# A PUNCH CARD SYSTEM FOR PROCESSING DATA FROM STAPEDECTOMY OPERATIONS

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DURING the past 6 years more than 1,200 stapedectomy operations have been performed in the Ear, Nose, and Throat department of King's College Hospital. About 2 years ago the author realized that it would be useful for the results and details of these operations, together with the clinical characteristics of the patients undergoing them, to be recorded in a way that would allow correlations between different sets of characteristics to be sought and recognized. In short, a data processing system was required. In addition, it seemed desirable to build up an index of all the patients, from which a list of those exhibiting any one characteristic, could be compiled without the difficulty of sorting the large number of case notes. The use of an electronic computer and card index, such as that described by Shea in 1960, would have satisfied both requirements, but for many reasons, including cost, this was not feasible. Instead, a punch card of the type produced by the Copeland-Chatterson Co. Ltd. has been used. A special card has been planned and printed to meet the particular needs of our department; this card and the details of its design will be described in this paper.

Peripheral punch cards have had many medical applications, and their use is probably familiar to most readers. Each card has holes arranged around its edge. Each hole can be labelled with one item of information that may be either present or absent. When, in a particular instance, a card is made out, the treatment of each hole will depend on the presence or absence of the particular characteristic for which it is labelled. If the characteristic is absent the hole is left untouched; if present the hole is punched with clippers so that it is extended as a slot to the edge of the card. A batch of cards can be divided into two groups in relation to the presence or absence of any item of information by passing a needle through the relevant hole in each card, and allowing those in which the hole has been punched out to fall away from the unpunched cards, which remain suspended on the needle. Repeated needling of different holes will separate the cards into piles with correlated characteristics.

Certain principles govern the design of a punch card of this type. In the first place a balance should be kept between the size of the card and the complexity of the problem with which it is expected to deal. A small card is much easier to sort than a large one, and can of course be punched with information much more quickly, and with less risk of error than a



https://doi.org/10.1017/S0022215100066809 Published online by Cambridge University Press

large one. On the other hand a large card can hold more information than a small one. This consideration calls for planned economy in the designation of holes. Any information that cannot be described as present or absent must be recorded on the face of the card. In addition, no holes should be allocated to data that may not be used in the sorting process. For example, our card does not have a hole for left or right ear, because we do not intend to look for relationships between laterality and other factors. The probable frequency with which a hole may be used must be considered. If a particular characteristic will only rarely be present, it may be better to classify it under a generic heading, thereby saving holes that would otherwise be allocated to all the other members of that group of characteristics. For example, it would be extravagant to provide a hole for each variety of congenital middle-ear abnormality that may be encountered, when a hole labelled "congenital abnormalities" will serve the whole group. The details of any particular one can be recorded on the face of the card. This kind of planning suggests that preconceived ideas are held about the type of analysis to be made, and even about the kind of results that may be expected. Such foresight is essential in the design of any data processing system.

Any card index must incorporate a mechanism for restoring the cards to a physical order after sorting. There are many ways of doing this, and the choice of the most suitable one should depend on the relative frequencies of punching and sorting, and the number of holes that can be provided for this function. Our cards are stored in alphabetical order, and punching is a much more frequent event than sorting. The system that we have adopted, based on these considerations, will be described later.

Certain considerations applied to the use of a data processing system at King's College Hospital that might not obtain in other departments. First of all the system was to be retrospective. About one thousand stapedectomy operations had been performed before the card index was available, and the recordings of detail from these operations demanded that information not regularly found in the case notes should be excluded from the card. Some of the data that have been omitted for this reason—such as the precise location of the otosclerotic focus—would otherwise have been included, but this price had to be paid for the advantages of investigating the large backlog of material. The second consideration was that the card should be easy and quick to punch, and not open to ambiguity. Stapedectomies are performed at King's by four consultants and two registrars, and there are frequently several such cases on an operating list. The card plan must be understood by everyone using it, and a card must be punched accurately in a few minutes after each operation—preferably by the operator.

The Copeland Chatterson Company produces cards in two standard sizes, 6 in. × 4 in. and 8 in. × 5 in., but will supply any other sizes to



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order. Two hole sizes are available; the large hole card has twenty-six holes to 6 in., and the small hole card 31 in. to 6 in. The King's College Hospital card is a small hole card, $8\frac{3}{4}$ in. × 6 in. This provides 150 holes of which all but the corner holes can be used.

A card is prepared for an ear, rather than for a patient, and for the first stapedectomy operation performed at King's on that ear. Information about any subsequent revision operation will be recorded on the same card. Certain schemes of grading and classification have been designed for this project, and they will be described below.

*Details of the card:* (Figs. 1 and 2)

The face of the card is used for recording information that cannot be recorded by punching holes, and also for a written description of some of the information carried by the holes. The surname is written as high as possible on the right hand side of the face, so that a particular card can be found quickly from its alphabetical order. One corner of each card is missing to allow correct alignment of a batch. The back of the card carries details of the classifications used. The card will be described in a clockwise direction starting from the missing corner.

The items on the first short side are self explanatory. The holes numbered 1, 2, 3, 4, are reserve holes. Coming to the first long side, the *severity of deafness* deserves some comment. This is intended as an assessment of the pre-operative cochlear function, based on the bone conduction pure tone audiogram levels. The system used takes account of the usual speech frequencies of 500, 1,000, and 2,000 c.p.s. for which an average figure is calculated, and in addition the level at 4,000 c.p.s. is recorded.

The *middle-ear findings* include a classification of footplate types based on that used by the author in 1962 in an attempt to correlate macroscopic findings with surgical technique. The classification is as follows:

Type I. A footplate so slightly fixed that pressure on the head of the stapes or crura displaces the footplate *in toto* from the oval window.

Type II. This is by far the commonest variety and includes all footplates that are predominantly thin with blue areas that can easily be penetrated by a needle point.

Type III. This kind of footplate is opaque and thick all over, but a hole can be made through it with a needle.

Type IV. This is a very thick footplate that cannot be penetrated by a pick, and on which a drill burr has to be used.

Type V. The well recognized "obliterated" oval window niche with no recognizable annular ligament.

*Operative problems* include findings and techniques slightly different from the usual, which have occurred sufficiently frequently in the author's



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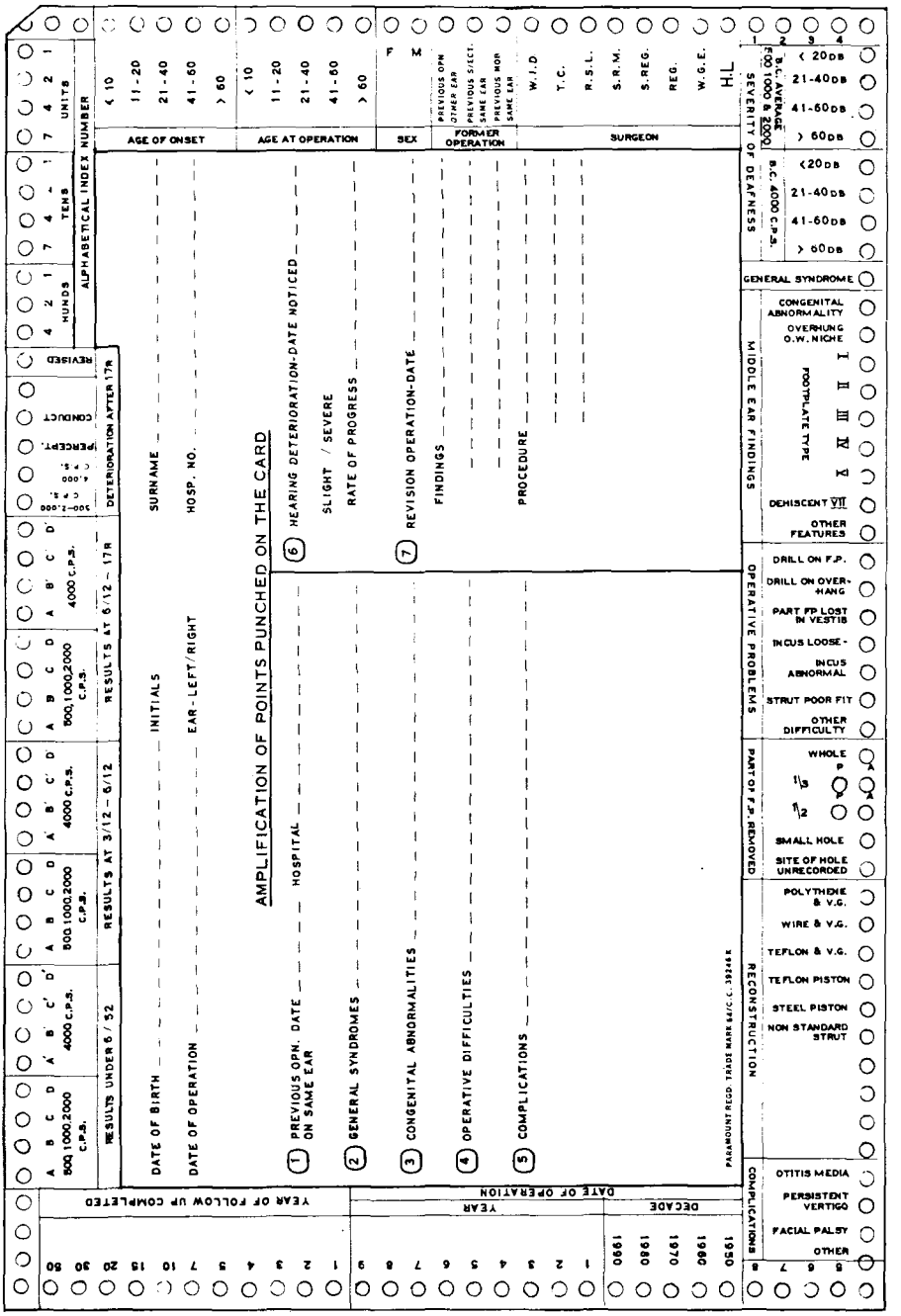



FIG. 1.
Front of punch card.



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experience to merit individual recognition. Some difficulties, such as those of access, have not been included because it is thought unlikely that these will affect the results, and there is no interest in their incidence for its own sake.

THIS CARD SHOULD BE PUNCHED FOR THE FIRST STAPEDECTOMY PERFORMED ON THE EAR CONCERNED AT K.C.H.
(IF REVISION IS LATER PERFORMED, INFORMATION WILL BE RECORDED ON THE FRONT OF THE CARD)

**EXPLANATION OF CODES**

TYPE OF FOOTPLATE:-

I - REMOVED WITH THE CRURA IN 'TOTO'
II - THIN, CAN BE REMOVED WITH A PICK
III - THICK, CAN BE REMOVED WITH A PICK
IV - THICK, DRILL USED ON IT OF NECESSITY
V - OBLITERATED NICHE

OPERATIVE RESULTS:-

FOR 500, 1000 & 2000 C.P.S.
(A) - HEARING LEVEL TO WITHIN 10db OF PREOP. B.C. IN ALL 3 FREQUENCES
(B) - SIGNIFICANT GAIN, BUT NOT UP TO 'A' LEVEL
(C) - NO SIGNIFICANT CHANGE FOR BETTER OR WORSE
(D) - HEARING MUCH WORSE OR LOST

FOR 4000 C.P.S. -
(A') - LEVEL TO WITHIN 10db OF PREOP. B.C.
(B') - LEVEL HIGHER THAN PREOP. A.C. BUT NOT UP TO A'
(C') - LEVEL ABOUT SAME AS PREOP.
(D') - LEVEL MUCH LOWER THAN PREOP.

ALPHABETICAL INDEX NUMBER: MUST BE SELECTED FROM THE 'DIVISIONS INDEX' ACCORDING TO THE FIRST LETTERS OF THE PATIENT'S SURNAME THE NUMBER IS PUNCHED ONTO THE CARD SO THAT A BATCH OF CARDS MAY SUBSEQUENTLY BE MECHANICALLY SORTED INTO ALPHABETICAL ORDER.

FIG. 2.
Back of punch card.



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*Part of footplate removed.* This rather arbitrary classification of the area and site of footplate removed is usually easy to apply, but use of the system has already shown that it would be useful to have a hole labelled "central" in addition to A (anterior) and P (posterior).

A hole labelled "Site of hole unrecorded" is needed because of the retrospective nature of the survey.

*Reconstruction.* Holes are designated for those techniques that have been used at King's, with a hole to cover rare improvizations. "Wire and V.G." refers to a thin wire strut devised by Sir Terence Cawthorne, made by twisting two lengths of wire together. Several holes have been left blank in this section to cover future changes in technique.

On the other short side of the card there is provision for recording the year of the operation, by decade and year, and also the year of follow-up completed. Combined needling of holes in this section should select the cards of those patients who have not attended for follow up.

*Results.* There is provision for recording the results at three different times after operation, in the first year. After this time the hearing level is presumed stable, unless the hole for "deterioration after one year" is punched. The classification of results is into A, B, C, or D for the frequencies 500, 1,000, and 2,000 c.p.s., and into A′, B′, C′, or D′ for the result at 4,000 c.p.s. The method used in this classification has been devised for convenience and applicability. The purist might object that the system uses different reference scales for different grades, for example, at one level we are comparing results with pre-operative bone conduction levels, and at another level with pre-operative air conduction levels. In practice very few anomalies arise, and it is only when the pre-operative bone conduction level was unrecordable that there is difficulty in deciding between an A and a B result.

*For 500, 1,000, and 2,000 c.p.s.*

A means a hearing level within 10 db. of the pre-operative bone conduction level in all three frequencies.

B means a definite gain, but not up to the A standard.

C means that the hearing is little changed for either better or worse.

D means that the hearing is much worse or lost.

*For 4,000 c.p.s.*

A′ means hearing to within 10 db. of the pre-operative level.

B′ means much better hearing at that frequency but not to within 10 db. of the pre-operative level.

C′ means little change in the level of hearing at 4,000 c.p.s.

D′ means that the hearing is much worse or lost.

An ideal result is recorded as AA′.



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If a revision operation is performed, the fact is noted by punching the appropriate hole and the details are recorded on the face of the card.

*Alphabetical Index Number* is the method mentioned above for sorting the cards back into alphabetical order after use. An index of surnames is available divided into 600 groups in alphabetical order in terms of the first letters of the name. These groups are numbered in order from one to six hundred, and the appropriate number for the patient's surname is selected from the list. This number is punched on to the "alphabetical index number", using the "hundreds", "tens" and "units", and combining digits as necessary to make such numbers as 5, 8, 9, etc. A batch of cards can be restored to numerical, and hence to alphabetical order, by needling and sorting the batch through each hole in turn, from the 1 of the units to the 4 of the hundreds, and at each needling putting the unpunched cards to the front of the pack. This procedure is easier to demonstrate than to describe.

This punch card system has now been used at King's for nearly 18 months, and in that time the details of over 600 operations have been recorded. It will probably be another year before the backlog of retrospective information from the remaining cases has been transferred from the case notes to the cards. When that task is completed sorting will begin, and the results derived from that sorting will, it is hoped, be the subject of another paper.

**Summary**

A punch card system has been used at King's College Hospital for over a year to record the details of stapedectomy operations. The design of this card is described in this paper.

**Acknowledgments**

I am truly grateful to my colleagues at King's College Hospital for their help and advice in planning the design of this card, and for their co-operation in recording information from their operations. Sir Terence Cawthorne provided the initial stimulus for this work, and all who work in the department at King's owe him an immense debt of gratitude for introducing John Shea's stapedectomy operation, and for allowing us access to his very large number of cases for this study.

The Copeland-Chatterson Co. Ltd., Gateway House, Watling Street, London, E.C.4 gave me a great deal of assistance in the preparation of the final design.

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https://doi.org/10.1017/S0022215100066809 Published online by Cambridge University Press

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