cent, 50 per cent, 38 per cent) and that use at half-raised increased (37 per cent, 50 per cent, 62 per cent). The work study team state that the nursing staff became more adept at adjusting the facility over time and so were able to be more selective.

General references: see lists of sources
Specific references: see 1.7, 4.1, 6.3, 6.12.

Appendix K

Statement 25: **There shall be a positive means for retaining securely in position on the back support some of the pillows and padding necessary for the patient's posture and comfort.**

Among the first requirements to be particularly stressed was that of retaining at least some of the pillows in position when a patient is sitting up, irrespective of the form of back support. It was quoted as an advantage of the railed type of support that pillows could be tucked in between them. One disadvantage pointed out was that if the patient slips down the bed and the pillows remain *in situ* they are no longer in the right configuration, neither should the way in which they are retained hinder a nurse adjusting them slightly when attending the patient. But obviously it is not enough to rely solely on the weight of the patient to keep them in position.

Two experiments were cited in which straps had been used. (One had not been completed, but the other was thought to have been proved successful.) The experimental prototype bedsteads provided two straps on the 'pull-out' back support that enabled pillows to be retained at two levels, approximately lumbar, and head and shoulders. The work study team responsible for ward trials noted that 'in practice the nurses normally used the lower sling, but rarely both'. The reasons given were the extra time and effort involved, and that it was not easy to position the pillows in the upper sling to suit the patient. This confirms an earlier comment that a loose 'soft neck pillow' is appreciated. Also a nurse found it difficult, on her own, to sit the patient up and at the same time fit pillows in the slings, particularly as she had to go to both sides of the bed to adjust the two straps. Nevertheless, the use of the slings when sitting a patient up increased during the period, probably due to the undoubted benefit to the patient in the opinion of both patients and staff.

In an attitude survey conducted among the patients in the women's surgical ward 57 per cent of those using the conventional railed type of support experienced difficulty with their pillows as compared with 25 per cent using the experimental prototype. The sample was a small one and not too much weight should be given to the difference of 32 per cent but it can be taken as indicative of a real problem to some extent ameliorated by pillow slings. At the same time, the straps increased the work for the nurse in those activities, such as stripping and making empty beds and preparing allocated beds, which had no

direct benefit to the patient. Thus a defective design solution can add to the nurse's work-load.

The requirement has been demonstrated as worth satisfying, and designs offered must be assessed regarding both the patient's and the nurse's convenience.

General references: see lists of sources
Specific references: see 4.1, 4.11, 6.2, 6.3, 6.4, 6.12.

Appendix L

Statement 26: **Use of back support shall cause minimum displacement of the patient's head and shoulders from the headend of the bed and shall, with mattress and footend on the bed, leave a clear length of at least 3ft 9in (114 cm) for the patient to sit in.**

Statement 27: **No form of back support when in use shall cause the mattress or the bedclothes to form ridges or folds beneath the patient.**

Many designs of back support structure when in use support the patient in a sitting position at a distance from the headend of the bed. This displacement, if excessive, may hinder the patient's access to light switches, or other wall-mounted services, and frequently requires that the locker be moved correspondingly, thus reducing the working area around the bed. Also many designs make severe demands upon the space in which the patient actually sits.

Sitting space calculation

Extended leg + buttock 75 percentile UK male	43 in	
Possible increase over 10 years	½in	
Clearance to footpiece	1½in	
	45 in	3ft 9in

This compares closely with the proposed new Swedish standard which implies a length of 49½in (126 cm) for the lower section of a breaking-base mattress support, from which must be subtracted a mattress depth of 4–6in, giving a sitting space of 45½–43½in (116–110 cm).

Designs which operate by raising part of the mattress support to form a 'backrest angle' tend, at the higher angles, to cause wrinkles in the bedclothes beneath the patient. Although hinged mattresses improve the situation, British nursing practice is to use beneath many patients thick absorbent draw sheets, if not thick waterproofs, and these are liable to wrinkle and fold in the angle, causing at times severe discomfort and possibly contributing to the development of pressure sores.

General references: see lists of sources
Specific references: see 1.7, 4.7, 6.4, 6.5, 6.12.

Appendix M

Statement 28 : **The back support shall be easily positioned by one person and such positioning shall be possible from both sides of the bedstead or from the footend.**

Statement 29 : **The action of the back support adjustment shall be light and smooth, and it shall not jam, even momentarily, under conditions of hospital use.**

Statement 30 : **When adjusting the back support it shall be possible for the operator to adopt a correct posture and work without strain.**

It has been pointed out in Appendix I that considerable care was taken by everyone consulted to draw attention to the disadvantages of existing methods of providing back support. This was emphasised by a five month ward trial in which the back support facilities of both the conventional beds and the experimental prototype bedsteads were seriously criticised for a range of mechanical and design faults. The criticisms of both types are listed below in detail to illustrate the complicated and in some cases conflicting requirements of this facility.

Pull-out: mechanism failed; came out of sockets; failed to stay in position, impeded by mattress, tended to creep down the bed, (leading to) angle wrong when fully extended, (and) extra pillows required to support head, 3 extension positions a limitation and extra pillows often required; surface slippery, pillows slipped, patients slipped down the bed; disturbed the patient, patient had to be moved, bed length reduced 23in (and) 24in; difficult for one nurse to operate, strain for one nurse to operate, gave operator backache, too wide for arm span (of nurse), awkward long arm reach to release catch, nurses required adequate practice; cumbersome, too big, heavy, hard, noisy, high, (leading to) obstructed view of nurses moving the bed; difficult to stow, slipped if not stowed correctly, no provision to stow (when removed from bed), when rapid access required (unless first stowed) swung loose and struck patient or pinched nurse's fingers; bars presented considerable surface to clean, corners formed dust traps, snagged bedclothes and nurse's fingers; did not provide handhold for patient or for propelling the bed.

Rising-base: mechanism failed, mechanism jammed; bed length shortened, pillows fell off the top; weight of patient caused difficulty in adjustment unless two nurses available, two nurses required to lower, could not be lowered from both sides of the bed; knob of release mechanism protruded and its use required effort and caused discomfort (to the nurse and patient); elusive (mechanism obscured).

Despite this catalogue of faults the general attitude was not one of condemnation but of resignation. 'No worse than the old type.'

Observations in the ward showed that, in addition to its being in use a great deal, the back support facility was frequently adjusted. With the conventional bed it accounted for 61 per cent of all adjustments; with the prototype, which had many additional features, the 'pull-out' back support accounted for 23½ per cent and the 'rising-base' for 10½ per cent of all adjustments. It is recognized that nurses are adaptable and may even endanger their own well-being if that of the patient is concerned. With a facility that accounts for such a high percentage of all adjustments the need for it to be easy, reliable and operable without strain, is vital. This specification draws particular attention to these requirements in the hope that future designs will be subjected to stringent assessment.

General references : see lists of sources
Specific references : see 4.1, 6.2, 6.3, 6.4, 6.12, 7.6.

Appendix N

Statement 31 : **There shall be on the bedstead means for positioning the mattress and mattress support at various heights.**

The most common fixed height for hospital beds including the mattress lies between 26–30in (66–76 cm) and represents a compromise between the needs of the patient and those of the nursing and medical staff attending them.

There is considerable world-wide concern over the number of accidents to patients in hospital and a high proportion of them are closely related to the bed area. The Ministry of Health monthly bulletin for December, 1963, quotes: '54 per cent of all accidents occur in the vicinity of the bed and could be lessened by having adjustable beds . . .' At a USA conference on hospital safety in 1961 it was reported: 'One out of every 40 persons admitted to hospital this year will either fall out of bed or fall in the bathroom . . . almost two-thirds of all patient injuries occur within 10ft (3 m) of the bed'. Another cause for concern is the rate of injury among nursing staff, particularly back injury. A high percentage of these are related to attending and lifting patients in bed, or into and out of bed.

The compromise of a fixed height bed not only fails to satisfy the needs of either category of user, but it constitutes a potential danger for both.

The response to the question in a television enquiry 'Should the bed be capable of height adjustment?' showed 97 per cent of nursing staff and 85 per cent of medical staff in favour.

The experimental prototype bedsteads used in a women's surgical ward for three months provided an 18in (46 cm) range of height adjustment. At the beginning of the period the most frequent height recorded in use approximated closely with that of the conventional hospital bed, but the use of this height decreased. The figures for the three months are 41 per cent, 24 per cent and 19 per cent.

General references: see lists of sources
Specific references: see 1.7, 3.16, 3.31, 3.41, 4.1, 5.1, 6.3, 6.4, 6.5, 6.9, 7.1, 7.6.

Appendix O

Statement 32: **There shall be a low position for the mattress and mattress support of less than 20in (51 cm) from floor to top of uncompressed mattress. Preferably there should be a low position of 18in (46 cm).**

Accepting that height adjustment shall be provided, the limits to the range must be determined. Many accidents occur when a patient falls or slips getting into or out of bed. Most domestic beds are lower than the fixed height hospital beds and patients may be confused, or especially at night forget where they are and not be able clearly to see the floor. Also, the trend towards early ambulation means that many patients are encouraged to leave the bed before they have regained their normal ease of movement and stability.

The lower limit should satisfy the small female patient.

Calculation

Seat height of 10 percentile UK female, 60–90 years old	14 in
Allowance for compression of the mattress edge	2 in
Allowance for slope of the thigh	1½in
Therefore lower limit	17½in

A similar calculation for the 18–40 year age group gives a height of 18in (46 cm). An American report gives 20–21in (51–53·5 cm) as a result of actual experiment, but there could be up to 1in (2·5 cm) difference in the relevant dimensions between USA and the (lower) UK figures.

The experimental prototype bedstead was designed to have a low limit for the mattress support of 14in (36 cm) which with a 4in (10 cm) mattress gave a height of 18in (46 cm). Due to the thickness of the mattress used (7–7¾in, 18–19·5 cm) and the variations in the prototype mechanisms the low limit obtainable during the ward trials varied between 19in and 23in (48–58 cm). The method of recording measurements of height allowed for tolerance, and the recording 20in (51 cm) covered 19–23in. Thus recordings for that height can be taken to represent use of the lowest height available. During the three months in which the prototypes were in the ward the use of the lowest height increased in all dependencies and

dramatically so in the ambulant and semi-ambulant groups.

	months		
	1st	2nd	3rd
	per cent	per cent	per cent
Totally ambulant:	·3	26	50
Partially bedfast:	10	27	45
Bedfast, not helpless: / Bedfast, partially helpless:	8	16	28
Bedfast, totally helpless:	3	3	14

The work study team have cautioned that these figures conceal a certain amount of misuse of the facility. And it is known that where the mechanism is faulty or difficult or time-consuming the bed tends to remain at one height. Nevertheless, other observation records show that the proportion of time spent out of bed by patients in the categories bedfast, not helpless and partially helpless, increased when height adjustment was available. For the 2 months with the conventional bed the totals were 9 per cent and 8 per cent. For the 3 months with the experimental prototype the totals were 22 per cent, 23 per cent and 18 per cent.

The fact that in the third month 54 per cent of the patients (that is to say the percentage of totally ambulant patients during the month) had their beds at the lowest height available for 50 per cent of the time indicates that with a normal curve of distribution, had 18in (46 cm) been available it would have accounted for a significant percentage of the use. However, the work study team and the ward sister are satisfied that the position of 20in (51 cm) was adequate for all the patients who used the bed during the trials. In the attitude survey 60 per cent of male and female surgical patients on a conventional bed reported difficulty getting into and out of bed. With the prototype, only 9 per cent of the female surgical patients reported difficulty. (No male patients were nursed on it.) It is possible that in a geriatric ward this percentage might be higher.

General references: see lists of sources
Specific references: see 3.14, 3.31, 4.1, 4.11, 6.2, 6.3, 6.4, 7.24, 7.31, 7.48.

Appendix P

Statement 33: **There shall be a high position for the mattress and mattress support of not less than 34in (86 cm) from floor to top of uncompressed mattress. Preferably there should be a high position of 36in (91 cm).**

Whereas the needs of the patient determine the lower limit of height adjustment, the upper limit should be related to the needs of the staff, nursing and medical. Medical staff will always include a number of men and medical attention is often critical and intricate. In respect of suitable working height the requirements of the female staff will fall within those of the male. Therefore, ideally, the upper limit would be determined by the tall male. However, only a minority of the work done at the bedside will involve tall men in delicate work and a more realistic limit would be related to the tall female.

An American study has arrived at the following calculation.

Calculation

Height, elbow to floor of (approx.) 90 percentile USA adult female	43in
Average thickness of shoe heel	1in
	44in
Less allowance between elbow and working height	2in
Less average body thickness (of patient)	6in
Therefore working height, floor to top of uncompressed mattress	36in

Other relevant figures include: Swiss recommendations for height of work surface for person standing 33in (84 cm); British Standard height for patients' trolleys 36in (91 cm) and dressings trolleys 34in (86 cm) and high bench height or worktop height 36in (91 cm); and the clearance requirement beneath the mattress support discussed in Appendix H of 30½in (77 cm).

Although the experimental prototype bedstead was designed to provide an upper limit of 36in (91 cm), due to the depth of the mattress used, 40in (102 cm) was in fact obtainable. During the three months of use in the ward the upper height ranges were rarely used. The work study team responsible for the trial concluded that 'bedfast patients need a range of heights from about 24in (61 cm)

to 31in (79 cm) and less frequently up to 34in (86 cm)'. On the strength of the trial statistics alone, it would be unrealistic to specify a higher limit. But the comments of staff should be taken into account, as well as the fact that a number of mechanical failures detracted from the overall benefits. The medical staff are reported as finding that 'it eliminated much of the back strain when examining or carrying out medical procedures'. The nursing staff judged that the height adjustment was not used as frequently as it might have been because of the operating time involved (for raising), shortage of staff and sometimes 'it was not considered worthwhile to alter the height of the bed but was easier to bend'.

If the upper limit of height adjustment is to satisfy staff needs, then, given adequate means of adjustment, it should eliminate any unnecessary bending.

General references: see lists of sources
Specific references: see 2.5, 2.20, 2.21, 3.14, 3.50, 4.1, 6.3, 6.4, 6.11, 7.31.

Appendix Q

Statement 34: **Intermediate heights shall be obtainable. Preferably all intermediate heights should be obtainable.**

Although the lower range of height provided by the experimental prototype bedsteads was the most frequently used during three months of ward trials, probably because 54 per cent of the patients were ambulant, there was a considerable scatter throughout the range. The work study team responsible for the trials summarised: 'Bedfast patients need a range of heights from about 24in (61 cm) to 31in (79 cm) and less frequently up to 34in (86 cm); ambulant and semi-ambulant patients need a range from about 20in (51 cm) to about 31in (79 cm). Patients with head and spinal injuries especially benefit from beds which can be adjusted from 27in (69 cm) to 32in (81 cm)'. They also drew attention to the fact that at the beginning of the trial unallocated beds were placed at a height of 28in (71 cm), approximately that of the conventional beds, but by the end of the trial the tendency had grown to leave them at 24in (61 cm), the more acceptable height for receiving emergency stretcher cases.

General references: see lists of sources
Specific references: see 1.7, 4.1, 6.3.

Appendix R

Statement 35: **The movement of height adjustment shall be smooth, and the rate of movement shall be acceptable.**

Statement 36: **Preferably height adjustment should be foot operated.**

In order to be acceptable to the patient, the movement of height adjustment must be smooth, free from jerks and not too fast. On the other hand, in order to be acceptable to the attendant, actuation must not be too heavy nor the movement too slow.

The experimental prototype bedsteads used during three months of a ward trial raised the mattress support $\frac{1}{2}$in (1·3 cm) for each 6in (15 cm) movement of the height adjustment pedal. This was acceptable but not ideal; small minorities of nurses commented, either that it was too slow or too jerky or too tiring. A rise of $\frac{5}{8}$in (1·6 cm) per pump would probably have been the optimum rate of rise, particularly if the mattress and the support structure could have been lighter (54 lb + 150 lb (24 kg + 68 kg) in the prototype). A steady rate of descent seems acceptable at between 5 and 10 seconds for 18in (46 cm) of travel.

Numerous observations of hand operated height adjustment have shown that the amount of work involved in raising a patient through, say, 12in (30 cm) is such that nurses frequently neglect its use. In conventional mechanisms, either the force required or the number of turns required is too high for convenience. Industrial work study experience would indicate the need to consider the transferring of this work to the leg muscles, which are much stronger.

The argument for pedal operation was approved by 80 per cent of the hospital participants in a television enquiry, and appears to have been borne out in the trials where the facility was used during the final month with the prototypes on average four times per day per bed. There is evidence that this is a very much higher usage than is experienced when most winding handle types of adjustment are available.

The foot-pedal permits adjustment when the attendant's hands are washed or gloved for treatment, and this was commented on during the trials.

General references: see lists of sources
Specific references: see 1.7, 4.1, 4.6, 5.1, 5.9, 6.3, 6.5, 6.11, 7.6, 7.30, 7.31, 7.48.

Appendix S

Statement 37: **The operation of height adjustment shall not cause the mattress or the back support significantly to change its angle.**

Statement 38: **The adjustment of height shall not cause substantial horizontal movement of the perimeter of the bedstead. In any case, horizontal movement parallel to the length of the bed shall not exceed 2½in (6.4 cm). Preferably all such horizontal movement should be avoided.**

The requirement is for a bedstead which has more than 14in (36 cm) of height adjustment, is at its lowest height only 14in (36 cm) from the floor, and provides a tilt adjustment whose angle remains constant at all heights. The most economical mechanisms to answer this requirement usually employ swinging arm structures which cannot provide perfectly linear motion. For example, as the mattress support rises vertically its angle to the horizontal may vary slightly; similarly it may move slightly in the horizontal plane because parts of the raising mechanism are moving on a curve. Clearly such variations must only be very small. The limit for change of mattress support angle should be 1° approximately during rise or fall through full range of height, that is, bed set initially at 0° may vary between $+\frac{1}{2}°$ and $-\frac{1}{2}°$, or bed set initially at 7° may vary between $7\frac{1}{2}°$ and $6\frac{1}{2}°$.

Experiments in the design of mechanisms and in the ward suggest that the limit for horizontal motion of mattress support relative to a fixed point on the floor, should be 2½in (6·4 cm). For example, if at any point in the height adjustment motion the headend of the bed reaches an extreme distance from a wall of, say, 7in (18 cm), then it may at no other point in the motion approach the wall more closely than 4½in (11 cm).

General references: see lists of sources
Specific references: see 4.14, 7.33.

Appendix T

Statement 39: **It shall be possible to tilt the whole of the mattress support so that its footend is higher than its headend.**

Statement 40: **Foot-high tilt of between 5° and 7° shall be immediately obtainable, irrespective of the positions of other adjustable parts, and means for obtaining it shall be clearly indicated.**

Statement 41: **At least 12° of foot-high tilt shall be obtainable, although not necessarily over the full range of height adjustment.**

Statement 42: **Intermediate degrees of tilt shall be obtainable. Preferably all degrees of tilt from 0°–12° should be obtainable.**

The inclusion of a foot-raising tilt facility as part of the bed structure received 90 per cent approval in a television enquiry and this was confirmed during a five month ward trial in which, for the middle three months, the ward was equipped with experimental prototype bedsteads that had a tilting facility. Out of 5,216 recordings of usage with the conventional bed, tilt was in use on 429 occasions or 7 per cent of the time; out of 8,739 recordings for the prototypes tilt was in use on 2,961 occasions or 34 per cent of the time.

The need for a small angle of tilt to be achieved very quickly in emergency was insisted upon by many of the medical and nursing authorities consulted. (The constraints imposed by this requirement are discussed in Appendix W.) The trial proved that quick, easy and safe foot-high tilt is extensively used; about 96 per cent of all observations showed the angles to be in the range 0°–8°. Often this may have been used simply to improve the comfort of patients sitting up, and it may be that redistribution of weight counteracted a tendency to slip down the bed.

Other enquiries indicated that there is a significant general purpose requirement for angles of tilt up to 12° (18in foot-elevation) principally for postural drainage. As these extreme angles are used for short periods at a time it is possible that the comparatively small usage recorded during the trial only partially represents the actual usage.

The requirement for head-high tilt was examined and it was concluded that the facility was required rather rarely and demanded very cautious use, and that again the

maximum angle likely to be called for would be about 12°. It seems reasonable therefore to suggest that it should be possible, for example, by exchanging head and foot pieces or by other *ad hoc* measures, to make occasional head-high care possible. In many cases the availability of low angles of back support (see Statement 24) may eliminate the need to tilt the entire body.

The limited evidence for lateral tilt was carefully discussed, the conclusion being that its practicability in use was not sufficiently certain to justify its inclusion; the angles required may exceed 20°.

General references: see lists of sources
Specific references: see 1.7, 3.47, 4.1, 5.1, 6.3, 6.4, 6.7, 7.15, 7.39.

Appendix U

Statement 44: **It shall be possible to position the top of the uncompressed mattress, at the headend of the bed, between 26–28in (66–71 cm) from the floor, irrespective of the degree of tilt given, so that the patient's head and shoulders may be at nursing height when necessary.**

In the design of many height adjustable beds the position of foot-high tilt can only be achieved with the headend of the mattress at a height too low for comfortable nursing. This is usually done for simplicity in mechanical design. Nevertheless, it imposes an awkward posture on staff attending to the patient's head and chest.

General references: see lists of sources
Specific references: see 7.6.

Appendix V

Statement 45: **A means for indicating the degree of tilt shall be provided.**

As bedsteads satisfying this specification will no longer need blocks or separate elevators, both of which give more or less automatic indication of the amount of tilt, some means of indicating the angle of tilt must be available on the bed, conveniently visible for the person applying it. Although it is the practice with many people to measure tilt in inches, this is not a straightforward or reliable indication of the angle given, particularly for bedsteads with short wheel-bases or tilting mattress supports.

The provision of an indicator will facilitate consistent treatment and possibly encourage better evaluation of the effectiveness of the various angles actually used.

Up to 7° of tilt must be obtainable under all circumstances and the bed must therefore be positioned in relation to the wall so that application of 7° of tilt does not cause the bedhead to hit the wall. Greater amounts of tilt are not an emergency requirement, and if there is a likelihood of the bedhead hitting the wall the bed can be pulled out first. If the range up to 7° is clearly marked it will not only aid an inexperienced member of staff but it will also help prevent impact with the wall.

General references: see lists of sources
Specific references: see 1.7, 6.7.

Appendix W

Statement 46: **There shall be a smooth perimeter to the mattress support and superstructure of the bedstead. No part of the lower structure shall protrude beyond this easily visible perimeter unless it is capable of being folded away.**

There is work study evidence showing that trollied equipment damages buildings for two main reasons. Firstly, an irregular perimeter (for example, protruding nuts which hold the bumpers in position) causes gouging of vertical surfaces. Secondly, protrusions not easily visible to the person propelling the equipment (for example, brake pedals on a bed) collide with corners, door stiles, etc., with added force because the user believes he is well clear of the obstacle.

The configuration of a bumper or other protection at the headend cannot be specified in detail. It must be possible for the bed with lifting pole fitted, to be tilted to at least 7° foot-high without having to be pulled out from its customary position and therefore a clearance is required between the headend and the wall. This, for a bed with a headpiece 32in (81 cm) high (see below), can vary between 4in (10 cm) and 8in (20·5 cm) according to the design of the bedstead and the architectural details of the ward. To attempt to maintain this clearance by means of a projecting bumper has disadvantages. It increases the overall bed length without necessarily eliminating all impacts with the wall.

There is no general solution to this problem. The equipment designer should provide a certain amount of protection but in some cases individual hospitals may have to deal with this as an architectural problem.

Statement 49: **There shall be on the bedstead at the headend means for protecting the patient's head and for retaining pillows on the mattress. A filled panel may be incorporated.**

In addition to the occasions when the bed will be propelled it is usual to place a bed with the headend towards a wall, and in this position there are many occasions in which it will be manoeuvred short distances. Apart from the fact that many people are accustomed to some form of headpiece to a bed, movement can easily dislodge pillows, and the patient's head must be guarded from impact not only with the wall but with any projections that may come in contact with the bed at the headend. Also there is the need to protect bedding

and exclude draughts.

A number of sources indicated that a continuous surface could be advantageous. On the experimental prototype bedstead used in a ward for three months this was provided by a continuous surface back support which, when not in use, folded back to form part of the headpiece. The staff commented that it was easier to clean and that it gave some protection to the patient from draughts. A filled-in panel at the headend may be one solution to the requirements but is not necessarily the only one, and it could impede the satisfaction of other requirements, for example, Statement 48.

The prototype headends, which were 35in (89 cm) high above the mattress support, proved to be too high in use and the trials seemed to indicate very strongly that there should be no significant obstruction to vision more than about 30in (76 cm) to 32in (81 cm) above the mattress support.

Statement 52: **There shall be on the bedstead at the footend means for protecting the patient's feet. A filled panel may be incorporated.**

With the head of a bed towards a wall the foot extends into the ward. It is then the most vulnerable area of a bed regarding contact with the general traffic of equipment and people moving about the ward. This vulnerability is particularly important when the bed is adjusted to low height and the patient is sleeping.

A continuous surface at the foot of the bed is considered by many as desirable and by some as providing additional support and protection. A television enquiry showed that three-quarters of hospital staff considered a continuous surface preferable to an open structure 'provided that it can be easily detached or hinged away'. (This constraint is covered by Statement 47.) It is possible that this opinion reflects a wish to improve on appearance in one of the few areas where appearance may be given precedence.

General references: see lists of sources
Specific references: see 1.7, 4.1, 4.9, 4.14, 5.1, 5.6, 6.2, 6.3, 6.4, 7.33.

Appendix X

Statement 47: **Full all round access with no obstruction above the mattress surface at any point around the perimeter shall be obtainable.**

Some activities (for example, transfer of a patient between the bed and patient transport, stripping and making the bed) and certain treatments (for example, chiropody) require the whole or part of the mattress surface to be clear and accessible. This means not only should it be possible to place some or all of the bedclothes and pillows clear of the surface (see Statement 55) but also no part of the structure should need to remain projecting above the mattress level, presenting a hazard to the patient or attendant or an obstruction to, for example, stretcher poles.

Statement 50: **It shall be possible quickly to obtain unobstructed access to the patient from behind the headend of the bed.**

The requirement that a headpiece shall be removable is a common one, ranking high in a number of specifications. This was confirmed by the response to the question in a television enquiry: 'Would you require the bedhead to be detachable?' The highest response in favour, 98 per cent, came from anaesthetists and there was no response lower than 79 per cent. Where the hospital staff returned group answers, 93 per cent were in favour.

This reflects not so much the need for detachable bedheads, as the need to be able, when necessary, to tend the patient from behind the headend of the bed with no structural impediment of any kind. This need arises primarily for medical reasons and often in circumstances of urgency. There are other occasions when it may be an advantage to have this facility, but it is the medical requirement which dictates the critical factors of speed and degree of access. The speed with which any structure can be removed may be impeded by the weight involved. This was found to be a problem during trials of the experimental prototype bedsteads and is covered by Statement 3 of this specification.

General references: see lists of sources
Specific references: see 1.7, 4.1, 5.1, 5.6, 6.2, 6.3, 6.4.

Appendix Y

Statement 48: **It shall be possible to propel the bed without the attendant's view being unduly obscured by any structure.**

The height of the filled-in headboards on the experimental prototype bedsteads used for three months in a hospital ward were found to obstruct the view of anyone propelling the bed. It was 35in (89 cm) above the mattress support. This could have been overcome by adjusting the height of the mattress support, but because the rail was not easy to grasp, the attendant tended to grasp the mattress support frame and to have lowered it would only have aggravated the problem.

Statement 54: **The structure at the footend of the bedstead shall not unduly obscure the patient's view.**

Most patients will continue to spend at least part of their waking time sitting in bed and it has been argued (in Appendix T) that a small degree of foot-high tilt can add to the general comfort of such patients. However, the advantages this slight degree of tilt might give would be diminished if the patient no longer had a reasonable view of his surroundings.

General references: see lists of sources
Specific references: see 4.1, 6.3.

Appendix Z

Statement 51: **The structure at the headend of the bedstead shall be suitable for use by an attendant when propelling and manoeuvring the bed.**

Statement 53: **The structure at the footend of the bedstead shall be suitable for use by an attendant when propelling and manoeuvring the bed or by a patient when using it for support.**

Statement 72: **When the bed is mobilised, it shall be possible to steer and control the bed, and there shall be clearance at the headend and at the footend of the bedstead for the legs and feet of the attendants moving it.**

A conservative estimate of the weight of a hospital bed is 280 lb (127 kg) which, with a patient of 140 lb (63·4 kg) means that an attendant will be manoeuvring at least 420 lb (191 kg). The dimensions of doorways, corridors and lifts (see Appendix F) require considerable manoeuvrability of the bed, and the surfaces over which it will pass (see Appendix FF) may include short slopes or ramps. Under all conditions the attendant or attendants must be able to retain as well as exercise control, and the structure grasped must be able to take the strains imposed by the combination of these factors. With heavier beds the problem of control on slopes becomes more important. On the experimental prototype bedsteads used for three months during ward trials, the footend and the bed stripper facilities were combined as one detachable structure. In order to position the bed stripper for use the attendant lifted a rail several inches and the structure then hinged down. The attendants found that this adjustment could be made inadvertently when they grasped the footend of the bed to pull it. Because of this, and because it came easily out of its sockets it was regarded by both attendants and patients as insecure.

With the encouragement of early ambulation, an increasing number of patients, while still unsteady, move around the ward and use for support such furniture as they expect to be stable. The footends of the beds are often the easiest and most obvious thing to grasp. In addition, several physiotherapists have emphasised the advantage of having a suitable structure for patients to hold for support or exercise in and out of bed.

General references: see lists of sources
Specific references: see 1.7, 4.1, 5.6, 6.2, 6.3, 6.8, 7.6.

Appendix AA

Statement 55: **There shall be on the bedstead at the footend means for temporarily storing clear of the mattress surface and clear of the floor the pillows and folded bedclothes.**

When a bed stripper facility is not provided as part of the bed structure the usual practice is to place the bedclothes either on a free standing article, for example, chair and/or stool, or on some form of additional support attached to the foot of the bedstead. These articles are often used for other activities or the same article is used for a number of beds. This increases the danger of cross-infection and adds to the work-load. The legs of free standing articles contribute hazards for the feet and legs of the attendant; attachments have to be stored when not in use. A television enquiry showed that over 90 per cent of all categories of nursing staff are in favour of a bed stripper facility being part of the bed structure. The movements involved in stripping and making beds require it to be at the footend.

Any addition to the length of the bed even for short periods is a disadvantage, particularly where space is restricted, for example, by drawn curtains. But this is true whatever the bedclothes are stored on, and it is unlikely that an integral bed stripper will take up more room than alternatives such as a chair. The current British Standard requires an area of 30in × 15in (76 cm × 38 cm) that hooks on at approximately 3–4in (7·5–10 cm) from the footend.

More important than the measurements is its ability to accommodate the bedclothes. Not only must all the bedclothes, that is to say, sheets and blankets, etc., be stored but also the pillows need to be placed somewhere too. It is possible that these could be accommodated independently of the bedclothes, as long as they are clear of the mattress surface and floor, and the means of storing them is part of the bedstead.

The bedclothes must not be permitted to touch the floor under any circumstances. Usually the height of the mattress support can be adjusted to prevent this during stripping and making the bed. In cases where small nurses, using the experimental prototype bedsteads, did not wish to raise the bed sufficiently for this, they devised alternative methods of folding the bedclothes to compensate.

The bed stripper on the prototypes provided an area of 31in × 18in (79 cm × 46 cm) at the foot of the mattress. However, during three months of ward trials it was found necessary, 15 per cent of the time, to use in addition a chair or stool to accommodate pillows. Its use accounted for 10½ per cent of all adjustments made to the bed. There is indication that the provision of the bed stripper as an integral part of the bedstead, easily positioned for use, led to its employment for an additional purpose. Just under 4 per cent of the times it was used was in connection with adjusting the pillows and making the patient comfortable, and did not involve moving the bedclothes. The work study team responsible for the trials have explained that nurses used it as a parking place for extra pillows or when they had to change a pillowslip.

Statement 56: **Preferably the pillows and bedclothes when temporarily stored should remain in position even when the mattress support is tilted up to 7°.**

It was found during the ward experiment that when the mattress support had a foot-high tilt of more than 9° the bedclothes on the bed stripper tended to fall towards the head of the bed. It has been argued that a greater degree of tilt would seldom be maintained for any length of time, or if it were, the patient would be in a condition that required special care in all procedures. Ideally, perhaps, a bed stripper facility should retain the bedclothes whatever the configuration of the bed, but to insist on this would impose an extreme requirement on design in order to accommodate a comparatively uncommon usage. The figure of 7° is related to Statement 40.

Statement 57: **When in position the bed stripper shall present a suitable support for the bedclothes at a level permitting easy bedmaking and stripping with the normal hospital procedures.**

Statement 58: **When the bed stripper is in position there shall be no hazard to the attendant's hands and arms or to the bedclothes.**

In general, the necessity for nurses to consume energy unproductively in lifting bedclothes significant distances up from the level of the mattress to the level of the bed stripper (or vice versa) should be avoided. In order to minimise air and dust movement, normal nursing procedure calls for a substantially horizontal movement of the bedclothes. Hand and arm movements are usually rapid. The bed stripper, the footpiece and any structures

associated with their stowage and/or mounting or dismounting must not present a hazard to hand and arm in rapid movement, or to the bedclothes.

General references: see lists of sources
Specific references: see 2.2, 4.1, 5.1, 6.3, 6.4, 6.15, 7.33.

Appendix BB

Statement 59: **There shall be safety sides capable of attachment to the sides of the bedstead which, when in position, prevent the patient from accidentally rolling or slipping off the mattress.**

Statement 60: **The safety sides shall not be the full length of the mattress and, when in position, the unguarded length shall not be at the headend. Preferably the sides should be threequarter length.**

There will be occasions in most wards when safety sides can provide a measure and a sense of security to patients who are, for example, disturbed, confused, delirious or unconscious. But there is no evidence that sides can be used to contain in bed a patient determined to leave it. If the sides are high and/or full-length this patient runs the risk of falling further or more awkwardly than if there had been no sides at all. A report on a conference on hospital safety in USA in 1961 records the 'startling fact' that 'in one hospital 50 per cent of all the patient injuries due to falls from bed occurred when the bedrails were in place'. If the sides are not full-length they act as an impediment to be gone round rather than a barrier to be surmounted.

Statement 61: **Preferably the height of the safety sides above the top of the uncompressed mattress should be 12in (30 cm). They shall not be less than 10in (25 cm), nor unacceptably high.**

With the possibility of mattresses of varying depths being used by different hospitals, it would be unrealistic to insist on the optimum height of 12in (30 cm) above the uncompressed mattress. Experience in hospital wards has shown that 10in (25 cm) is the minimum height that will provide sufficient protection for a restless patient.

General references: see lists of sources
Specific references: see 1.7, 3.31, 3.41, 4.4, 6.4, 7.33.

Appendix CC

Statement 63: **The safety sides shall readily attach and detach, and they shall stow within the bedstead structure. Preferably they should not encroach on the dimensional and other requirements stated elsewhere in this specification.**

Statement 64: **The safety sides shall be capable of being lowered without necessitating removal from the bedstead. When lowered they shall not hamper access to the patient. Preferably when lowered they should not hamper bedmaking. Preferably the lowering movement should require minimum clearance between the bed and its surroundings.**

Statement 65: **Operation of the safety sides shall be quiet.**

A television enquiry showed that 88 per cent of hospital staff consider safety sides should stow on the bedstead. The dimensional requirements that may impose the severest constraint on methods of stowing and lowering safety sides are those concerning structural depth under the mattress (see Statement 21 and Appendix H).

The conventional sides used during the control periods of the ward trials were described as heavy and cumbersome, ideally requiring two nurses to attach or detach them. They did not stow on the bed. They were responsible for 77 per cent of the recordings of misuse or failure to use the conventional bed's facilities. However, the numbers are small in this statistic and the percentage represents 58 occasions in 2 months. The smaller and lighter sides on the experimental prototype bedsteads were responsible for 7 per cent of similar recordings for that bed, or 20 occasions in 3 months.

Some designs of safety sides lower by sweeping out in an arc from the bedside before stowing. With a locker or other equipment close to the bedside this can necessitate extra movement and may hinder a nurse reaching a patient in an emergency.

The facility most likely to be adjusted at night is the safety side.

General references: see lists of sources
Specific references: see 4.1, 5.1, 6.3.

Appendix DD

Statement 66: **It may not be necessary for each bedstead to have a pair of safety sides.**

Observations during five months in a women's surgical ward recorded very small use made of safety sides, even though those provided by the experimental prototype bedsteads were generally regarded as easy to use. The conventional sides were recorded in use 23 times in 2 months, the prototype sides were recorded in use 52 times in 3 months. However, in another survey when 25 counts in 7 wards were made during 11 weeks the use was found to be highest in the 30-bedded geriatric ward. Twice there were 5 or 8 pairs of sides in use, on 21 occasions there were 6 pairs.

Therefore the particular requirements of the ward must be taken into account. Should general use increase due to more satisfactory designs the number may have to be increased in accordance. The work study team responsible for the trials have commented that even a few patients in the fully ambulant category used the prototype sides at night to give themselves an added sense of security.

General references: see lists of sources
Specific references: see 4.1, 4.10, 6.3.

Appendix EE

Statement 67: **It shall be possible to attach various auxiliaries including a lifting pole to the bedstead, but the means for mounting need not be part of the bedstead. The specification is not intended to satisfy the heavier orthopaedic requirements.**

The following fittings need to be attachable to the bedstead: a lifting pole – preferably designed not to strike the partition at the headend when the bed is tilted; a drip pole – British Standard pole for transfusion bottles; balkan beam equipment; a urine receiver; drainage bottles; an oxygen tent. Where the means of attachment is part of the auxiliary equipment rather than part of the bedstead there are several advantages. The bedstead itself can be simpler, cleaner and better looking. The overall economics are better since one well designed clamp on a drip pole gives a flexibility of positioning around the bed that would otherwise require numerous sockets built into the bedstead. The saving increases if, as is usual, beds greatly outnumber drip poles. This is true of other auxiliaries such as lifting poles and to some extent balkan beams.

Hospital staffs traditionally dislike clamps because they often damage paint finishes, but with care in design and modern techniques (especially the use of plastics coatings on attachments) this damage can be prevented – with the bonus of quietness in fixing and use.

General references: see lists of sources
Specific references: see 1.7, 2.17, 6.2, 6.4, 6.6.

Appendix FF

Statement 68: **There shall be on the bedstead means for making the bed mobile or immobile.**

Statement 70: **The means of mobility shall permit easy smooth movement of the bed throughout the hospital including occasional travel over short stretches of paving or concrete.**

Statement 73: **When mobilised, the bed shall be capable of traversing small obstructions and floor discontinuities such as ramps and lift thresholds.**

Increasingly beds are being wheeled about in hospitals and this trend is encouraged and planned for in new hospital buildings. It has been estimated that in a general surgical ward with a fully mobile bed system, assuming an average patient stay of 10 days, the following requirements should be met. In 5 years a bed may make 300 single journeys with a patient. The length of a single journey will rarely exceed 300ft (91 m) in which there may be up to eight right-angle changes of direction. Up to 150ft (46 m) of this journey may be a clear run without stopping or significantly changing direction. The speed of travel is often likely to be as much as 3 miles (5 km) per hour. In a highly mobile system the time elapsing, for a particular bed, between the outward journey and the return journey could be anything between half an hour and 5 days.

Lift threshold tolerance is $\pm \frac{3}{4}$in (1·9 cm) maximum. With normal distribution within this tolerance 95 per cent of lift arrivals would be within a tolerance of $\pm \frac{1}{2}$in (1·3 cm). It seems likely that up to half of all out-of-ward single journeys will use a lift once, that is, statistically two irregular thresholds every 600ft (183 m) of travel. However, to account for surgical beds with shorter patient stay, say, 5 days, and which statistically will make more but shorter journeys it should be assumed that many beds may be confronted with two irregular thresholds, say, every 200ft (61 m). The speed of movement into and out of lifts will be much less than that for straight travel.

General references: see lists of sources
Specific references: see 1.7, 2.7, 6.8, 7.33.

Appendix GG

Statement 69: **The state of mobility or immobility of the bed shall be easily seen, and the means for changing the state shall be readily discernible.**

Statement 71: **When mobile the bed shall be acceptably stable.**

Statement 75: **When immobile the bed shall be acceptably rigid and stable.**

With this specification mobility accentuates many problems. Beds are likely to be considerably heavier than the conventional designs, so that modern castors and probably very short wheel-bases will be required to achieve the necessary high manoeuvrability. It is likely that castors with a wheel diameter of 5in or 5½in (12·5 cm or 14 cm) best combine compactness and good riding characteristics although experiments have shown good results with high quality sprung wheels of 4in (10 cm).

In turn the stability requirements when the bed is immobilised are unusually strict. The new designs will facilitate early ambulation, more and more patients with uncertain balance will be entering or leaving their beds unassisted and using other beds, including unoccupied ones, as support. Thus it becomes essential that immobilising devices are easy to operate, fully effective, and that failure to immobilise a bed should be quickly noticed. Higher resistance to sideways forces is required than has been provided by designs produced in this country hitherto.

Statement 76: **Preferably, in any configuration, the mattress support should not deflect more than 1in (2.5 cm) when a downward load of 140 lb (64 kg) is applied at any place.**

The combination of a short wheel-base and a wide range of height adjustment and tilt demands particular care in structural design. The deflection should be regarded as a generous limit at an extreme point, say, a foot corner of the mattress support. The experimental prototype bedsteads used in ward trials gave about half this deflection.

General references: see lists of sources
Specific references: see 1.7, 5.6, 6.3, 6.4, 6.8, 7.6.

Appendix HH

Statement 79: **Materials or constructions that can support or harbour micro-organic life, can inhale or exhale airborne particles, or can permit moisture to accumulate or stand, shall be avoided.**

For the purpose of control of infection, the principle of avoiding the use of materials which can support or harbour micro-organic life, or which trap moisture, etc., where such life can develop, is well known and should be adhered to. However, examples have been found where equipment incorporated constructions which, when moved or handled, inhaled a volume of air, with possibly infective airborne particles. A return movement or subsequent handling caused the volume of air to be exhaled, expelling the airborne particles. This could be a serious cause of cross-infection. Vented mattresses, telescopic tubes and sliding covers are examples of inhaling/exhaling constructions. In general, mechanisms which cause appreciable displacement or disturbance of air should not be employed.

General references: see lists of sources
Specific references: see 1.7, 7.12.

Appendix II

Statement 80: **Materials and design of the bedstead shall be calculated to facilitate the cleaning of the bed and its immediate surroundings.**

Observation of domestic staff at work suggests that both the time employed in the cleaning of an item of equipment and the efficacy of the cleaning operation depend upon the number of 'wipes' which are required to encompass it. The fewer the number of wipes needed the better the quality of the result, as well as the speed. The number of surfaces and corners should be kept to a minimum. Where possible, internal corners should be of not less than finger radius to facilitate wiping out. The obstructed area of the floor should be kept to a minimum.

General references: see lists of sources
Specific references: see 1.7, 6.4, 7.26.

4 Lists of Sources of Information

The following lists do not include all the sources consulted, only those that supplied relevant material. Nor do they include individual names of people, manufacturers or hospitals. Many sources in these categories gave information and assistance in confidence, and to list some individuals and not all would be invidious. A number of the sources provided general material and do not appear under any appendix as a specific reference.

Anyone wishing to consult or locate sources listed here should contact the King's Fund Hospital Centre, 24 Nutford Place, London, W.1.

The sources are divided under the following headings:

1 King's Fund Papers
2 British Standards
3 Published Material
4 Unpublished Material
5 Research Unit Reports
6 Research Unit Working Papers
7 Official Bodies, Associations, and other Organisations

The final list, 8, gives articles, television programmes, conferences and exhibitions related to the progress of the study.

1 King's Fund Papers: Enquiry into the Design of Hospital Bedsteads

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1.2 Methods of production and supply, THC 66/257.

1.3 Notes on characteristics of a hospital bedstead suitable for the majority of patients in a general ward, THC 64/256, July and November, 1963, reissued as THC 65/365, 1965.

1.4 Notes on mattress length and width, THC 64/195, April, 1964.

1.5 Notes on the properties of backrests, THC 64/241, June, 1964.

1.6 Report of a conference held at the King's Fund Hospital Centre on Tuesday, 17 May, 1966, THC 66/265.

1.7 Working party on the design of hospital bedsteads: minutes of meetings, February, 1963–October, 1966.

1.8 Working party secretary: correspondence, memoranda and reports of investigations, discussions and visits.

2 British Standards

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2.2 *Bed Strippers for Use in Hospitals,* BS 1854:1952, *add* August, 1952.

2.3 *Bordered Mattresses (Excluding Cellular Rubber Mattresses) for Hospitals, Institutions and Government Departments,* BS 1818:1961, *add* October, 1962, December, 1963.

2.4 *Castors Part 1. Castors for Hospital Equipment,* BS 2099: Part 1: 1956, *add* May, 1960.

2.5 *Dressings Trolleys,* BS 3236: 1960, *add* September, 1960.

2.6 *Electrical Resistance of Conductive and Anti-static Products Made from Flexible Polymeric Material,* BS 2050: 1961, *add* May, 1962.

2.7 *Electric Lifts Part 1. General Requirements,* BS 2655: Part 1: 1958, *add* March, 1959, March, 1960, May, 1961, November, 1964.

2.8 *Electric Lifts Part 3. Outline Dimensions,* BS 2655: Part 3: 1955, *add* May, 1957, March, 1958, July, 1961.

2.9 *Flexible PVC Sheeting for Hospital Use,* BS 3878: 1965.

2.10 *General Purpose Trolleys for Anaesthetists' Use,* BS 3112: 1959.

2.11 *Hospital Bedside Lockers,* BS 1765: 1951.

2.12 *Hospital Bedsteads for General Purposes,* BS 1682: 1950, *add* August and December, 1952, October, 1954, August, 1955, August and December, 1956.

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2.21 *Patients' Trolleys (Tilting Top) for Indoor Use in Hospitals,* BS 2057: 1953, *add* May, 1958.

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3 Published Material

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6.2 Correspondence: arising out of the circulation of the preliminary draft specification and from the publicity received by the study.

6.3 Experimental prototype general purpose hospital bedstead designed and constructed by the research unit in the Royal College of Art workshops.

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6.5 Reports on visits to hospital wards and attendance at hospital planning meetings.

6.6 Study of the factors to be taken into consideration in the choice of finish.

6.7 Study of the needs, measurements and extent of use regarding foot-high, head-high and lateral tilt.

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6.9 Study to determine the nature of demand for bed height adjustment and the incidence and distribution of adjustment throughout the day.

6.10 Study to determine the overall length of hospital bed that could be accommodated in present and planned hospital buildings.

6.11 Study to determine whether UK figures were applicable to the hospital field without modification, in particular with relation to patient height, patient weight, female nurse height and female physical capacities.

6.12 Survey and analysis of the methods in use for providing back support to patients in bed.

6.13 Survey of British mattress manufacturers to determine the availability of mattresses suitable for use in hospital on a flat and rigid base.

6.14 Survey of the use, abroad, of flat and rigid bases on general purpose hospital bedsteads; and the mattresses used on them.

6.15 Survey to locate past, present and planned specifications, designs and trials of general purpose hospital bedsteads in Great Britain.

7 Official Bodies, Associations, and other Organisations

7.1 Academisch Ziekenhuis der Vrije Universiteit (University Teaching Hospital), the Netherlands

7.2 Association of Industrial Medical Officers

7.3 Boards of Governors

7.4 Boards of Management

7.5 Bouwcentrum (Building Centre), the Netherlands

7.6 British hospital bedstead manufacturers

7.7 British mattress manufacturers

7.8 British Plastics Federation

7.9 British Standards Institution

7.10 Building Centre, The

7.11 Bureau of Standards and Quality Control, USA

7.12 Central Public Health Laboratories

7.13 Centrala Sjukvårdsberedningen (Central Hospital Planning Bureau), Sweden

7.14 Chartered Society of Physiotherapy, The

7.15 Chest and Heart Association, The

7.16 College of Aeronautics, Cranfield, The

7.17 Commonwealth Scientific and Industrial Research Organisation

7.18 Consumers' Association

7.19 Council of Industrial Design

7.20 Department of Health, Education and Welfare, USA

7.21 Department of Human Anatomy, Oxford University

7.22 Foreign hospital bedstead manufacturers

7.23 Foreign mattress manufacturers

7.24 Furniture Industry Research Association, The

7.25 General Nursing Council, The

7.26 Hospital Domestic Administrators' Association, The

7.27 Hospital Management Committees

7.28 Human Biomechanics Laboratory, Medical Research Council

7.29 Human Factors Division, Army Operational Research Establishment

7.30 Imperial College of Science and Technology

7.31 Loughborough University of Technology

7.32 Manchester University Institute of Science and Technology

7.33 Ministry of Health:
Architects' Division
Central Pathology Committee
Electrical Safety Division
Engineering Division
Library
National Health Service
Central Organisation and Methods Unit
Nursing Division
Supply Division

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8 Articles, Television Programmes, Conferences and Exhibitions Related to the Progress of the Study

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REQUEST FOR INFORMATION

In order to obtain further information about any aspect of the Report, please detach this sheet and return it to the King's Fund.

To the Director
King's Fund Hospital Centre
24 Nutford Place
London W1

Please send me information about the following aspects of the enquiry:

Signed

Date

Name and Address (block capitals please):

Comments on the subject are invited and may be written overleaf

From:

I give below my comments on the King's Fund Report Design of Hospital Bedsteads