

Radiographs often used are of the teeth, but other relevant body areas include chest, skull, abdominal, extremity and spine radiographs (Murphy et al, p.727). Identification features sought include anatomic, disease and post-surgical impressions.

Although not used widely, radiographs have a high success rate. Of 212 victims in the Canary Islands plane crash, 15 were identified by medical radiographs. In a retrospective study of 3,005 cases, 6% were identified by medical radiographs (Murphy W A et al, p.729), and in the Green River murder investigation, three of the 36 bodies were identified from x-rays (Haglund W D et al, p.1669).

Advantages

Between 1961 and 1970 in America, the number of x-ray visits per 100 people increased from 47.9 to 55.9. A substantial proportion of the population would therefore have ante-mortem radiographic records.

Radiographs usually include skeletal parts, which are hard and resilient and withstand considerable trauma. Skeletons are virtually inert features, therefore unique features remain permanent. It has been suggested that medical radiograph details are so individual that twin pairs could be separated through this method (Murphy W A et al, p.731). In criminal dismemberment, the dismembered body components still have potential for radiographic identification.

Disadvantages

Identification from x-rays is completely dependent on ante-mortem records, which must also be a part of the body recovered. The skeleton could be grossly disrupted by trauma, losing the body part on the ante-mortem record. X-ray identification is also time-consuming - average 7.9 days (Murphy W A et al, p.729), and requires bulky equipment. Portable x-rays are available, but rely on batteries, which may discharge rapidly, affecting exposure factors. Because this method is unwieldy, it is only used in identification where dental and fingerprint techniques are not applicable (Lichtenstein J E et al, p.1004).

Personal Effects

The term refers to items found with the body remains (Wolcott J H et al, p.1019). They are collected and compared with ante-mortem photographs. Although mainly used to provide supportive evidence, this method can give positive identification. The technique is simple and relatively cheap.

Disadvantages

Use of this method must be approached with caution. Personal effects are not a body part and one persons effects may be taken for those of another due to traumatic juxtaposition. In the Canary Islands crash, four cases occurred where personal effects did not match the remains, which were identified by other means (Wolcott J H et al,

p.1019).

Criminals may remove or replace personal effects on a body to mislead. This method is prone to error, but may confirm an identity postulated by other means.

Summary of Present Methods of Identification

Current identification methods have a high success rate, dental and fingerprint techniques being particularly effective. However, situations occur where these methods become useless or compromised (Table 2), therefore new techniques should be welcomed by investigators to collect wider evidence for primary identification or to support other evidence.

The Past Use of Chiropody and the Foot in Identification

Chiropody and the foot have played a limited role in identification. The F.B.I. Unidentified Person form only records crippled feet or toes (including club foot and webbing), fractured or missing toes and foot scars (Fierro M F) despite many foot pathologies. Forensic Chiropody was first mentioned in 1935 (Muir E). The article described a murderers bare footprint, with missing fifth toes, speculating on the reasons for this and eliminating most speculations for geographic reasons. The suspect suffered from double Ainhum, predominant in the country concerned. Although this speculation followed the conclusion of the

Table : 2
Potential problems that may hinder or prevent identification with respect to current methods used

Potential problem	Dental	Fingerprint	X-rays	Personal effects
Disrupting effect of trauma	*	**	*	**
Criminal interference	**	**		**
Lack of ante-mortem data	*	**	**	**
Imperfect ante-mortem data	*			
Imprecise examination				*

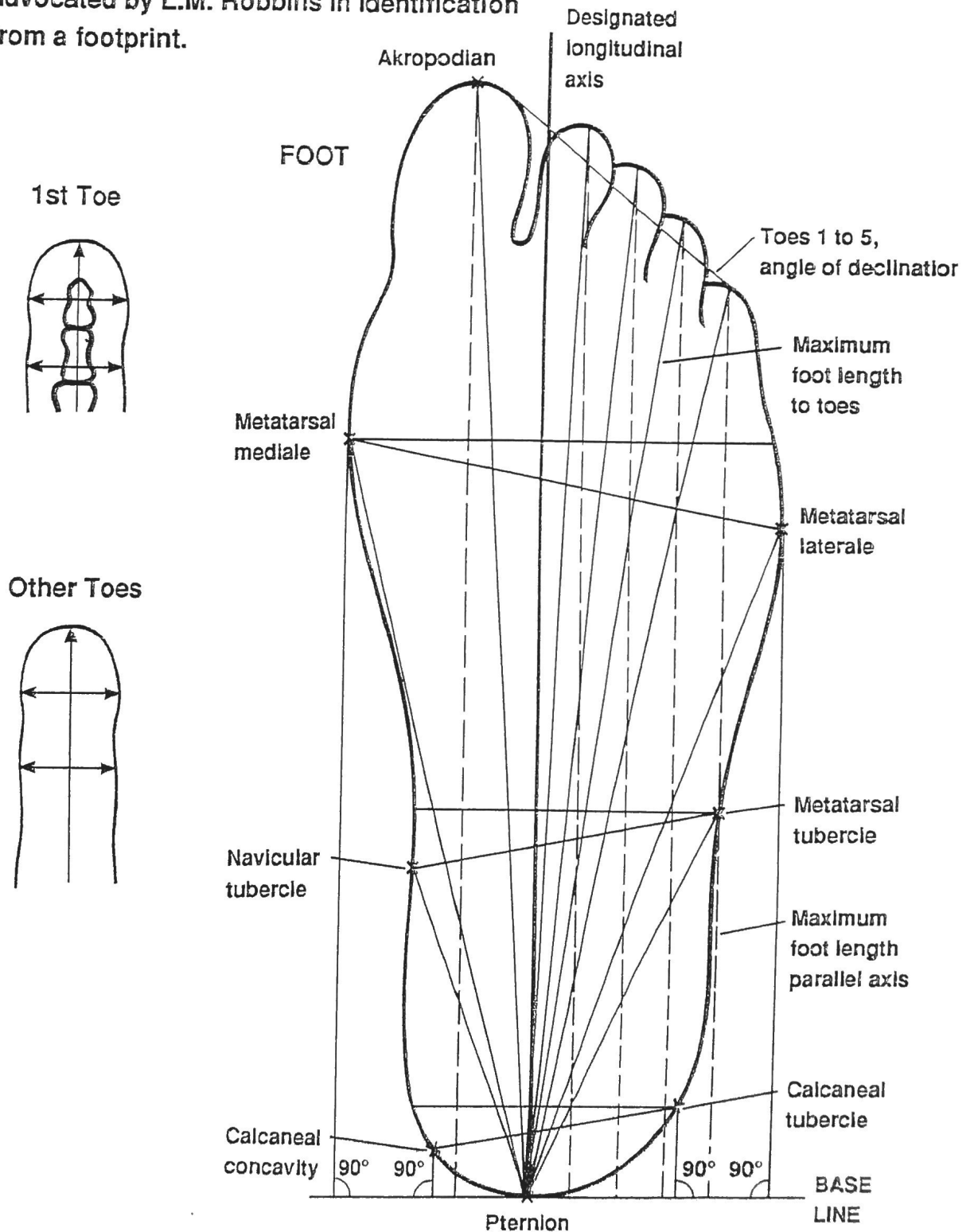
(* could occur ** highly probable)

event in question, it represents the first recorded forensic problem solving approach by a chiropodist.

In 1965, a paper entitled "Some guidelines in forensic podiatry" (Turchin C R), gave expectation of basic instruction in podiatric identification. Instead, advice was offered on how to avoid professional malpractice litigation. This advice was sensible and practical, but of no value to true forensic science. Robbins' study of footprints represents the greatest foot involvement in forensic work to date (Robbins L M). Robbins is a physical anthropologist with 30 years experience in footprint analysis. Using anthropological technique, Robbins defined measurement landmarks of the foot, and from this, determined scientific measurements and angles between landmarks (Diagram 1).

Robbins also described footprint morphology. Footprint data can be measured with a grid, recorded, and used to compare known/unknown feet, or give postulations about that individual (e.g. height and weight estimates) (Robbins L.M.). This identification method could be improved by Podiatrists knowledge of foot function (Nirenberg M S, p.250). Other studies suggest converting these foot measurements into indices, simplifying registration, recording, and observation (Qamra S R et al) (Laskowski G E et al).

Diagram : 1
 Visual Anthropological Measurements
 advocated by L.M. Robbins in identification
 from a footprint.



Footprints can identify criminals, infants in hospitals, or give information on the owner of the print. In the West, footprint identification is rare. By 1985 there were only 4 cases of conviction on plantar print evidence in the U.K. (Tulley S, p.63). This is due to predominately shod feet in the West. In far Eastern countries, many walk barefoot, therefore bare-footmarks are frequent (e.g. in the Central Forensic Laboratory in Chandigarh, between 1978-1979, 48% of all track marks investigated involved bare footmarks (Qamra S R et al). In 1979, L J Lucock gave the paper 'Identification from footwear' to the British Academy of Forensic Sciences (Lucock L J). Lucock had expertise in drawing conclusions of shoe-owners from wear marks, particularly in determining whether two shoes belonged to the same person.

The examination described evaluated the shoe size with an internal size stick, noted sole and heel wear patterns, and noted wear variations between minor deformities (e.g. Hallux Rigidus, Hallux Valgus), along with signs of short shoes. Creasing patterns and upper distortion according to foot deformities are also noted. Shoe insoles give footprint impressions and lining wear marks indicate contact areas, and degree of shoe pressure, demonstrating shape and lie of toes in the shoe.

Lucocks' paper was based on research. The methods were

practiced in 1982, when Indian Chappals recovered from a crime were compared with others from the suspects house. The comparative measurements incriminated the suspect through unique common characteristics (Tripathi R S and Jogulamma M R). Lucocks' work is useful in identification, but relies on shoes being old enough to register wear marks.

Foot anatomy has been used in identification. In the 1982 finding of two arms and legs, identification was assisted by the finding of Hallux Rigidus (Schneider V et al). Similarly, in 1988 the finding of a single foot gave positive identification and incrimination of a suspect (Sivaloganathan S and Butt W P). In both cases, radiographs were used, in the former, to confirm Hallux Rigidus, in the latter, to confirm known surgical arthrodeses and demonstrate exact comparison with ante-mortem x-rays.

In 1984, I E Doney produced a paper entitled 'Mass Disaster Identification, can Chiropodists help?' (Doney I E and Harris P H G). Chiropodists work was highlighted and the potential of chiropody records in lower limb identification in disasters discussed. The fine detail noted by chiropodists is not recorded by other medical practitioners. Doney argued that although mainly elderly persons receive chiropody treatment, there is a preponderance of elderly at risk. Doney suggested

identification may also be possible by chiropodists recognizing their individual styles of treatment, or by recording distinctive lesions (e.g. haemangioma, cyst and pigmented naevus) and their sizes. He also suggested that marking chiropodial appliances with details of the manufacturing chiropodist would help identification enquiries. Footprint use in identification was noted, and the paper concluded that chiropodists may assist disaster teams by charting foot lesions, especially where feet only are recognizable. These methods could also identify headless murder victims.

This paper was well received, but correspondence with Dr Doney confirmed that disaster agencies did not act on the suggestion, causing personal loss of interest (Appendix 1).

Chiropody and the foot appear to have potential in identification. Investigative authorities have disregarded this potential, which merits full investigation and exploitation, as all identification methods can become useless. In some situations, foot examination and charting may assist. The foot may survive trauma, being protected by shoe and sock in the West.

Following Doney's paper, an American surgeon confirmed that foot charting of Naval crews was being undertaken, as in fires protected feet are the last body part to be destroyed, leaving identification from feet the only means

possible (Filer D).

Feet can offer identification in circumstances rendering other methods useless, or where doubt exists, offer supportive evidence. Criminals familiar with dental and fingerprint identification may overlook possible identification from chiropody records and neglect the foot in defensive mutilation.

In May 1989, the American Podiatric Medical Association broke precedent to print a paper written by a podiatry student, entitled 'Forensic Methods and the Podiatric Physician' (Nirenberg M S). The paper was considered to be of prime importance, drawing attention to the neglect of podiatry in forensic work, noting the dearth of forensic podiatry literature. The foot's uniqueness was highlighted and a resume of footwear evidence, footprints and shoeprints offered. In discussing the analysis of such evidence, Nirenberg believed that podiatrists are better placed than anthropologists to analyze such evidence with knowledge of foot function as opposed to morphology, quoting a case whereby podiatric evidence acquitted a suspect previously arrested on anthropological evidence. Nirenberg concluded that Forensic Podiatry should follow similar directions as Forensic Odontology via educational programmes and research.

The purpose and history of chiroprody records and their relevance to identification.

Chiroprody records, record patients personal details (Name, address, telephone number), medical history notes, supervised medication, foot disorders, details of foot lesions and treatment methods undertaken. In the National Health Service (NHS) records belong to the Secretary of State for Health and Social Services, although opinions contained therein belong to recording chiroprodists (Idris-Evans D and Pooke M J, Ch.7). Private practice records belong to the private practitioner and those in Schools of Chiroprody to the School. Legal implications of records include confidentiality and as stated in NHS circular HC(80)7 (Idris-Evans D and Pooke M J, Ch.7), a need to retain accurate health records for possible litigation.

Chiroprody records developed haphazardly, with past records being used merely for financial reimbursement (Idris-Evans D and Pooke M J, Ch.1). Due to concern over chiroprody records, in 1980 a research project investigated systems then used, recommending future direction. A standardised chiroprody record was recommended, allowing ease of notation with treatment details recorded in full (Idris-Evans D and Pooke M J, Ch.17). A standardised system has not yet been adopted, however the report led to increased litigation awareness and chiroprodists subsequently recorded treatment and lesion details more accurately.

Chiropody records chart foot deformities and lesions requiring treatment.

Such conditions may not be unusual in themselves, but when observed as combinations as a whole, may demonstrate individuality sufficiently to identify that individual either in isolation or from other individuals.

Project Aim.

This project is undertaken in light of the current awareness of the neglect and potential of Forensic Podiatry, and utilizes information contained in chiropody records on type and situation of lesions recorded. Doney's suggestion that chiropody records can be used in identification is scientifically evaluated.

The overall aim is to evaluate the potential of chiropody records in forensic and mass disaster identification.

Justification for this investigation has been given in the opening discussion, namely that all current methods of identification, though excellent and proven can be rendered useless, giving a constant need to widen the 'armoury' of available identification techniques.

In pursuing this aim, several sub-aims will be achieved, namely:

1. Display and discuss current taught chiropody notation.
2. Statistically suggest numbers receiving chiropody

treatment in the U.K.

3. Assess chiroprodial lesion pattern individuality.
 4. Assess the success rate of chiroprodists judgement when identifying from chiroprody records.
- Each sub-aim will be considered along with the results.

Examination of Notation Currently Taught in the Recognized

Schools of Chiroprody in the U.K.

Chiroprody records consist of long hand and abbreviated form, taught at Schools of Chiroprody. The notation taught is appended for reference. Despite Society of Chiroprodists attempts to standardize notation (Society of Chiroprodists), no standard notation exists, so all Schools of Chiroprody were contacted by post requesting details of notation currently taught. This information was recorded in tabular form to facilitate clear reference to abbreviations and isolate abbreviations with multiple meanings, which were also presented separately for reference.

Results

Of the 14 schools, 13 replies were received. Ten schools taught complete abbreviation systems and forwarded lists of these. The three other schools confirmed that their students write notes long hand, although two schools allowed the abbreviations:

B Both
R Right

L Left

One school also allowed:

TNA Total nail avulsion

PNA Partial nail avulsion

The school not replying was telephoned. The policy at that school is that only the abbreviations:

B Both

R Right

L Left

are taught. Staff apparently persist in teaching several unofficial abbreviations, but the Head insisted that students must write notes in full initially using easily understood abbreviations for repeated notes. No subsequent abbreviations were recommended. Long hand was therefore taken to be the system taught at that school.

Between all 14 schools, 396 abbreviations represent 207 different terms. Different abbreviations taught for a single term range from one to six, the mean number for one term being 1,914. Some abbreviations have different meanings between schools, as do some similar abbreviations (Table 4). Twenty three abbreviations can represent several meanings. Table 3 lists numbers of conditions abbreviated in respective subject areas.

Table : 3
The number of different chiropodial conditions/ situations abbreviated in the respective subject areas

Subject areas	Number of different conditions/ situations abbreviated
Skin conditions	13
Nail and associated conditions	20
Foot deformities	14
Terms of location	38
Ligaments and tendons	5
Arches	2
Pulses	2
Medical conditions	20
Footwear	3
Dressings	39
Materials and drugs	26
General	13
Administrative	12

Table : 4
 Taught chiropodial abbreviations representing different meanings

Abbreviation	Meaning	Number of schools teaching abbreviation with this meaning
C	Area of callus	2
c	Witin	1
SHV	Vascular corn	1
HV	Hallux Valgus	4
p.p.	Pressure point	1
p.p.	Pes Planus	1
pp (etc)	Plantar aspect of 1st. etc	1
pp	Plantar phalangal area	1
S.F.	Fissures	1
S.F.	Sponge rubber	2
O	Nail plate	3
O	Oval pad	1
Gen. Op.	Nails of both feet cut, filed and cleared	1
Gen op	Operaling	1
O.Ex	Subungual exostosis	1
O.E	On examination	7
1,2,3, etc	Dorsum of respective toe	7
1,2,3, etc	Toes (number)	14
B	Both feet	4
B	Burulis	1

Abbreviation	Meaning	Number of schools teaching abbreviation with this meaning
PIP	Plantar metatarsal area	3
PIP	Plantar metatarsal pad	6
D.P.	Dorsalis pedis pulse	1
O.P.	Oreal pad	1
D/P splint	Dorso-plantar splint	1
C-C	Childain	1
Cc	Venous congestion	1
D	Diabetic	1
D' Pad	D' medial arch support	1
U.D	Pad with U'	2
H	Minor capillary haemorrhage	2
H	Minor capillary haemorrhage	1
(H)	Minor capillary haemorrhage	5
(H)	Minor capillary haemorrhage	3
(B)	Minor capillary haemorrhage	2
(B)	Minor capillary haemorrhage	1
Haem.	Minor capillary haemorrhage	2
Haem.	Non-minor capillary haemorrhage	4
O.P	Onychophosis	1
Op	Operate/ Operating	2

Abbreviation	Meaning	Number of schools teaching abbreviation with this meaning
7 etc.	Return in 7 etc. days	1
7 etc.	Return in 7 etc. weeks	2
7 etc.	Return in 7 etc. weeks	1
(7) etc.	Return in 7 etc. weeks	2
(7) etc.	Return in 7 etc. days	2
52	Return in weeks	2
52	Return in months	3
12	Return in months	4

Determination of Approximate Numbers of the Population who
Currently Receive Chiroprody Treatment.

This measure suggests the population proportion with current State Registered Chiroprody records, i.e. proportions suitable for chiroprody identification.

National Statistics were obtained for:

1. U.K. population.

2. Numbers currently receiving NHS chiroprody treatment in England, Wales, Scotland and Northern Ireland.

The sum of the statistical information in 2. gives total numbers receiving U.K. NHS chiroprody treatment. As no current statistics relate to numbers currently receiving private State Registered chiroprody treatment, the following procedure was undertaken to statistically determine this information.

Private practices are businesses requiring telephone services. All business lines have British Telecom Yellow Pages entries. All State Registered practices listed in Yellow Pages for the U.K. were counted, assuming this gives a comprehensive record of such practices.

One hundred practices from this total number of State Registered U.K. practices were randomly selected, using random numbers (J Murdoch and J A Barnes). To select, the first number pair referred to directory area codes, the second pair to the practice of that area in that directory list position. When that number was greater than the list

size, the list was counted through again until the designated number corresponded with a listed practice. If a practice was selected twice, the preceding practice was used. Care was required when using the directory, as some chiroprodists have multiple practices in different areas.

Block notifications of State Registered practices were collated with alphabetic directory lists, as not all practices are listed on both. The 100 selected practices were contacted by post, requesting information on patient numbers listed with that practice (Appendix 2). The form was designed to receive replies anonymously and where the exact number was unknown, an estimation was invited. Numbers of chiroprodists employed in the practice were also requested and stamped, addressed envelopes enclosed.

From the replies, statistical inference suggested total numbers receiving private State Registered chiroprody treatment.

The standard error (SE) of the mean for numbers attending each practice was calculated to suggest a population mean. Clinical experience suggested some individuals receive NHS and private treatment concurrently. To avoid counting these individuals twice in the statistical determination of numbers receiving treatment, a questionnaire was distributed to a random selection of 100 chiroprody patients attending the Sheffield Health Authority (Appendix 3). The

random method was to ask one in five re-attending patients to complete the questionnaire. Complete anonymity was guaranteed. The questionnaire asked whether concurrent private treatment had been received within the last two years and whether that chiroprapist was State Registered. When unsure of State Registration, the chiroprapist's name and address were requested to check against the State Register (Appendix 4). The standard error (SE) of the proportion related this sample to the population. Treatments are carried out in Chiroprody schools by students under supervision. State Registered standard treatment records are kept at these schools. Numbers receiving such treatment must be included in determination of numbers with chiroprody records of State Registration standard. All schools were contacted by post requesting numbers of patients treated. From the combined information from National Statistics sources, questionnaire and schools replies, the number and percentage of the population receiving State Registered chiroprody treatment in the U.K. was suggested.

Ethical Considerations.

Those involved in the study have a right to anonymity and this right should be explained to those being studied (Kane F). questionnaires were designed to respect anonymity and explained the reason for questionnaires. There were no

foreseeable adverse consequences to subjects from participation.

Results.

National chiroprody statistics are not kept for Northern Ireland. The Northern Ireland Department of Health and Social Services gave telephone information that such statistics are being compiled, but only information for three of their four Health Boards was available. This information was used to indicate probable numbers receiving NHS chiroprody treatment in the fourth Health Board (Appendix 5), to suggest probable numbers receiving NHS chiroprody treatment throughout Northern Ireland.

From the NHS statistics for the U.K:

Of the total U.K. population of 56,900,000 (Government Statistical Service 1989), with 95% certainty, between 2,419,549 and 2,421,694 receive NHS chiroprody treatment (Appendix 6).

Of the 100 randomly contacted private practices, 66 replies were received. Four were incomplete. Of the 62 completed replies, 33 were estimated and 29 exact figures for numbers attending each practice. When these numbers of patients per practice are plotted in histogram form (Table 5), there is heavy positive skewing, with a second slight peak at 3201-4000 patients per practice.

Numbers of practices

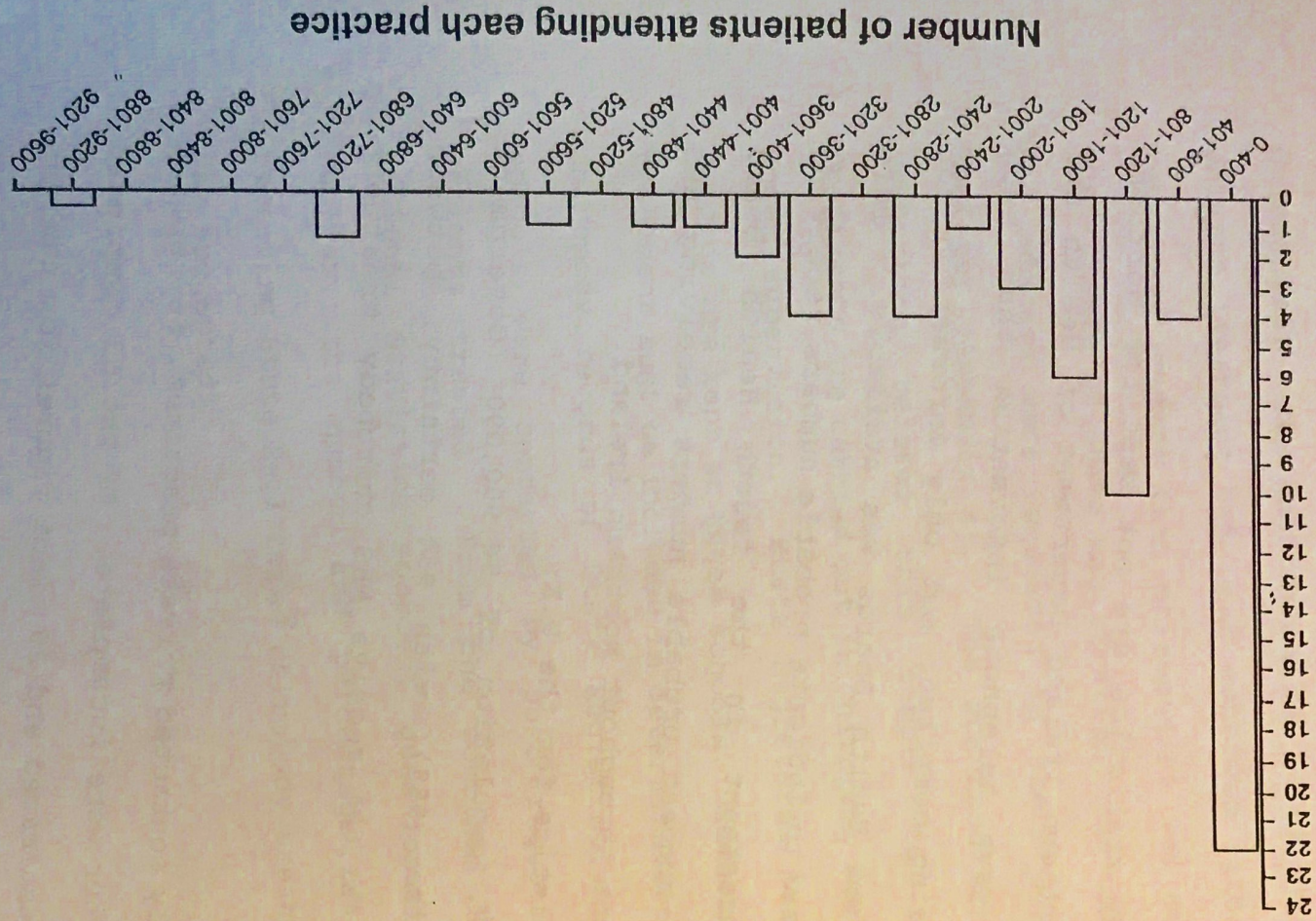


Table : 5
Numbers of patients attending individual private practices

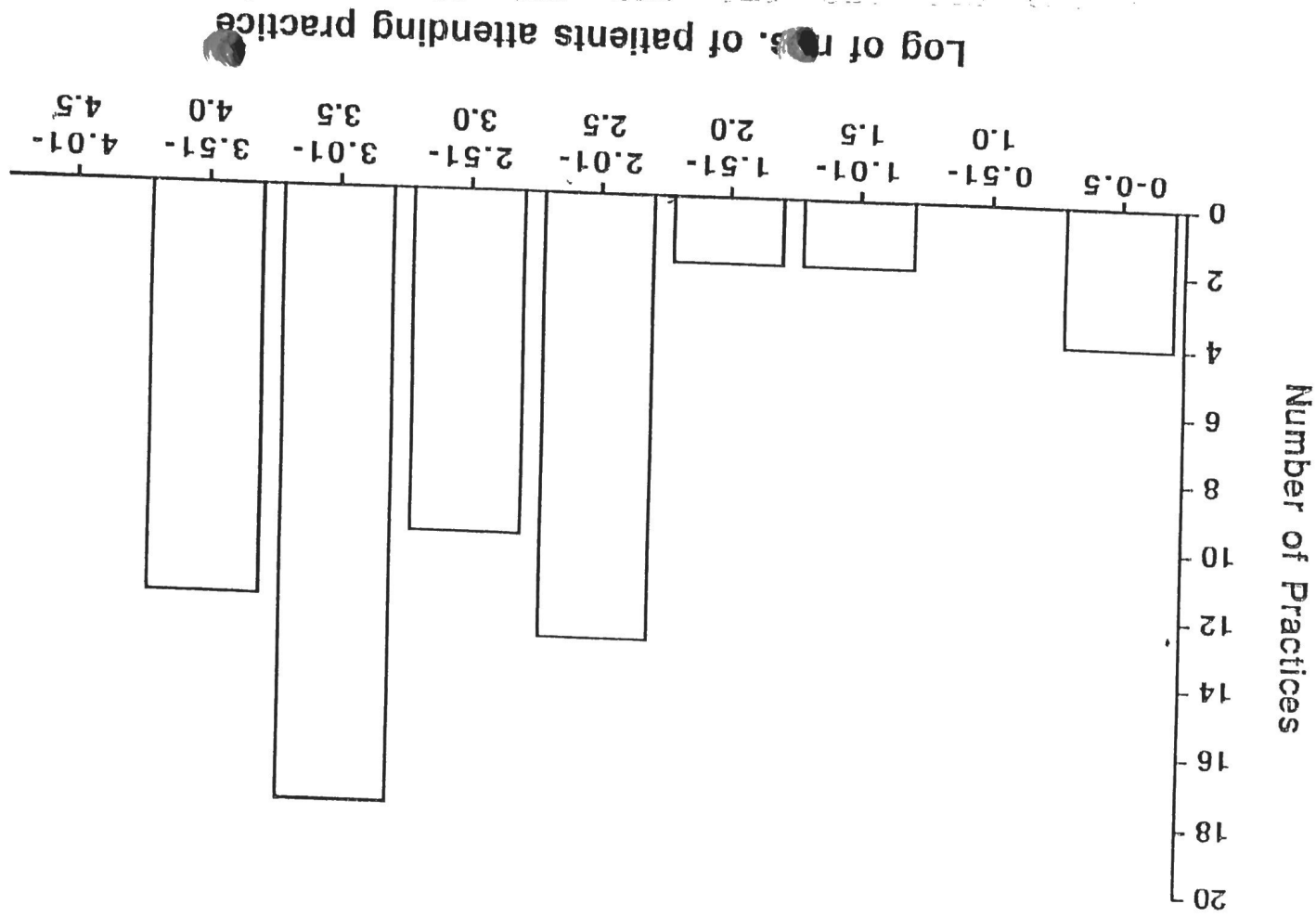


Table : 6
 Log normal distribution of nos. of patients attending individual private practices

Plotting the logarithm of the x-axis gives reasonable lognormal distribution (Table 6). Statistically analyzing the lognormal distribution, the sample logmean is 584.4 and for the population, the SE mean shows with 95% confidence, 343.08 < population mean < 995.4 (Appendix 7).

The count of State Registered private practices totalled 1,765 practices. There being 1,765 such practices and the mean number attending each practice being 343.08-995.4 (with 95% confidence), with 95% confidence, the total numbers receiving private State Registered chiropody treatment in the U.K. lies between 605,536 and 1,756,881 or 1.064-3.09% of the population (Appendix 8). In the adjustment to this figure via NHS patient questionnaire, 100% questionnaire response was obtained, as patients completed the questionnaire during treatment attendance (See Table 7). Twelve of the 100 respondents had received concurrent private State Registered chiropody treatment.

The SE proportion for this figure is .0325, indicating 95% certainty that the population proportion of NHS patients also receiving private treatment lies between .0563 and .1837, or 5.63-18.37% (Appendix 9). There being between 2,419,549 and 2,421,694 NHS chiropody patients in the U.K., with 95% certainty, between 1,975,078 and 2,285,353 receive only NHS chiropody. with 95% certainty, between 605,536 and 1,756,881 individuals receive private State Registered chiropody treatment.

Table : 7
Results of NHS patient questionnaire

Category of response	Number with this response
Had not received private treatment, while accepting NHS treatment.	49
Had received un-registered private treatment while also accepting NHS treatment.	39*
Had received state-registered private treatment while also accepting NHS treatment.	12*

(* denotes figure obtained after checking details of replies where the patient was unsure of the Chiropractors' Registration status)

Of the 14 schools, 13 replies were received listing numbers treated in the last academic year (Appendix 10). The other school gave telephone information that they did not keep these figures, but 14,500 treatments were given during the past academic year. An approximation of 3-4000 attending patients was given. Four other schools had also provided treatment numbers for the academic year. This information was used to calculate treatments/annum given to patients. Assuming normal distribution, the SE mean demonstrated 95% confidence that the mean number of treatments for individuals attending Chiropody Schools is between 3.325 and 4.073/annum. With 95% confidence, 3,560 to 4,361 patients received treatment at the school in question in the last academic year, confirming the approximation of 3-4000 (Appendix 11).

The sum of this information shows with 95% confidence that 90,216-91,017 currently receive treatment at Schools of Chiropody.

Taking sums of upper and lower limits of this information:

	Lower Limit	Upper
Limit		
Numbers receiving private chiropody treatment	605,536	1,756,881
Numbers receiving NHS treatment only	1,975,078	2,285,353
Numbers receiving treatment at Schools of Chiropody	90,216	91,017
TOTAL	2,670,830	4,133,251