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Title and Subtitle HOSPITAL BASED SYSTEMS FOR STUDYING ROAD CRASHES: Hunter Region Study

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ABSTRACT A pilot study was undertaken in the Hunter region of Australia during 1985-86 to determine feasibility, benefits and costs of alternate data bases to be used for analysis of the medical outcomes of road traffic crashes. Results are reported for the most cost-effective option, the linking of existing, routinely collected data from two different sources: police traffic crash records and the discharge summaries for hospital in-patients.

The method of linking these files in the absence of unique personal identifiers, names or addresses is described. The effectiveness of the method is evaluated with the aid of results from another option, accessing data from the hospital medical records.

KEYWORDS: TRAFFIC CRASHES ACCIDENTS MONITORING MEDICAL ROAD SAFETY DATA BASE OUTCOMES

NOTES:

(1) FORS research reports are disseminated in the interests of information exchange.

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DEPARTMENT OF TRANSPORT

FEDERAL OFFICE OF ROAD SAFETY

HOSPITAL BASED SYSTEMS FOR STUDYING ROAD CRASHES: HUNTER REGION STUDY

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The Traffic Authority of New South Wales has been strongly supportive of the project and their research unit assisted with the provision of data processed by that Unit.

Officers of other services approached in the course of this study willingly gave of their time to discuss the issues raised. The project team gratefully acknowledges all of these inputs.

EXECUTIVE SUMMARY

1. A pilot study was undertaken in the Hunter Region of Australia during 1985-86 to determine the feasibility, benefits and costs of creating a data base to be used for analysing the outcomes of road traffic crashes.

2. The traffic crash files compiled by the Traffic Authority (N.S.W.) and the hospital morbidity collection files were linked for the period January - June 1985 in the Hunter Region.

3. The linked file consisted of 423 admissions for the first six months of 1985, which reprsented 71% of all admissions. It was estimated that 19% of these would be false links and hence only 296 records (51% of all admissions) were used in the analysis.

4. The linked file allows analyses using both traffic related and medical outcome data, and examples are given using the pilot data set.

5. While the linked file consists of a sample from the population of all hospitalised traffic crash victims, (not every record can be linked), such a sample would be large enough to determine associations between medical outcome and traffic variables if taken from five consecutive years of traffic and hospital data.

6. Although this study has used data from the Hunter Region in New South Wales, the methodology of linking hospital and road crash data files could be used in other regions or States where the original data files exist. This would enable the development of similar systems to be established elsewhere.

7. Data were also abstracted from the hospital medical records. The additional data collected included the abbreviated injury score which was shown to be related to length of stay in hospital and the number of diagnoses in the hospital separation form.

RECOMMENDATIONS

1. The traffic crash files compiled by the Traffic Authority (NSW) and the hospital morbidity collection files for the years 1979 to 1984 are sufficiently comprehensive in coverage throughout the State of NSW as to allow for analysis of traffic crash patterns and medical outcome pre- and post- random breath testing. While the traffic crash files are available in computer readable format, the hospital admissions resulting from traffic crashes are not available as one file. These should be extracted from the NSW hospital collection and made available to the Traffic Authority (NSW) as part of their data base. Approximately 110,000 admissions occurred during the six year period, and the computer file would contain over 50,000 records after allowing for the sampling of morbidity records and the absence of 1982 data. The inclusion of the sampling factor at each hospital in the computer file would enable the appropriate statistical analyses to be made.

2. In addition to, but in association with analyses of the individual files, a linked file should be created consisting of those records in the traffic file and those in the morbidity file which can be linked together with an acceptable degree of confidence. The report gives details on which computer algorithm and criteria should be used to carry out the linking of the files.

3. The linked file should be created for as many years as possible. For NSW, six years could be used, and the linked file would contain more than 20,000 records with 10% being false links or 10,000 records with 1% being false links. The feasibility of doing this in other States depends upon the availability of the data sources (traffic and hospital files).

4. Mechanisms should be provided for updating the hospital morbidity and linked files over future years. The methods used will depend upon the respective data collections in each State.

5. The linked files will allow for analyses of the major medical outcome variables (diagnoses, procedures performed, length of stay, etc.) in terms of the traffic crash variables (such as speed zone, vehicle type and make, rural/urban crash etc).

6. Incorporating the BAC (blood alcohol content) for the driver onto the linked file will give scope for further analyses. The information on alcohol in the hospital records is neither valid nor precise.

8. The cost of abstracting additional information from the doctors' medical records retrospectively is prohibitively costly, particularly given the amount of missing data in these records. Although this additional abstraction allows for the computation of an index of the 'severity' of the crash, using length of stay in hospital is a suitable and cheaper surrogate measure.

9. Interviewing patients while in hospital to obtain detailed information on the causes of the crash is not feasible as a routine data collection. Such interviews would have to be restricted to particularly relevant crash types (e.g. motor cycle crashes with length of stay greater than 30 days) and preferably after the patient left hospital. Specific research projects with detailed research objectives would have to be established. After approval from ethics' committees, the specific projects may be able to use the above recommended data bases to draw their sample of patients.

10. The system developed in the Hunter could be used as a model by States who are establishing similar hospital based data for studying road crashes.

1. INTRODUCTION

1.1 *Background*

Each year in Australia, approximately 3,000 persons are killed and 28,000 persons are hospitalised as a result of road traffic crashes. Traffic crashes are a major cause of trauma, death and loss of effective working years; they are costly in terms of human and financial resources. The availability of relevant information on factors associated with crash events and on their outcomes is a necessary element for the development of effective strategies to reduce this road toll.

One outcome measure, the trend in hospital admissions arising from traffic crashes, has been monitored in the Hunter Region using the New South Wales Hospital In-patient Statistics Collection [1]. The study of admissions to Hunter hospitals resulting from traffic crashes during 1977-1983 indicated that admissions are predominantly male (70%) and in the age group of 15-24 years (45%). The importance of the occurrence of traffic crashes for this age group is confirmed by the Australian Bureau of Statistics (ABS) collection which indicates that the most common cause of death for 15-24 year olds is motor vehicle traffic crashes [2].

Following the introduction of random breath testing in New South Wales, the Department of Health began providing data on hospital admissions to the former Traffic Accident Research Unit which is now called the Traffic Authority of New South Wales. These data were made available to assist the NSW Ministerial Road Safety Sub-Committee in the continued evaluation of the effectiveness of the Random Breath Testing Programme [3]. Since 1 July 1983, all hospitals in the State have reported quarterly, for each month: (a) the number of separations of patients who had been admitted as a result of motor vehicle crashes; and (b) the total number of inpatient days in respect of patients who had been admitted as a result of motor vehicle crashes.

The present study was proposed in 1985 to expand the data base available on road traffic crashes. This joint project involves members of the Department of Health (Hunter Region), NSW, the University of Newcastle and the Hunter Health Statistics Unit in a pilot study conducted in the Hunter Region of New South Wales. It is intended that the results of this pilot study will be able to be generalised to data collections in other States.

1.2 *Aims of this Study*

The aims of this pilot study have been to:

1. assess how traffic crash and hospital data can be made more relevant for monitoring the causes and medical outcomes of traffic crashes in general, and

2. to determine what additional data can be obtained from other sources, such as hospital medical records, ambulance records and patient interviews.

1.3 *Objectives*

The primary objective is:

. to establish guidelines for a model system that can be recommended for wide-spread adoption throughtout the States and Territories in Australia.

Further objectives are:

. to provide a model traffic crash data base, by linking data from hospitals and police traffic reports;

- to collect additional data from hospital and ambulance records and determine a method for recording injury severity;
- to demonstrate how this data base could be used to investigate the association of personal, environmental and vehicle factors with traffic crashes; and
- to discuss the feasibility of implementing this methodology widely throughout Australia.

1.4 *Official Data Sources*

1.4.1 *Vital Statistics*

The Australian Bureau of Statistics (ABS) makes regular releases of information relating to the outcomes of road traffic crashes. Motor vehicle traffic crashes are distinguished as a cause of death in ABS publications of *Deaths* and *Causes of Deaths* for Australia, and for individual States [4] . These data are based on information supplied to the ABS by the Registrars of Births, Deaths and Marriages in the States and Territories.

1.4.2 *Road Traffic Accident Statistics*

The ABS also compiles statistics on the basis of road traffic crash reports completed by police officers. Summary statistics from this compilation are published monthly, *Road Traffic Accidents Involving Fatalities, Australia,* and quarterly, *Road Traffic Accidents Involving Casualties [Admissions to Hospitals] Australia.* [5]

1.4.3 *Traffic Authority of NSW*

The Traffic Authority of New South Wales has responsibility for the compilation of data from information contained in reports furnished by police in that State. In addition to providing data to the ABS, the Traffic Authority of New South Wales publishes a more extensive annual statistical statement, *Road Traffic Crashes in New South Wales.* Information is provided in that Statement on traffic crash events and includes:

age and sex of licence holders;
vehicle registration numbers;
age and sex of various classes of road user killed, and injured;
seating position of car occupants killed;
age, sex and vehicle for all drivers and riders involved in crashes;
month, day of week and time of day;
severity of crash;
mechanical faults reported;
pedestrian/railway controls and speed limit (as appropriate);
roadway features and speed limit at intersection, and at other crash location;
items involved;
alcohol involvement; and
locality (by local government area, and by freeways and highways).

1.5 *Other and Unpublished Data Sources*

1.5.1 *Police Traffic Reports*

The data base compiled from police reports in New South Wales covers the circumstances of the crash event, traffic units involved, and persons killed or injured. A copy of the report form used in New South Wales is reproduced in Appendix A. These data contain information collected at the crash site. The information collected

> "is confined to matters of objective fact as reported by the investigating police and therefore does not include matters of opinion. This practice is consistent with the general recognition by traffic safety research workers throughout the world that traffic crashes are multicausal in origin and that research and planning of countermeasures cannot be based on the belief that every crash has a single or even a main cause" [6].

This data base contains over 100 items of information. In addition to the tables published, more extensive analyses of this data source are in progress within the Authority in association with the University of New South Wales.

1.5.2 *Ambulance Reports*

In terms of the crash sequence, at least for a proportion of crashes involving casualities, a second data collection is made by officers of the Ambulance Service. An Ambulance Report Form, a copy of which is reproduced in Appendix A, is completed by the attending officer for every call to which the Service responds. Data recorded when a traffic crash scene is attended include medical information relating to the injured persons. There is also provision on the report form for brief details about the crash, such as speed and position of persons in the vehicle. Ambulance data provide a link between hospital and police data sets.

1.5.3 *Hospital In-Patients Statistics Collection*

This collection (also known as the hospital morbidity collection), provides an on-going source of data such as, demographic characteristics, length of stay, diagnoses, operations performed and cause of injury (if applicable), for patients of public and private hospitals in NSW. Data from the medical record of each hospital inpatient are abstracted onto a separation form for the in-patients statistics collection after the patient is discharged. The collection, in New South Wales, contains the fields shown in Appendix A.

1.5.4 *Hospital Medical Records*

A major source of medical data that is presently not generally utilised in traffic crash research is the hospital medical record. Certain data are routinely processed from this source for the hospital morbidity collection. This collection was designed primarily for administrative and planning needs. Hence information that is particularly relevant for traffic crashes is not coded, such as drugs used, blood alcohol, prior medical conditions etc. Such data may be contained within doctors' notes, nursing notes, or other reports filed in medical records, but are not currently abstracted in any statistical format.

1.5.5 *Other Potential Data Sources*

The list of other potential data sources includes:

- coroners' reports;
- autopsy reports;
- records of rescue services, and
- death registrations.

1.6 *Components of the Study*

The present study considers a selection of options for expanding the data base available on traffic crash events by the inclusion of additional information of a medical nature. The study proceeded on three levels:

Component A: linking already-existing and routinely maintained computer files;

Component B: making fuller utilisation of hospital in-patients' records;

Component C: collecting more information from patients.

Component A is the linkage of the two major statistical collections: namely the police traffic crash reports and the hospital morbidity files. The practicality of including these data and a further data collection residing in files kept by the Ambulance Service as a merged data set is reviewed. The feasibility of establishing a link between the two major collections is demonstrated using data for the Hunter Region. The linkage procedure developed has been tested using data for the period January 1, 1985 to June 30, 1985. This procedure has also been applied to 1984 data, to generate an integrated data base for further research.

Component B of the study reviews the data residing in medical records as a source of additional information relating to road traffic crashes and to subsequent injury management. Hospital medical records, including ambulance reports, constitute the largest source reviewed. These are supplemented by Coroners' reports and autopsy reports of people who died as a result of road traffic crashes.

Component C involves assessment of patient interviews as a means of extending the data base. From the outset this phase was the most problematic and is a subsidiary component of the study.

The time period for collecting data is: January to June, 1985. The study area is the Hunter Region of New South Wales which cover the local government areas of

1. Cessnock
2. Dungog
3. Gloucester
4. Great Lakes
5. Lake Macquarie
6. Maitland
7. Merriwa
8. Murrurundi
9. Muswellbrook
10. Newcastle
11. Port Stephens
12. Scone
13. Singleton

Investigation of hospital in-patients' records was conducted in depth at three Hunter hospitals:

Royal Newcastle Hospital;
Cessnock District Hospital; and
Singleton District Hospital.

While the Royal Newcastle Hospital serves the metropolitan area, Cessnock District Hospital serves a mixed rural/urban population and Singleton District Hospital has a larger rural catchment than the other two hospitals.

2. TRAFFIC TRAUMA INFORMATION SYSTEM

The aims and objectives of this pilot study have been set out in Sections 1.2 and 1.3 and the different components of the study were outlined in Section 1.6. These, taken together, are directed towards developing an improved traffic trauma information system. Before guidelines are formulated for a model system, the following areas need consideration:

1. the potential users of the information system;
2. the needs to be met by the collection;
3. desirable content;
4. the practicality of the proposed collection; and
5. costs involved.

2.1 *Potential Users of the Data Base*

The study team has received indications that several groups are interested in the proposed extension of the data base, including:

Federal Office of Road Safety;
Department of Health (NSW);
Traffic Authority of NSW;
Royal Newcastle Hospital Department of Anaesthesia and Intensive Care; and
Road User Trauma Advisory Committee.

It may be envisaged that, if an extended data base was established and maintained, further groups would seek to use it. Consequently, one question to be resolved is the extent to which existing data sets should be merged and additional data should be collected in a general purpose framework.

2.2 *The Needs to be Met by the Collection*

A review of literature on road traffic crash outcomes and on other aspects of road traffic crash research, confirms that the uses of a systematic collection of injury data vary with the potential user group. Baker, in the context of evaluating methods of scoring severity of injury, identifies six uses for such measures [7]. These functions also apply to the provision of an injury data base, and in general they are:

1. triage;
2. clinical decisions;
3. planning trauma systems;
4. evaluation of emergency systems and trauma care;
5. recognition of changes in the epidemiology of injuries; and
6. estimation of the cost of injuries.

To these should be added a set of concerns voiced by traffic and road safety authorities. The most evident of these are listed as:

7. insights into crash causation;
8. evaluation of counter measure development;
9. identification of target groups for safety education compaigns; and
10. association of specific injury outcomes with vehicle design factors.

All of these needs constitute legitimate demands to be placed on a full trauma information system and should be referred to in assessing any proposed system.

2.3 *Desirable Content*

The desirable content of a statistical collection is determined by the purpose for which it is to be used. There may be a disparity between desirable content and actual content, the latter being modified by the framework within which the data are collected. A consideration of examples of the modification of content in collections such as the police traffic crash files and the hospital morbidity collection helps to highlight what would be the preferred content in a comprehensive information system.

Collected from the viewpoint of evidence to be used in establishing fault or culpability, the traffic crash files are restricted to matters of fact concerning the immediate circumstances of a crash event and broad classifications of outcome. These files contain

- little information of a non-traffic nature on the circumstances of the crash event,
- only the broadest possible indication of extent of injury (no injury/injured/killed), and
- treatment of injuries, in broad classifications of location and provider of service.

The existing morbidity collection was designed primarily for internal hospital administrative and planning purposes. Nevertheless, in addition to basic administrative data, it contains a number of items relevant for assessing the nature and medical outcomes of road traffic crash injuries. Among items included are:

- basic demographic data;
- diagnosis codes recording the nature of injury (ICD-9);
- treatment procedures codes (ICPM); and
- admission and discharge dates.

These data items can be used to evaluate one type of cost (hospital-medical cost) of injuries. The morbidity file also contains some information of a traffic nature (external cause of injury), but no information of an engineering or traffic engineering nature.

In terms of the functions listed above, each of these data sets offers insufficient information. Taken together, their content is relevant for at least half of the needs listed in Section 2.2 including:

- the epidemiology of injuries;
- cost of injuries;
- counter measure development;
- targetting groups for special attention; and
- vehicle design issues.

Additional data relating to physiological states, severity of anatomical injury, and patient management are particularly relevent for the first four of the needs listed. Some of these data are potentially captured by existing recording systems, such as the patients' hospital medical records, ambulance records, and coroners' reports.

Some data items which are potentially relevant for need 7, (insight into crash causation), are not well covered in any of the existing collections. These items include:

- sources and extent of road/driving training driver has received;
- familiarity of driver with the prevailing road conditions;
- duration of journey and time since last resting period; and
- other conditions of stress which might modify driving behaviour.

2.4 *Practicality of the Proposed Data Base*

This study has looked at one set of options for meeting the data needs listed above.

Details of the results of this investigation are given in:

- sections 3 to 5 - linking existing files;
- section 6 - utilising hospital in-patient records; and
- section 7 - collecting new data.

In summary, the main conclusions drawn are:

1. a computerized linking of records in the NSW traffic crash file and the NSW hospital morbidity collection was achieved, despite the problems posed by the absence of a unique personal identifier in either file;

2. there is a trade-off between the proportion of records linked and the level of confidence that the records linked refer to the same person. If 10% of the false links are acceptable, over 50% of the records in the regional files can be linked by the recommended procedure. Twenty-eight percent of the records can be linked with a high probability (99%) that the links are correct;

3. application of this technique over a wider time span, e.g. 1979-1985 would generate a useful data base for the analysis of personal injury in road traffic crashes. At the highest level of confidence in the correctness of the links (1% error) this data base could be expected to contain 2,000 records in the Hunter or more than 10,000 in NSW. Appropriate sampling weights can be determined for each successfully linked record;

4. data in hospital medical records provide different information from that in the morbidity collection, insofar as they allow the severity of injury to be expressed as a score rather than in terms of length of stay;

5. considerable difficulties are evident in the abstraction of data from medical records. Some of these difficulties are inherent when data collection of a statistical nature is not the primary intention of the record keeping;

6. it is more practical to explore the greater use of existing data files than to embark on an extensive collection of new data.

These conclusions could be applied to those States and Territories which have hospital based morbidity data systems and traffic crash files.

2.5 *Costs Involved*

The costs involved in producing the linked data set are the design of the linking procedure, computer software development, computing time and disk space, analyses and testing of linkage. Using NSW as an example, to produce a hospital traffic crash file and the corresponding linked file for a six year period (1979-85) for all of NSW and analyse the results would require at least a full time computer / statistican for one year ($30,000), plus $15,000 for computing time and part-time research staff.

The costs involved in an expanded medical record abstraction for traffic admissions are design and management of abstraction process, medical records staff time, coding and editing of data, data entry, linking with traffic file and analyses. The cost estimate for the Hunter Region alone for one year is $25,000. Further, there still remains the problem of linking these data to the traffic crash files.

Clearly, the computer linking for the whole state over a six year period is going to produce the larger data set for a reasonable cost.

3. CO-ORDINATION OF EXISTING DATA SOURCES: COMPONENT A OF THE STUDY

3.1 *Introduction*

The first task in this study is the linking of existing data collections which are maintained in computer-readable form. The study set out to:

. develop a methodology for linking these data sets;
. test the feasibility of making the link between files by a computerised technique;
. evaluate the effectiveness of the technique and its costs; and
. demonstrate the use of such an integrated data base.

Subsidiary outcomes are to:

. provide information on the coverage of motor vehicle crash victim information by individual from the source data sets and
. offer an assessment of the quality of data available.

Of the data bases outlined in Section 1.5, the following three are maintained in computer readable format and could be used to monitor traffic crashes:

. police traffic crash data;
. ambulance report data; and
. hospital morbidity collection.

3.2 *Police Traffic Crash Data*

Police crash reports are prepared at each local police station and forwarded to Sydney at the end of each month. The report form used in NSW is included in Appendix A. The traffic crash report generates three data sets, which are maintained in the following files:

general information file;
traffic unit information file; and
casuality unit information file.

3.2.1 *General Information File*

The general information file contains data relating to the crash as an event, such as when and where the crash occurred, road features and conditions, weather conditions, number and type of items and traffic units involved in the crash, and number of persons killed or injured.

3.2.2 *Traffic Unit Information File*

The traffic unit information file consists of a separate set of data for each traffic vehicle involved in a crash. This record contains data which links it to the general information file and relates to the type, age and make of the traffic unit, direction of travel, manouvres, number of occupants, factors or errors associated with the traffic unit, and resulting damage to the traffic unit, as well as data relating to the driver/rider of the traffic unit.

3.2.3 *Casualty Unit Information File*

The casualty unit information file contains a separate set of data for each casualty in a crash. This data set includes basic information on age, sex, position in vehicle, degree of casualty, location of treatment and hospital (if admitted). A list of items included in these files is provided in Appendix B.

3.2.4 *Processing Practice*

In New South Wales police crash reports from all over the State are forwarded to Sydney for data processing at the end of each month. The Traffic Authority of New South Wales processes these data for statistical purposes and stores the resulting files on magnetic tape.

3.2.5 *Data Provided for the Study*

For the purposes of this study, the Traffic Authority made available computer tapes containing traffic crash data for all reported crashes involving injuries which occurred during the study period in the thirteen local government areas constituting the Hunter Region. The period selected for intensive study and testing purposes was from January 1 to June 30, 1985. Data for 1984 were also obtained, and used in the development of the linkage technique. Consequently the resulting linked files cover:

geographical area:	Hunter Health Region, NSW (as defined in 1985) (13 local government areas)
time periods:	1984 (January to December) 1985 (January to June)

3.3 *Ambulance Report Data Set*

Officers of the Ambulance Service of NSW complete a report form, a copy of which is included in Appendix A, for each patient transported by ambulance. One copy of this report is intended to remain in the hospital records of patients transferred to hospital. There is provision to enter statistical data for computer analysis from another copy of the report. A list of the fields indicated to be available for coding in this format is given in Table B2 in Appendix 2.

Ambulance report data are used within the Service primarily for purposes of medical procedure review. The data processing resources of the Ambulance Service are not extensive.

Ambulance report data represent a potentially valuable link between the crash event and the treatment of the hospitalised patient. Negotiations were initiated with the Central Office of the Ambulance Service in Sydney to obtain Hunter data for the study. Unfortunately when preparing the extraction of the Hunter data from the State's tapes, a programming problem was found and consequently the corrected tapes have not been available in time to allow for the inclusion of the Ambulance data within this Study's schedule. An assessment of Ambulance report data residing in hospital medical records is given in Section 6.

3.4 *Hospital Morbidity Collection*

3.4.1 *Nature of the Collection*

The NSW hospital morbidity collection is the principal source of information on inpatient utilization of acute hospitals in NSW. Data processing by the Hunter Health Statistics Unit (HHSU) began in 1979 and has been continuous since then. Similar data are also available for all of NSW, except in 1982, although sampling methods have been used since 1979 (see table 3.1 for details of the NSW collection). The purpose of the collection is to provide information on diagnoses, surgical procedures, lengths of stay and patterns of use of care in each hospital.

TABLE 3.1 NSW Morbidity Data Files Maintained at HHSU

YEAR	PUB. HOSP.	PRIV. HOSPS.	DIAGNOSIS CODE	PROCEDURE CODE	SAMPLE (coverage)
1977	yes	no	ICD 8	Dept Health	100%
1978	yes	yes	ICD 8	Dept Health	100%
1979	yes	yes	ICD 9	ICPM	50%*
1980	yes	yes	ICD 9	ICPM	50%*
1981	yes	yes	ICD 9	ICPM	50%*
1982	data not processed except in Hunter / Illawarra Regions				
1983	yes	yes	ICD 9	ICPM	40%**
1984	yes	yes	ICD 9	ICPM	40%**
1985	should be available in December 1986				

* except for the Hunter public hospitals, hospitals with less than 1,000 separations per year and hospitals with computerized admission/transfer systems (major Sydney teaching hospitals), which have 100% samples.

** rotational sampling was used, except for Hunter public hospitals, hospitals with less than 1,000 separations and hospitals with computerized admission/transfer systems (major Sydney teaching hospitals), which have 100% samples.

3.4.2 *Data Collection Procedures*

Discharge data are collected from the medical record of every patient using a standard form, a copy of which is included in Appendix A. The form submitted is abstracted from the medical record by the medical records department in each hospital. The diagnoses are coded by the ICD-9 manual, while the operations are coded with IC-PM. The processed form contains items relating to date of birth, sex, birthplace, marital status, postcode (but not name); administrative information, admission and discharge dates, discharge status, source of referral, insurance, and medical record number; and medical information, up to 5 diagnoses, up to 4 surgical operations or procedures. Table B3 in Appendix B contains the detailed information for the items coded onto the computer.

The medical record numbers are unique to the individual in most hospitals, however there is no common medical record number across all hospitals.

3.4.3 *Morbidity Data Processing*

Since 1983 morbidity data in NSW have been processed using a rotational sample of hospitals other than Hunter public hospitals, hospitals with less than 1,000 separations a year and hospitals with computerized admission/transfer systems (major Sydney teaching hospitals). For these hospitals, a 100% sample is processed. The annual data files for years 1979 to 1984 contain the appropriate sampling weights to be assigned to each admission, thus enabling summary statistics for the State to be compiled.

Hospital separation data for the Hunter Region are processed locally by the Hunter Health Statistics Unit for the Department of Health. Morbidity forms are sent monthly from individual hospitals to the Unit, where they are checked and entered onto a computer. These data are available on computer within three months of separation by the patient.

An exception to this procedure occurs since January 1985 for the largest hospital in the Region (Royal Newcastle Hospital). In this hospital medical records personnel enter the morbidity data directly onto the hospital computer. These data are transferred to the Hunter

Health Statistics Unit at regular intervals on computer tape. The Hunter Health Statistics Unit then transmits a copy of its files for the Region to Head Office in Sydney.

3.4.4 *Vehicle Crash Codes*

Admissions due to vehicle crashes are coded with 'external cause' codes, in addition to the diagnosis codes assigned to the injuries sustained. Relevant ranges within the external cause codes are:

E810.0 - E819.9 Motor vehicle traffic accident
E820.0 - E825.9 Motor vehicle non-traffic accidents
E826.0 - E829.9 Other road vehicle accidents.

Injuries to persons whose crashes are reported in the police traffic crash file should be coded within the first of the external cause code ranges listed above. Off-road motor vehicle crash injuries are coded within the second range. Injuries received in pedal-cycle crashes, animal-drawn vehicle crashes and crashes involving an animal being ridden are coded using the third range listed.

Non-traffic and non-motor vehicle accidents are not the concern of this study. However, all of the code ranges indicated above were included in the pilot study. Reasons for doing this are:

. to provide a check on the compatibility of coding practices between the two data collections; and

. to maximise the possibility of successful links by allowing for coding variations arising from incomplete information, particularly in the hospital source.

3.5 *Data Issues for Traffic Crash and Morbidity Files*

3.5.1 *Coverage of Sample*

For any given period, returns in either the traffic crash or the hospital mobidity data base may be incomplete. The main reasons are:

. police investigation of a crash may not have been completed by the end of the recording period;

. since the morbidity form is completed on the discharge of the patient from hospital, some overlap into the next period is likely among patients admitted in any given period;

. in either system work overloads or other problems may delay the submission of returns until after the cut-off date set by the processing unit.

A result of this is that data for some crashes or admissions which occurred in 1984 may be found in the '1985' files. The extent of sample period overlap found in the data files used is summarised in Table 3.2.

TABLE 3.2 Date of Crash/Admission found in Previous Period

	Police File		Hospital File	
	No.	%	No.	%
1984	68	2.1	40	3.2
1985 (6 mths)	74	4.6	31	4.0

3.5.2 *Sources of Errors*

Potential sources of error in data files occur in the reporting of information and in the recording of information. Reporting errors include the deliberate or inadvertant provision of false information and the provision of incomplete information. Recording errors include clerical errors in recording information, coding errors and data entry errors.

Reporting errors are often difficult to trace. This error rate may vary widely, depending on the reliability of the relevant information source(s) and the collection procedures undertaken. The provision of trained personnel, responsible for initial information collection (as is the case with the data sets considered in this component of the study) helps to minimise errors of this nature.

Recording errors are more easily identifiable by providing clerical and data entry checks. Errors of this nature are reported to be approximately 4% in the traffic crash data set and less than 1% in the hospital morbidity collection processed at the HHSU.

Some allowance is made in the design of the linkage procedure for the presence of both types of error in the key variables used, as will be outlined in describing details of the linkage methodology. Information errors and clerical errors in recording are also an issue for the second component of the study, the abstraction of additional data from medical records. The possibility of information errors takes on added significance in the assessment of the collection of new data reported in Section 5.

3.5.3 *Lack of Personal Identifiers*

The process of linking Australian data files is complicated by two considerations relating to personal identification; the lack of unique identifiers and confidentiality requirements.

Australia does not have any system which gives unique personal identification numbers for its residents. In addition, the requirement to preserve privacy and the confidentiality of personal information is an important issue. In keeping with this personally-identifying information, such as names and addresses, is suppressed in the preparation of records for statistical data files. This leads to a major problem since without either of these types of information it is necessary to use less precise identifying variables such as age and sex as the key to linking individual records in the two source files.

4. LINKAGE TECHNIQUE: COMPONENT A OF THE STUDY

4.1 *Methodological Considerations*

Techniques have been developed for computerised linking of records in the absence of unique identifiers and applied in epidemiological studies following on the work of Newcombe and his colleagues in Canada and Acheson at Oxford [8]. These have most frequently been used in contexts where the identifying characteristics include surname, given name or initials, sex, and date of birth. A common feature of these procedures is the assignment of a "weight" according to the correspondence of compared data items in the records and the value of these items in terms of establishing a "match". A mathematical model can be propounded for this procedure [9]. Various methods have been proposed for calculating appropriate weights [10] and are based on:

- prior information on the distribution of populations;
- frequencies of occurrences in the files under consideration;
- samples drawn from these files; and
- weights derived in a previous linkage.

The present approach differs in two major respects from those reported elsewhere; the usual personal identifiers are absent and a change in the method used to assign weights was made. The absence of personal identifiers magnifies two practical problems which plague the use of a linkage methodology. These problems are:

- the identifying items, singly or in combination, are not unique to a particular individual and
- identifying items may be missing or miscoded on certain records.

These problems are addressed by assigning a score to represent agreement between two records, and the components of the score were chosen to reflect the possibilities of miscoding.

4.2 *Weighting Procedure*

4.2.1 *Alternative Procedures*

The weights used were not derived by any one of the empirically-based systems listed above because:

- the lack of previous work of this nature in Australia meant that there was no previously established weighting system to be used as a springboard for this exercise;
- inadequate prior knowledge about the populations covered by the traffic crash files and the morbidity collection, and of their distributions, with the result that conditional probabilities were not available to provide estimates of the odds that two records compared on a set of identifying items do in fact refer to the same individual;
- wider testing would be required to establish the general Australian applicability of a weighting system developed from the sample under consideration;
- an empirically-based weighting system derived from data for the immediate past would be compromised by known rapid, and possibly temporary, changes within the hospital system affecting the present handling of traffic crash and other cases. For example, in early 1985, the provision of services in public hospitals in NSW by doctors, particularly by anaethetists, was severely curtailed as a result of an industrial dispute. An effect of this was to significantly change the pattern of presentation and handling of traffic crash victims at hospitals. Policy decisions, for example, to establish a regional trauma centre, would have a similar impact.

4.2.2 *Approach Adopted*

The weighting system which has been used is based on subjective estimates of the credence afforded the linking of records on the following fields:

date of crash/admission to hospital;
sex;
age; and
hospital.

Perfect coincidence on all of these items results in the maximum possible score on the presumption that the records compared refer to a single individual and event. It is possible that this maximum score may not have sufficient discriminatory power. That is, a record in one file may achieve the maximum score with more than one record in the other file.

As an indirect check on the discriminatory power of the selected criteria the weighting procedure was applied to the traffic crash and hospital files internally for 1984. The occurrence of the maximum score (of 199) within the traffic crash and hospital file denotes the records for two individuals on a given date, who were reported to be of the same age and sex, at the same hospital. The results indicated that these criteria are incapable of discriminating between only 0.9% of records in the morbidity file and between 3.1% of records in the full traffic crash file of all persons injured in traffic crashes in the Hunter Region.

The possibility of reporting and recording errors in each of the data fields used in the selection criteria is also acknowledged. In particular, with the traffic crash file containing age recorded in years and the hospital file recording date of birth, inconsistencies can readily occur. Acceptance of these features lead to the proposition of a range of scores which are considered 'acceptable' for a 'match'.

The weights used and the range of scores accepted are derived by:

- listing in order of subjectively assessed credence all the possible combinations of agreement conditions which would be accepted for the recognition of a match (Table 4.1);

- assigning 'weights' to the individual agreement conditions such that the sum of weights results in a ranking of scores in the same order as the subjective credence list (see Table 4.2).

A cut-off point for acceptance was set at the score of 150, for initial testing.

TABLE 4.1 Agreement scores for Traffic Crash and Hospital Files on date of crash/admission, sex, age and hospital.

Date	Sex	Age	Hospital	Score
*	*	*	*	199
*	*	±1	*	194
*	*	conditional	*	191
*	*	*	major	190
+1	*	*	*	189
*	*	*	other	186
*	*	±1	major	185
+1	*	±1	*	184
*	*	conditional	major	182
*	*	±1	other	181
+1	*	conditional	*	181
+1	*	*	major	180
*	*	conditional	other	178
+1	*	*	other	176
+1	*	±1	major	175
+1	*	conditional	major	172
+1	*	±1	other	171
+1	*	conditional	other	168
*	*	unknown	*	161
*	*	unknown	major	152
+1	*	unknown	*	151
*	<>	*	*	150

*	full agreement
+1	admission date is one day after crash date.
+/- 1	age recorded in the two files differs by one year.
Conditional	for persons between 26 and 59 years, age in the two files differs by two years, or for persons sixty years and over, age differs by up to eight years.
unknown	age recorded as unknown/not stated.
major	hospital recorded is one of the three major crash receiving hospitals in the Newcastle urban area.
other	hospital codes not equal and code in neither file is one of the major crash receiving hospitals.
<>	not equal.

TABLE 4.2 Weights used in Agreement Scoring

		Weight
Date:	Admission date = crash date	60
	= crash date + 1	50
	= all else	0
Age:	hospital file age = police file age	50
	= police file age ± 1	45
	= conditional *	42
	police file age = unknown/not stated	12
	= all else	0
	* conditional: FOR hospital file ages over 25 and under 60 years conditional = police file age ± 2 OR FOR hospital file ages 60 years and over conditional = police file age ± 8	
Hospital:	Codes are equal	40
	one code is one of the three major trafficcrash receiving hospitals in the Newcastle urban area	31
	Code in police-file = unknown	29
	None of the above	27
Sex:	Codes are equal	49
	Codes are not equal	0

4.3 *Screening the Data Files: Step 1*

The first step necessary for activating the linkage procedure is to screen the data files to isolate records relevant for the study sample, and as defined in terms of time and locality of crash. The base files (the police traffic file and the regional morbidity file) both contain irrelevant records relating, respectively, to traffic crashes in which no injuries occurred and hospital admissions from other causes. The reduction in size which can be achieved by screening out irrelevant records is illustrated using 1984 data in Tables 4.3 and 4.4.

TABLE 4.3 Traffic Crashes Reported to Police 1984

	NSW		HUNTER REGION	
	No.	%	No.	%
Total number of crashes	65203	100.0	5113	100.0
Number of fatal crashes	910	1.4	87	1.7
Number of injury crashes	26115	40.1	2173	42.5
All crashes involving death or injury:	27025	41.4	2260	44.2
Total killed or injured	37308	100.0	3200	100.0
Number of persons killed	1037	2.8	98	3.1
Number of persons injured	36271	97.2	3102	96.9
Number of injured persons admitted to hospital	9100	24.4	801	25.0

TABLE 4.4 Hospital In-Patients Separations, Hunter Region, 1984

	Number	%
Total Separations	92393	100.0
Motor Vehicle Traffic Accidents (E810.9-E819.9)	1125	1.2
Motor Vehicle Non-Traffic Accidents and other Road Vehicle Accidents (E820.0-E829.9)	428	0.5
Total Motor Vehicle and Other Road Vehicle Accidents (E810.0-E829.9)	1553	1.7

Records used for intensive investigation and evaluation of the linkage technique are restricted from both data files to:

location: Hunter Region, NSW (13 local government areas);
time period: 1985 (January to June); and
hospital file: external cause code ranges - E810-E829.9.

A further option is to restrict the traffic crash file to the records in which the casualty is recorded as admitted to hospital. Review of the 1984 data file indicated that this step would restrict the traffic crash file to a data set smaller than the size of the morbidity file for external code ranges E810.0-E819.9 (Tables 4.3 and 4.4).

While this restricted set is the relevant one for consideration in this study, that option was not taken initially because there is a conceptual disparity between the two files with regard to what constitutes an "admission" to hospital. It is useful to have results from the pilot study which can be used to test the implication of this disparity.

4.4 *Identifying Hospital Transfers and Multiple Admissions: Step 2.*

It was considered important, for the sake of completeness, to investigate the occurrence of inter-hospital transfers and multiple admissions in this pilot study. From the results obtained, it would seem that this step could be omitted in applications of the methodology to other years and to the whole of NSW.

Where there are multiple hospital admissions for an individual person resulting from a single crash event, only the first admission is relevant for linking with the traffic crash file. Subsequent admissions can occur because of a transfer of the patient between hospitals or because of re-admission after discharge from hospital. Medical record numbers which are specific to the individual hospital do not offer any check on a multiple admission arising from a transfer or on subsequent treatment at one hospital after discharge from another. An investigation of codings for source of referral and mode of discharge, within the most restricted external cause code range (E810.0-E819.9) in the 1984 morbidity file for the Hunter, identified 172 admissions (15.2%) as transfers from another hospital and 92 separations (8.2%) as being by way of transfer to another hospital. This indicated the need for further review of the files.

The advantages of identifying subsequent admissions and associating them with the initial admission are:

- completion of the linkage process and tracing of the sequence of medical procedures which follow upon the crash event;
- avoidance of errors arising from the creation of spurious links; and
- presentation of a more accurate picture of the adequacy of the linkage procedure.

Records were isolated for which there was a high probability that they referred to a subsequent admission following an initial admission recorded for a particular individual. The method employed was to firstly sort the hospital file records by sex, postcode and date of birth of patient and secondly to manually assess coincidences of the same sex, birthdate and postcode as potential transfers or re-admissions. The complete record sequence was written to a separate file for analysis and the subsequent admissions purged from the hospital file to be linked with traffic crash data. The results are summarised in Table 4.5. A high proportion of the transfers identified by this method were confirmed by comparing other data fields, as shown in Table 4.6.

TABLE 4.5 Transfer and Probable Re-admissions from Same Crash. Hunter Hospitals (E810.0-E829.9). Percentages refer to total records searched.

	Total Records Searched in Period	Multiple Records Accepted as Referring to same person			
		Transfers	Other Re-ad.*	Total recds.	Persons Involved
1984	1553	49	26	75 (4.8%)	71
1985	807	29	6	35 (4.3%)	31

*Re-admission within one month.

TABLE 4.6 Inter-Hospital Transfers Identified by Search Indication of Transfer in Morbidity Records

Time Period	Receiving Hosp. Record*	Sending Hosp. Record+	Both Records	Neither Record	Total Transfers
1984	44	38	33	-	49
1985 (Jan-June)	20	22	15	2	29

*Source of referral: 'other hospital'
+ Mode of discharge: 'other hospital'

However, less than half of the number of transfers expected on the basis of the 'source of referral' or 'mode of discharge' codings referred to above were identified by this method. The primary reason is that many of the transfers involve hospitals outside the region. From the results reported in Tables 4.5 and 4.6 it was concluded that the recording of source of referral and mode of discharge in hospital morbidity returns may not be sufficiently comprehensive to constitute the main method of identifying transfers or multiple admissions.

4.5 *Computerised Linking: Step 3*

The weighting system described in Section 4.2 can be used to compute a matrix consisting of the score for every record in the revised hospital file when compared with each record in the relevant traffic crash file. In practice the full computation of this matrix is not necessary and the procedure can be simplified by:

1. ordering both files by crash/admission date;

2. aborting the calculation for all scores which will fall below the cut-off point (i.e. complete calculations only when the dates match or the admission date is one day after the crash date).

The results can be depicted as two arrays, one consisting of observations in the hospital file, the other consisting of observations in the traffic crash file, with a vector consisting of those scores which fall within the acceptance range. It is possible for a record in one file to achieve a score above the cut-off value in comparison with more than one record in the other file.

For 1985 (Jan-June), the revised files consisted of:

1598 records in the traffic crash file
775 records in the morbidity file
992 calculated scores in excess of the cut-off value.

The algorithm used to select matched records according to the calculated scores proceeds as follows:

1. for the set of comparisons recording the highest score (initially, 199),

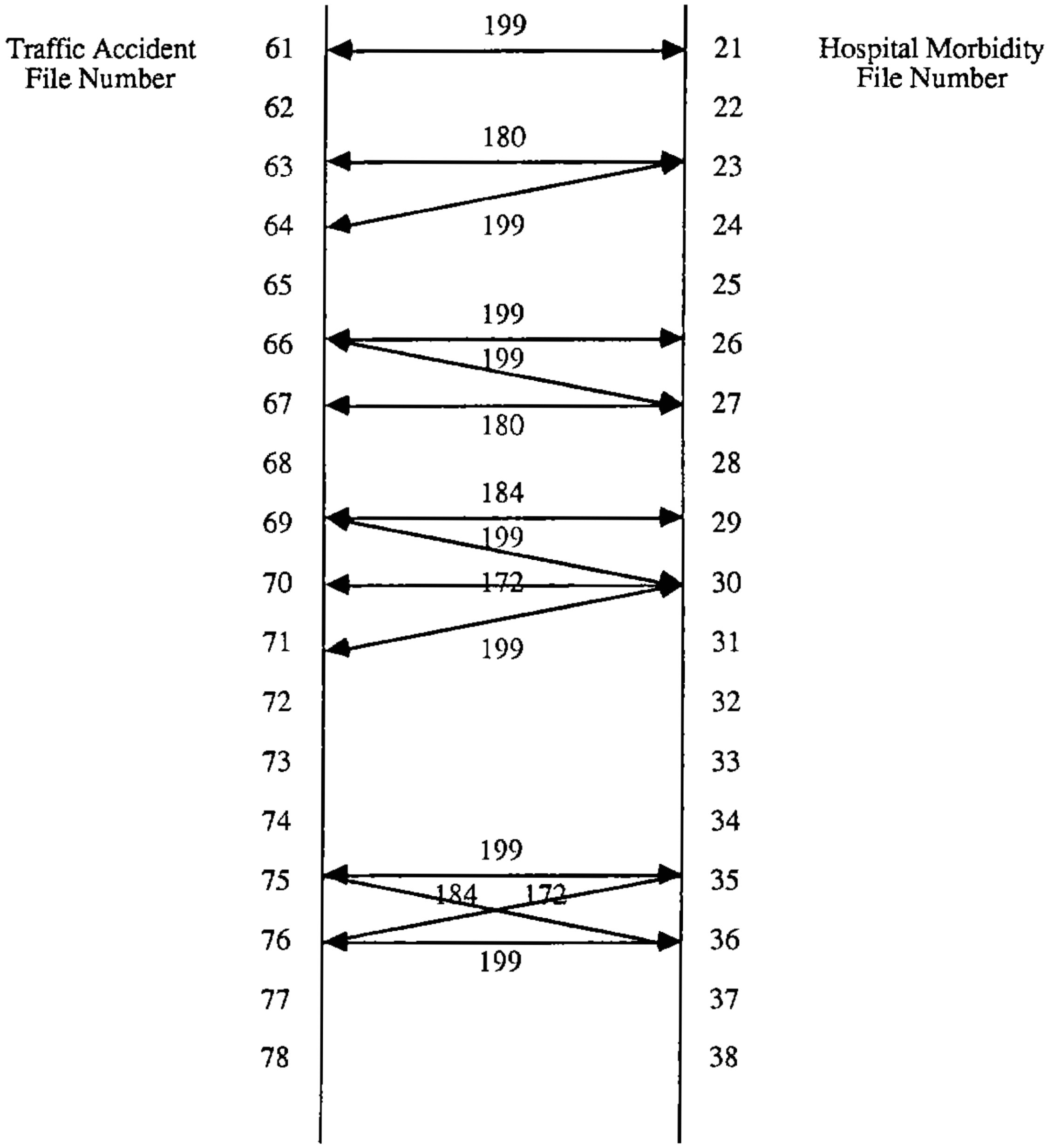
   (a) accept as linked every pair of records for which neither record has any other calculated score in comparison with other records;
   (b) where a record in one file has recorded the highest score with one record in the other file and has lower scoring combinations with other records in the second file, accept as linked the highest scoring combination and delete all the other comparisons and their scores in which either of the linked records are involved:
   (c) where one or more records in a file has recorded the highest score with one or more records in the other file, declare the match to be ambiguous, delete all other combinations and their scores with each of the ambiguously linked records in the same way as if they were linked;

2. proceed to the next-highest score and repeat step 1.

3. Stop when agreed minimum score is reached.

Figure 4.1 gives a diagrammatic representation of the links that can be obtained. There are two ambiguous links: the links involving traffic crash file numbers 66 and numbers 69 and 71. Hence these records and the hospital morbidity file numbers 26, 27 and 30 are regarded as unlinkable and all records associated with these clusters are deleted.

FIGURE 4.1 Schematic Presentation of Multiple Scoring Situations.
The lines join two records that have scores greater than 150.
Records without a line represent unlinked records.



Records matched
61 21
64 23
75 35
76 36

Records unmatched because of ambiguity.
66 26
67 27
69 29
70 30
71 -

Links made between the 1985 (Jan-June) data files and the resulting scores are shown in Table 4.7

TABLE 4.7 Comparison Scores and Links made for 1985.

Scores	Inititial number of scores	Links made
199	195	164
194	79	49
191	14	8
190	83	44
189	33	18
188	1	0
186	23	13
185	103	35
184	17	7
182	28	7
181	54	13
180	14	15
178	15	4
176	26	15
175	81	13
173	2	0
172	36	9
171	35	6
168	18	2
150	15	1
Total	922	423

The decision rule to reject completely all records involved in ambiguities is a stringent one. Other possibilities can be suggested, for example, where the traffic crash file records for an ambiguous comparison refer to a single crash event. Most of the ambiguities (86% of those in the 1985 file) arise because two or more police casualty records match with a single hospital record. In 9 out of 10 cases of this kind, all of the police records matched to a given hospital record were associated with an individual crash event. In such cases, all of the data in the 'general information file' is common to all of these observations, and some data in the 'traffic unit information file' may be. In these circumstances, any one of the potential ambiguous links could be accepted for some analyses (in 1985, 27 ambiguous maximum scores relating to 12 crashes were of this nature). Also, a proportion of the ambiguities can be resolved by manual decision making. (In the 1985 data, 2 (17%) of the ambiguous sets involving the maximum agreement score could be resolved by reference to the traffic crash file 'treated/admitted' code).

5. ASSESSMENT OF COMPUTERISED LINKING: COMPONENT A OF THE STUDY

5.1 *Capacity of Technique*

Using the procedure described in Section 4, with a stringent decision rule to exclude ambiguous cases (see Section 4.5 above), allows linking to be done in a fully-automatic fashion. The results of this are shown schematically in Figure 5.1.

The linkage procedure matched 423 records within the data files for January - June 1985. A further 137 in the traffic crash file and 181 records in the morbidity file, for which one could reasonably expect to have found a match, remained unlinked. Thus the crude linking rate achieved is 76% for the traffic crash file, and 70% for the morbidity file.

5.2 *Exploration of Unmatched Traffic Crash Records*

5.2.1 *Extent of Failure to Link*

There was a total of 1,175 records within the traffic crash file (consisting of all traffic crash casualties, both injured and killed) which were not linked. The majority of these records (88%) were coded with a positive indication that the casualty had not been admitted at a hospital. Such records cannot be regarded as genuinely "unlinked" records.

Data in the traffic crash file indicated hospital admission for 137 of the casualty records not linked. An analysis of these records showed that

29 records had been debarred from linking by the exclusion of ambiguous matches;
18 records fell outside the time span for the study and related to crashes in 1984;
12 records indicated admission to a hospital outside the Hunter Region.

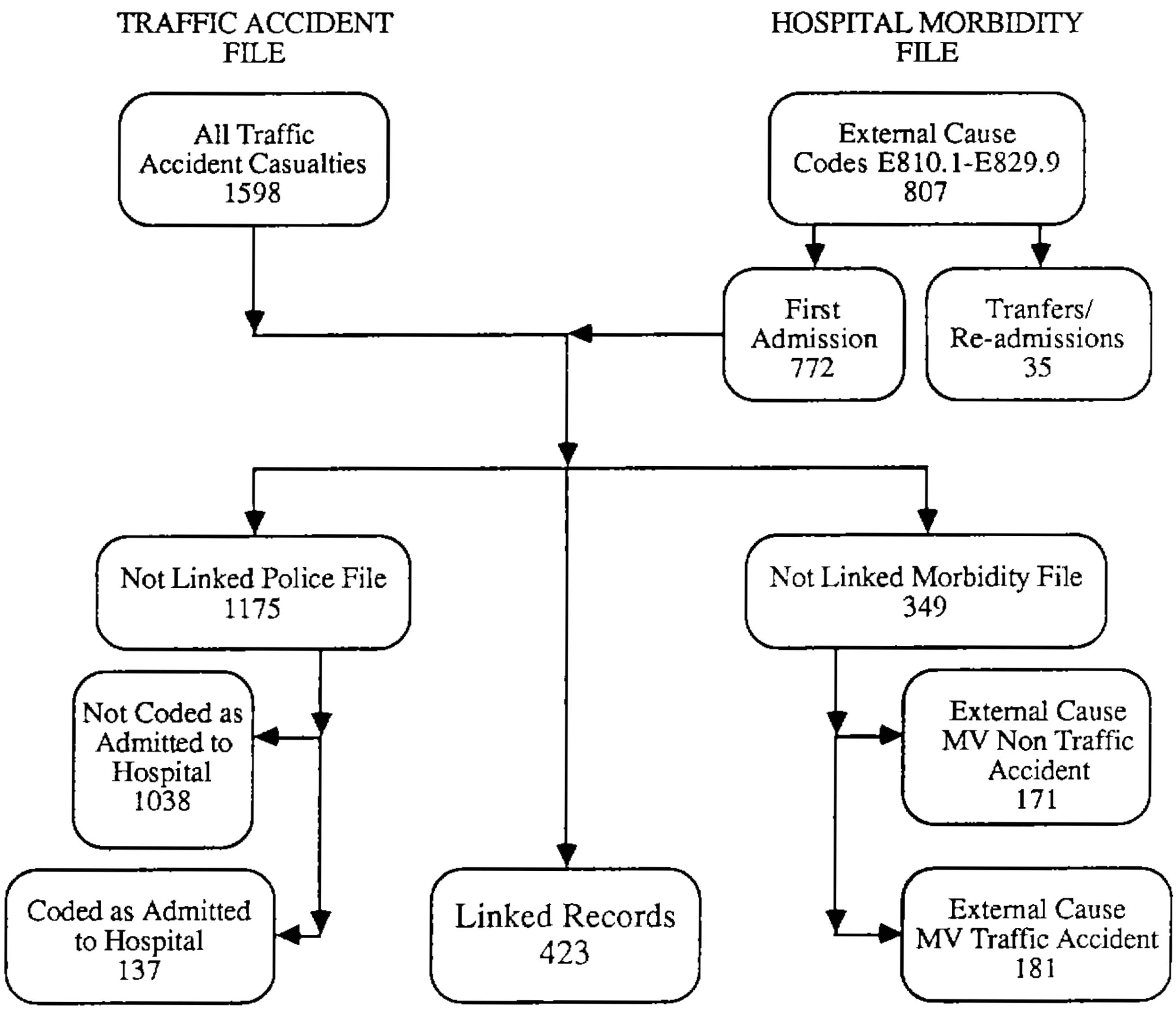
Of the remaining 78 records, 60% referred to crashes in the second quarter of the year (Table 5.1).

TABLE 5.1 Traffic Crash Records not Matched for Casualties Shown as Admitted to Hunter Hospitals, 1985 January - June *

Crash Date	Number
January	8
February	10
March	13
April	18
May	18
June	11
Location+	
Urban	35
Other	43
Total	78

* Excludes cases of ambiguous matches
+ Urban: Newcastle and Lake Macquarie local government areas.

FIGURE 5.1 Summary of Results of Linking Technique.
1985 (January - June)



Because of the short time period of this study (six months) some of the problems with regard to the completion of records, referred to in Section 3.5.1, have been accentuated. A more important consideration is that the short time period may have biased the result against patients incurring longer stay in hospital, whose medical records remained active after the end of the study period. The impact of this problem will be reduced for data files linked over longer time periods.

5.2.2 *Extended Search for Sample of Unlinked Police Records*

A further investigation of unlinked traffic crash records was conducted, using the casualty register at the largest hospital in the region (Royal Newcastle Hospital). This hospital was given in 29% of unlinked traffic crash records. A search was made for 38 records, including 6 not linked because of ambiguity and 3 with 1984 crash dates. This search provided a trace for 79% of the records sought which indicated that 42% of codings were not consistent with the hospital admission procedure, 37% of the casualties had been admitted and 21% remained untraced (Table 5.2).

TABLE 5.2 Result of Search of Casualty Register Royal Newcastle Hospital

Casualty not located	8
Died soon after arrival	2
Treated at casualty only	3
Treated at casualty Xray or other use of hospital facility	11
Admitted	14
Total	38

For two cases among those admitted, the failure to establish a link between hospital and police records had been caused by a discrepancy in age in the two files greater than that allowed by the linking methodology. The remaining casualties had been admitted at the following times:

1984	all months	2
1985	January	1
	February	1
	March	-
	April	6
	May	2
	June	2

The major cause of failure to links records appears to be the accuracy and completeness of coding the fields used; namely age, sex, date of crash and to which hospital person was admitted in the traffic file and date of birth, sex, date of admission and external cause code in the hospital file.

5.3 *Exploration of Unlinked Hospital Records*

Analysis of the 352 unlinked records in the morbidity file used for initial testing, showed that only 41% satisfy both the criteria of time period (admission date between January - June 1985) and external cause of injury due to motor vehicle traffic crash.

Among the 166 records which satisfy these criteria, 22 were debarred from linking by the decision rule to exclude ambiguous matches (Table 5.3).

TABLE 5.3 Unlinked Records in Morbidity File

	All Unlinked Records	Debarred because Ambiguous	Not Accounted For
Admission date: 1984	20		
1985			
Motor vehicle traffic accidents (E810-E819)			
E810 Motor vehicle traffic accident involving collision with train	1	-	1
E811 Motor vehicle traffic accident involving re-entrant collision with another motor vehicle	1	-	1
E812 Motor vehicle traffic accident involving collision with another motor vehicle	12	1	11
E813 Motor vehicle traffic accident involving collision with other vehicle	7	-	7
E814 Motor vehicle traffic accident involving collision with pedestrian	13	4	9
E815 Other motor vehicle traffic accident involving collision on the highway	2	-	2
E816 Motor vehicle traffic accident due to loss of control, without collision on the highway	19	8	11
E817 Noncollision motor vehicle traffic accident while boarding or alighting	4	-	4
E818 Other noncollision motor vehicle traffic accident	15	1	14
E819 Motor vehicle traffic accident of unspecified nature	92	8	84
	166	22	144
Motor vehicle nontraffic accidents (E820-E825)			
E820 Nontraffic accident involving motor-driven snow vehicle	-		
E821 Nontraffic accident involving other offroad motor vehicle	14		
E822 Other motor vehicle nontraffic accident involving collision with moving object	-		
E823 Other motor vehicle nontraffic accident involving collision with stationary object	7		
E824 Other motor vehicle nontraffic accident while boarding and alighting	1		
E825 Other motor vehicle nontraffic accident of other unspecified nature	17		
	39		
Other road vehicle accidents (E826-E829)			
E826 Pedal cycle accident	65		
E827 Animal-drawn vehicle accident	1		
E828 Accident involving animal being ridden	60		
E829 Other road vehicle accidents	1		
	127		
TOTAL	352		

One possible explanation of the presence of unlinked records in the hospital file is the occurrence of a lag of more than one day between a crash and hospitalisation for definitive treatment of the injury. The source of referral of patients whose records were not linked indicates that 35% had received treatment or advice from another hospital or a medical practitioner prior to admission to hospital.

TABLE 5.4 Hospital Records Not Linked to Traffic Crash Files.

Source of Referral	Number
Casualty	175
Out patients department	16
Other Hospital	50
Medical Practitioner	72
Self	1
Others	0
Not indicated	38
Total	352

Within the group of 144 'not accounted for' records, 22% are in the code range E815.0-E818.9 (Table 5.3). This range covers motor vehicle traffic crashes which do not involve collision with another vehicle. Such single vehicle crashes may not be reported to police. Similarly, many of the 58% of unaccounted for motor vehicle traffic crash casualties which occurred in crashes 'of unspecified nature' may have escaped the attention of police. If this is the case, up to 16% of motor vehicle traffic crashes involving casualties may have avoided the notice of police. (Mass and Harris drew a similar conclusion [11]).

5.4 *Assessment of Linked Records*

Three main issues were considered in assessing the ability of the linkage procedure to establish correct linkage of records from the two files and to avoid false links. These issues are:

- the discriminating power of agreement scores in the range 150-199;
- the efficiency of including all external cause codes between E810.0 and E829.9;
- the efficiency of including all police casualty records.

To assist in this assessment, a sample of linked records was reviewed, drawn from those casualty records which had been extended by information gathered in the medical records abstraction component of the study.

5.4.1 *Sample of Linked Records for Review*

Not all of the admissions for which additional patient information has been abstracted from medical records were linked by the computer algorithm with police file details. However 203 linked records were available. These were used to verify the credibility of the linking procedure. The size of this sample, which constitutes 48% of the linked records, was larger than had been anticipated due primarily to the impact of a doctors' dispute. A result of this situation was the promotion of one of the surveyed hospitals (Royal Newcastle Hospital) as the regional trauma centre. This had the following consequences for the present study:

1. the sample reviewed is large in absolute numbers and as a proportion of the total links made;
2. the discriminating power of hospital nominated (in the traffic crash file) is reduced, as patients were diverted to the major regional hospital;
3. the methodology is being tested under the more difficult circumstances of a large,

regional hospital, with consequent increases in the odds of false 'chance' links being made.

A small number of the hospital records in the sample of linked records for which abstracted data are available (14 records) were coded with external cause codes outside the range for motor vehicle traffic crashes. It had been expected that only records in the external cause code range E810 - E819 would be included in this sample. However the records in question had not only been linked by the computing algorithm with traffic crash records but had contained sufficiently ambiguous crash information that they had not been excluded from the abstracted data file during the editing process. Because of the third consideration identified above, results of the review are shown separately for these external cause code ranges.

5.4.2 *Manual Review of Linked Records*

The manual review drew upon, in addition to the variables used as linking criteria,

. the full range of data in the traffic crash file; and,
. such crash and other information as was contained in the medical records.

These latter records, in 82% of cases, included some items of information (in addition to the linking variables) which were relevant for the assessment of the link.

There is little consistency in the relevant items contained in individual medical records. This is understandable since there is no provision for the systematic recording of crash information within the medical record keeping procedures. Items of information used, if available, for comparison with traffic crash file details include:

type of vehicle;
position in vehicle;
some circumstances of the crash;
location of crash;
hospital of first reception;
postcode;
time of admission.

The medical record information, even if sketchy, could be used to conclude that, for example, the record for the 20 year-old male admitted to Royal Newcastle Hospital on 21 January and annotated "motor bike crash" should not have been linked with the police record of a person of the same age and sex injured on the same day in a single vehicle car crash and admitted at the same hospital. Similarly, the record annotated "hit a telegraph pole" probably should not have been linked with the police record of a head-on collision. In crashes where the driver was injured, post code of casualty (hospital record) and of driver (traffic crash file) were used as confirmatory evidence, without necessarily being grounds to reject a possible link. On the other hand, comparison of time of admission and time of crash could provide evidence leading to the rejection of a link.

The results of this manual assessment of the sample of linked records is shown in Table 5.6 and led to a revision of the accepted cut-off point to reject all links below a score of 186.

Use of the weighting system to relax the requirement that there is agreement between the hospital nominated in the traffic crash file and the hospital of the record in the morbidity file proved a valuable feature of the methodology. The proportion of all correct links made on this relaxed condition is 13%. Efficiency is reduced however, as this relaxation introduced 28% of the false links. Nevertheless, continued inclusion of these records is recommended to avoid biasing the results for subsequent analyses since there is a presumption that the cases included in this manner would be the more seriously injured casualties.

TABLE 5.5 Summary of Results of Review of Linking 1985

Linking Scores	External Cause Codes E810.0 - E819.9 total	Number Reviewed	% of total	Manual Review correct No	%	false No	%	uncertain No	%
199	154	75	48.7	69	92	1	1	5	7
191-194	54	35	64.8	22	63	3	9	10	29
186-190	67	46	68.7	26	57	7	15	13	33
150-185	82	33	40.2	15	45	13	39	5	15
total	357	189	52.9	132	70	24	13	33	17

Scores	E820.0 - E829.9 total	Number Reviewed	% of total	Manual Review correct No	%	false No	%	uncertain No	%
199	10	1	10.0	1		-		-	
191-194	3	2	66.7	1		1		-	
186-190	8	3	37.5	-		2		1	
150-185	45	8	17.8	1		5		2	
total	66	14	21.2	3	17	8	57	3	17

5.4.3 *Evaluation of Screening of Files*

For the reasons set out in Section 3.4.4 above, the files used for pilot testing with 1985 data were more extensive than might be used in a routine process. From this testing, it is demonstrated that additional screening of the hospital data files could be undertaken without a marked loss in effectiveness.

As Table 5.5 shows, the review of linked records demonstrates that two-and-a-half times more false links would be excluded, than true links omitted, by screening the external cause code range to exclude records coded E820.0-E829.9. The efficiency of screening in this way is confirmed by the review of unlinked records. Half of the unlinked records lay in the external cause code range E820.0-E829.9 (Table 5.6). The same situtation with respect to closer screening does not hold for the traffic crash file.

TABLE 5.6 Performance of Screening Codes - 1985 Motor Vehicle Traffic Crash Casualties Admitted to Hospital

	Linked file records	Unlinked file records
Treated at scene/by doctor in his surgery	20	152
Treated at a hospital	178	794
Admitted at a hospital	207	140
Dead on arrival	1	18
Not treated or admitted	6	48
Unknown/not stated	11	23
Total traffic crash File	423	1175
External cause:		
MVTA(E810.0-E819.9)	357	181
MV nontraffic crash (E820.0-E825.9)	21	42
Other road vehicle crash (E826.0-E829.9)	45	129
Total Morbidity File	423	352

5.5 *Summary of Assessment*

Assessment of the linkage options considered leads to the following recommendations in the event of a routine implemenation of the linking technique:

	Restriction Proposed.		
	External Cause Range (E810.0-E819.9)	Treated/admitted code: Admitted at a hospital	Block files according to sex *
File effected	Morbidity	traffic crash	Both
Results:			
Reduction in file size	29%	78%	Male 32% Female 68%
Loss of record links			
(scores 150-199)	16%	51%	0.02%
(scores 186-199)	7%	36%	0.00%
Action	Recommend	Not recommend	Recommend

* Linkage technique affected within each block separately.

The restrictions proposed will reduce the percentage of false links as well as increasing file handling efficiency. It is concluded that, even without the restrictions proposed above, the linking algorithm developed is effective (Table 5.7).

TABLE 5.7 Summary of Linking Technique Results (1985 data)

Scores accepted	% of records linked	estimate of false links (%)
199	28	1
186-199	51	11
150-199	73	19

6. MEDICAL RECORD DATA: COMPONENT B OF THE STUDY

6.1 *Introduction*

Hospital inpatient medical records form a data pool that have great potential to supply information relevant when assessing:

- factors surrounding the occurrence of the traffic crashes;
- specific types of injury associated with different crash events; and
- the personal injury costs of traffic crashes and the costs and outcomes of procedures for handling trauma victims.

Potential uses for the data were outlined in Section 2 above. Many of these require measurement of the extent of injury. Consequently, the provision and management of data for this purpose was considered in some detail. What needs to be established initially is:

- what data are available on a regular basis;
- the consistency with which data appears in the medical record;
- the quality of the data; and
- the uses to which it can be directed.

A sample of medical records was reviewed to provide the basis for making an assessment in these terms.

6.2 *Measurement of Injury*

6.2.1 *Diagnoses Codes*

Diagnoses are recorded on the hospital morbidity form using the International Classification of Diseases based on the recommendations of the Ninth Revision Conference, 1975, and adopted by the Twenty-ninth World Health Assembly of the World Health Organisation (referred to as ICD-9). Coding with ICD-9 informs a researcher about the nature of the injury and the anatomical site involved. It does not indicate the severity of the injury nor the comparative severity between different injuries and sites. Widely used measures of injury severity are: the Abbreviated Injury Scale (AIS), for anatomical severity scoring; the Injury Severity Score (ISS), for scaling multiple injury; and the Glasgow Coma Scale [see, 12].

6.2.2 *Abbreviated Injury Scale*

Since the AIS is frequently used, both alone and in conjuction with other scoring systems, it was decided to further encode the provisional and final diagnoses using the Abbreviated Injury Scale (AIS) [13,14]. The AIS was developed in 1971 because there was no single comprehensive system for rating tissue damage that was accepted by both physicians and others involved in crash investigations. The Scale was published under the auspices of the Joint Committee on Injury Scaling in the United States [15].

In brief, the AIS breaks the body down into six regions:

1. Head or neck;
2. Face;
3. Chest;
4. Abdominal or pelvic contents;
5. Extremities or pelvic girdle and
6. External.

Severity has also been broken down into six sub-groups. The 1-6 numeric codes are not a linear progression, but are simply a means for distinguishing between the severity of different injuries.

AIS 1. Minor
2. Moderate
3. Serious
4. Severe
5. Critical
6. Maximum injury, virtually unsurvivable.

6.2.3 *Injury Severity Score*

The ISS draws on the AIS scores given to individual diagnoses to calculate an overall severity score [16,17]. To determine the ISS, one separates the diagnosis into the different body regions. The highest AIS is selected for each region. Using the highest score for a maximum of three individual region scores, the square of each of the scores is calculated and then added together.

For example:

Injury	AIS	Region	Score Used
Carotid artery laceration	4	head/neck	*
Concussion	2	head/neck	
Femur, undisplaced fracture	3	extremities	*
Humorous, undisplaced fracture	2	extremities	
Leg, laceration	1	external	*

* denotes highest 3 values which are scores used.

$$\begin{aligned} ISS &= 4^2 + 3^2 + 1^2 \\ &= 16 + 9 + 1 \\ &= 26 \end{aligned}$$

When using ISS the AIS score of 6 is disregarded as a 6 indicates that the injury is so severe that the patient should be dead. The highest possible ISS score is 75. The ISS will also indicate the overall comparative rate of severity between patients with different injuries.

6.2.3. *Other Injury Scales*

The Glasgow Coma Scale is another severity scoring system. This scale draws on neurological observations and is used by itself or in conjunction with anatomical indices [see 18]. The Acute Physiological and Chronic Health Evaluation or APACHE is another severity scoring system that uses physiological indicators [19]. It was decided that the data necessary for these systems should be included among those abstracted from medical records to enable the data base to be of value in studies envisaged for a later date.

6.3 *Framework for Collecting Data from Hospital Records*

6.3.1. *Design of an Abstraction Form*

A systematic framework was used for the review of hospital records. This was provided by the design of a form for the abstraction of data from medical records. The abstraction form covered the items needed for the construction of the forementioned indices and was designed in consultation with the Director of Intensive Care Services at Royal Newcastle Hospital. A number of models were trialled at that hospital before the final format was decided upon. A copy of the abstraction form used is in Appendix A.

The final form was designed in three sections:

Section A : patient identifiers to enable linkage with other data files;
Section B : clinical information from the inpatient record; and
Section C : relevant details from the Ambulance Report.

6.3.2 *Identifying Information*

Section A contains all of the details that are required for linking the various data files. In addition it records if the patient was referred from another hospital, that hospital's code, and the mode of transport to the hospital. Name and address of patient were not collected.

6.3.3 *Clinical Information*

The clinical details in Section B include the recording of the provisional diagnosis. Most data collections only record the final diagnosis. It was decided to include the provisional to allow for the examination of the difference in the degree of completness, detail of recording and actual diagnosing that occurred.

As a significant number of multiple injury crashes occur, it was felt that one could not arbitrarily restrict the accepted number of diagnoses to five (as in the morbidity collection). Therefore, an unlimited number of diagnoses was accepted.

The diagnoses were coded using ICD-9 to check the accuracy of the codes in the morbidity file (in the case of the final diagnosis), and to highlight the difference between the clinical detail recorded in the provisional diagnosis as opposed to the final. The provisional and final diagnoses were further coded using the Abbreviated Injury Scale (AIS) and the Injury Severity Scores (ISS) were calculated.

The initial results of the physiological observations that were measured when the patient presented at the hospital were recorded. The values for temperature, pulse, blood pressure and respiration are grouped using the Acute Physiological and Chronic Health Evaluation or APACHE system. The neurological observations were also grouped using the Glasgow Coma Scale.

In order to determine the intensity of care involved, a note was taken to indicate if the patient was treated in an intensive care unit (ICU) or a coronary care unit (CCU) and the number of days involved. A record was also made of the different treatments that were given to the patient when they were admitted.

The patient's past medical history was recorded to determine if it would have a significant bearing on the outcome or severity of the present injury. If the medical records contained an indication that the patient uses any sort of drug, this too was recorded.

Up to four surgical procedures are already coded in the morbidity file, however all of the procedures performed during the admission were recorded and re-coded with IC-PM to check the accuracy of the original coding. A checklist for any post operative complications was used.

In addition to the limited information existing on the morbidity file, a more comprehensive list of the specialist services involved in a case was abstracted. This could help improve the determination of the overall cost of treating road traffic crash cases. Even though the listing on the abstracting form was more than sufficient for Cessnock and Singleton Hospitals, the "other" category was very heavily utilised at Royal Newcastle Hospital. When re-examining the abstracting forms, a manual tally of the additional specialities that had been relegated to the "other" category was taken.

Any follow-up treatment recommended on discharge of the patient was recorded. The alternatives listed reflect usual follow-up practices. If a patient was transferred to another hospital the code for that hospital was recorded.

6.3.4. *Ambulance Report Details*

Section C was included because it was originally anticipated that there would be a problem with the location of the Ambulance data, with resulting uncertainty as to the availability of this data collection in machine-readable format. The Ambulance Service reporting system provides for one copy of their report form to go into the hospital medical record. Section C of the abstraction form recorded the date and time that the Ambulance was booked, the time it arrived at the crash and at the hospital. These times, together with the time of the crash from the police tapes would help determine if increasing delay between the time of crash and time of arrival at the hospital significantly effects the outcome of the injury.

The areas of the body affected and the type of injury shown on the ambulance report were recorded. The examination and the recording of the vital signs were noted and their vital signs points were calculated. A copy of the ambulance 'transtat' data was made. This is the ambulance officers' alphanumeric coding of the type of injury and the treatment given. Additional details of damage to the car and whether the injured party was wearing a seat belt were also to be taken from the Ambulance Report if available.

6.3.5 *Accident Information*

The history of the crash was recorded to determine if any further details describing the actual crash were noted apart from those already given on the traffic crash tape.

6.4 *Abstracting of Data from Hospital In-patients Medical Records*

6.4.1 *Sample of Hospitals*

Medical records data were reviewed at three Hunter hospitals. The hospitals were selected to provide examples of a range of record-keeping practices, and a sufficient size sample for assessing the feasibility of using hospital records as a routine source of additional data. The three hospitals selected in the sample are:

- Royal Newcastle Hospital (RNH) - a 524 bed teaching hospital that is the region's major trauma centre;
- Singleton District Hospital - a 104 bed rural community hospital situated on the New England Highway and close to the major coalfield-related heavy traffic areas;
- Cessnock District Hospital - a 176 bed general hospital that is located in a medium size city in a rural community.

6.4.2 *Access to Records*

In order to gain access to the medical records of all patients admitted to these hospitals as a result of a road traffic crash during January-June 1985, the formal consent of each hospital administration was required. The practices followed by hospitals in this regard varied from the direct granting of approval by the Chief Executive Officer (CEO), to an approach by the Chief Executive Officer to the Hospital Board for approval, to the requirement that a member of the Study Team appear before the hospital Ethics Committee to justify the request. The requisite approval was received from the three hospitals involved, upon the assurance of strict adherence to the provision of confidentiality of the patient.

6.4.3 *Sampling Frame*

For these hospitals, a computer listing was obtained from the morbidity collection for the first six months of 1985, of the medical record number for all separations where an external cause of injury was indicated which fell between the codes E800.0-E829.9, which encompasses transport crashes. The code range was not restricted initially to those crashes resulting specifically from motor vehicle road traffic crashes in case errors had occurred in the initial morbidity coding and the crash was coded to an incorrect category.

Some records under the code E929.0 (late effects of motor vehicle crash) were also reviewed, to assess the scope for linking these records with the relevant crash. Crash information given in the medical records proved to be too imprecise to be of use in locating these crashes in police files, e.g., "motor vehicle accident two years ago". These records were not entered in the computer file designed for linking with the morbidity collection and with the police files.

6.4.4 *Data Collection*

Data abstraction was completed in the hospital medical records office by trained personnel from the Study Team (medical records administrator, registered nurse). Not all records were located, as indicated in Table 6.1. Failure to locate the records for a unit record number for which an abstraction form had been returned is most likely to be due to the re-activation of treatment for that person or to other medical review of the case.

After abstraction forms were completed they were reviewed and coded by the Regional Medical Record Administrator. After all of the charts had been reviewed and the forms were coded, each form was scrutinised to determine if it was to be finally accepted for the Study. Cases were rejected for a number of reasons:

- the crash did not result from a motor vehicle road traffic crash e.g., riding a bicycle in a playground, riding a horse on a property etc.;
- the admission was a follow-up and not the original admission after the crash;
- the patient was admitted to Belmont Hospital and not Royal Newcastle Hospital (these hospitals use a common medical record system).

Where appropriate, information from re-admissions was appended on the abstraction form for the original admission.

TABLE 6.1 Medical Records Abstraction
Hospital In-patients' Records, January-June 1985.

	Royal Newcastle Hospital	Cessnock/ Singleton Hospital	Total
Records listed	382	99	481
Records Abstracted	340	85	425
Records Excluded	68	32	100
Cases entered on file	272	53	325

6.4.5 *Recording problems.*

Some of the problems encountered in the medical records abstraction were:

- charts containing no nursing notes;
- early notes from admissions missing;
- patient admitted to the major hospital, later transferred to another unit of the hospital and only the latter notes filed in the chart;

- patient admitted to one hospital then transferred to another using common unit record numbers and stationery (in such cases it is very difficult to distinguish the notes originating in each of the hospitals);
- nurses' notes stating that neurological observations were taken, but no record of them in the charts;
- difficult to determine when initial observations were taken; and
- ambulance reports were rarely located.

Results from quantifying the occurrence of those problems occurring with sufficient frequency to warrant coding, are given in Section 6.5.

6.4.6 *Coding Problems*

The main coding problems were:

- many diagnoses recorded as "Injury" to a site. Non-specific terminology is not suitable for use with AIS;
- head injury with no further details is coded to AIS = 2 (the same as concussion). In those cases where head injury is noted to be severe it is difficult to allocate another score to reflect the degree of the severity;
- difficult to give an AIS score for head injury to brain matter e.g. cerebral haematoma, as positive indication on a CT Scan etc. must be made. It is impossible to do this when coding retrospectively;
- difficult to score the AIS for diagnoses relating to the eye or peri-orbital region;
- no AIS scores for diagnoses of post traumatic epilepsy, radial nerve palsy, hemiplegian etc, which are conditions caused by the crash and contribute to increased length of stay;
- no AIS score for foreign body in wound, e.g. glass;
- provisional diagnoses and final diagnoses often do not match, thereby resulting in different ISS scores.
  e.g. Provisional diagnosis:
  Lacerated cheek
  Subconjunctival haemorrhage eye
  Fractured scapula
  Fractured transverse process L1-L4
  L. Renal injury - ruptured collecting system.
  ISS = 24

  Final diagnosis:
  Renal contusion
  Multiple abrasions
  ISS = 10;

- irregularities found on ambulance scores for the vital signs sections. The point scores and tallys given did not always correspond to those indicated on the Master Sheet.

While these problems are noted, it was nevertheless possible to assign AIS and ISS scores to all cases and the initial ISS was used in the analysis.

6.5 *Assessment of Data Obtained in Medical Record Abstraction*

The data abstracted are consistent with Royal Newcastle Hospitals' role as a trauma centre. Consequently, some of the following comments relate primarily to the larger hospital operating in this fashion. Where a different pattern was observed in the recording of information at the smaller hospitals this is noted.

- 41% of patients at RNH had been referred from another hospital
- 63% of referrals to RNH came from outside the Newcastle urban area
- 22% of patients had residential postcodes lying outside the Hunter Region
- 10% of patients were transported to hospital by helicopter
- 58% of patients were transported by road ambulance,
- for 24% the means of transport was not known.

In assessing the usefulness of the data abstracted, the following points are made.

1. Information available in the in-patients' records varies with type of injury, severity of injury, and patient management (including transfer of patient between hospitals) as well as, thoroughness of recording and record storing practices.

2. As a consequence, no single figure can be put on the proportion of records containing "useful" information.

3. All of the information searched for was found in no single record.

4. As noted in section 6.4.5 above, the presence of a high proportion of transferred / referred patients has implications for the availability and meaningfulness of data in the medical records. For example, the initial observations in the trauma centre medical records may have been taken a considerable time after the crash, and after the patients' condition was stablised at another hospital.

5. Missing observations were encountered or 'unknown' codes used, even in the recording of mode of transport and the initial observations. In the sample of 325 records processed the following summarizes the "unknown" / "missing" codes used.

	Total	RNH	Cessnock/ Singleton Hospital
Transport to hospital	24%	19%	49%
Initial observation of vital signs:			
time recorded	15%	14%	2%
place recorded	10%	11%	2%
temperature	23%	27%	6%
pulse	4%	4%	2%
systolic blood pressure	10%	10%	8%
respirations	37%	40%	17%

6. Neurological observations are not routinely recorded for all patients. Neurological observations were not recorded for 51%, 61% and 2% for Total, RNH and Other hospitals respectively.

7. *Sufficient valuable clerical information* can be abstracted from 63% of medical records to allow for an assessment of the physiological state of the patient immediately after the crash (relevant for assessment of the merits of various treatment mechanisms).

8. This information is particularly relevant for persons needing/receiving intensive care; 21% of patients in the sample were treated in an intensive care unit.

9. The following variables lie predominantly within the normal range and therefore their usefulness in future analysis is limited:

	Percentage of Known Values in 'Normal' Range		
	Total	RNH	Other Hospitals
temperature	93	92	98
pulse	82	80	90
systolic blood pressure	80	79	86
respirations	49	78	71

10. The relatively small size of the sample of 325 records for which observations were recorded outside the 'normal' range impairs the usefulness of this information in a general purpose file:

	Number of Observations Recorded Outside 'Normal' Range		
	Total	RNH	Other Hospitals
vital signs: temperature	18	17	1
pulse	56	51	5
systolic blood pressure	59	52	7
respirations	46	39	7
neurological observations: eye	23	23	0
motor	27	27	0
verbal	42	40	2

11. The small number involved for other conditions recorded also raises doubts about the advantage of generally abstracting this information from existing records for the following fields:

	Number of Observations Recorded		
	Total	RNH	Other Hospitals
patients intubated	33	33	0
past medical history indicated:			
hypertension	10	10	0
respiratory conditions	13	11	2
diabetes	2	2	0
stroke	1	1	0
psychiatric	5	4	1
cardiac	6	6	0
gastro-intestinal tract	5	3	2
Renal	1	0	1
Epilepsy	1	1	0
Other	19	15	4
unstated conditions	91	68	23

12. Although 189 patients were transported by ambulance, ambulance reports were filed for only 39 cases (21%); all but one of those located were at the RNH. Even among this number some fields were incompletely recorded.

'Unknown' Coding Used in Ambulance Report Fields:

time ambulance booked	72%
time ambulance at crash	69%
time ambulance at hospital	64%
person attending (ambulance officer/ paramedic)	31%
area of body affected	13%
type of fracture noted	15%
examination details	13-15%

	first recording	second recording
vital signs details:		
time	36%	38%
pulse	13%	23%
blood pressure	18%	23%
skin colours	97%	97%
respiration rate	15%	33%
respiration effort	87%	87%
level of consciousness	15%	28%
pupils	33%	31%
vital signs score	18%	46%
impact position	39%	
seat belt	100%	

Transtat fields: % with 'unknown'/'missing' codes.

Bystander	59	Intubation	49	Units	56
Effect	62	Analgesia	51	Fluid/Drug	59
Roaduser	49	Effect	54	Units	59
Severity	51	Splints	31	Fluid/Drug	59
Treatment	26	Splints	49	Units	59
Consc/Unconsc	26	Mastsuit	49	Fluid/Drug	59
Suction	49	Tourniquets	54	Units	59
Airway	46	Stretcher	28	Protocol	56
Breathig	54	Kits	54	Protocol	59
IPPV	54	ECG	49	Protocol	59
Circulation	56	ECG	51	Protocol	62
Posture	15	ECG	51	Rescue	56
O2 therapy	20	D.C. shock	54	Complications	56
Litre	26	Fluid	51	Hazards	51
Demandvalve	51	Units	51	Tens Pneum Re	51
Cannulation	31	Drug	56	Comments	51
				Medical Review	51

6.6 *Costs of Medical Records Abstraction*

Costs incurred in the medical records abstraction component of the study fall into three groups:

development costs;
running costs; and
analysis costs.

Development costs include:

time require to gain permission for access to records;
time involved in the design of the abstraction form;
printing; and
pilot testing.

Running costs cover:

location and abstraction of records;
coding; and
data entry.

Analysis costs include costs of:
data processing;
review; and
report preparation.

Continuation or expansion of this approach to the abstraction of data from medical records would involve costs on all three categories.

Development: In the light of results reported in the previous section, it would be recommended that consideration be given to the redesigning of the abstraction form with respect to data items covered before any subsequent use. Experience in the field also indicated that the abstraction form could be improved by some changes in the order of items, coding options, and layout.

Running costs: From the experience of this pilot study, the recurrent cost items, with experienced staff, are estimated on a per form basis as:

cost per form:	time in mins
location and abstraction	17.5
coding	7.5
data entry	2.0

Analysis costs: Analysis costs are a function primarily of the type of output required from the data collection. It is not appropriate to convert these to a per record basis.

6.7 *Coroner Records*

6.7.1 *Abstraction of Coroners' Data*

In addition to abstracting the medical records of patients who were admitted to hospital, the Study team received permission from the Newcastle Coroner to examine files for all people who died as a result of road traffic crashes in the area covered by his jurisdiction. The Coroners' files include:

- detailed police report;
- autopsy report;
- hospital report (if patient died in hospital);
- copy of death certificate.

A separate form was designed to abstract the details from autopsy reports. A copy of this form, called Autopsy Report, is included in Appendix A. The person's demographic details and accident's date are used to link these reports to the police tapes.

6.7.2 *Assessment*

The sample of records covered is small. Over 6 months, 28 reports were provided by the Newcastle Forensic Pathologist. The following points are made on data residing in the coroners' files:

- the data in these reports are summaries of completed professional analyses, from which the data are presented in a systematic, structured format;
- as a result, abstraction of data is greatly simplified;
- the different nature of the data available in these reports confirm the desirability, for further analyses, of holding these data in a separate file from other casualty data.

A major benefit from the detailed diagnostic data has been that it has assisted in determining the AIS score for those patients who die soon after their admission to hospital.

In the latter cases the provisional and final diagnoses are usually given in non-specific terms e.g. head injury. These general terms usually have a low AIS rating, and consequently the ISS is also in the lower range, where most other patients with similar or even higher scores seem to recover. In other words, the ISS is not high enough to indicate death as a result.

In order to overcome this anomaly, the abstracting forms for both inpatient record and autopsy report were manually linked and the diagnoses were compared. In the example given, the provisional/final diagnosis of head injury would then be seen to be fractured base of skull and a subdural haemorrhage to the occipital region. The AIS would change from 2 to 4 which is more reflective of the nature and severity of the injury. After re-assessing all of the diagnoses in this manner the ISS became more indicative of the end result.

6.8 *Conclusion*

Additional information was obtained for 325 traffic crash admissions retrospectively from the hospital records. Much of the data sought could not be obtained from the medical records. To obtain reliable hospital data the coding forms should be completed by hospital staff while the patient is in hospital. Given the number of forms already completed in hospitals, and the costs and delays associated with these, there will be problems in implementing any new collection.

7. PATIENT INTERVIEW COLLECTION: COMPONENT C OF THE STUDY

This section of the report discusses the feasibility of patient interviews as a source of additional data for the monitoring of causes and medical outcomes of road traffic crashes. It presents an outline of the research strategy that would need to be implemented in order to conduct a worthwhile study and then evaluates the impact of incorporating this component into the overall research project. This aspect of the study was found to be impractical and hence this section contains only summary notes on the initial investigation.

7.1 *Research Strategy*

A research strategy for the collection of new traffic crash data has two stages. The preliminary stage lays down the procedure leading to a particular data collection exercise. The second stage is the conduct of this exercise for a specific target group. These stages are set out and brief comments are made on each in turn, as they apply to the collection of new data from persons involved in traffic crashes.

7.2 *Preparatory Steps*

7.2.1 *Specification of research area*

(a) Decide on general areas for investigation. Patient interviews are potential sources of information on (i) the circumstances surrounding the crash, and (ii) the consequences of the crash. Some of the circumstances surrounding the crash which are not systematically recorded in current data collections are; previous medical histories and prior state of health, and psychological, sociological and environmental factors.

(b) Thorough review of literature in the areas identified. Preliminary search of the literature relating to traffic crashes does not reveal any substantial body of research on these aspects, or on the use of follow-up surveys of outcome measures.

(c) Discussion with collaborators in appropriate areas, e.g. behavioural science staff, medical/therapeutic staff working with road traffic crash victims or police.

(d) Determine hypotheses and important variables to be included in the data collection.

7.2.2 *Measurement*

(a) Assess measures available for the variables proposed; obtain copies of any other questionnaires or measuring instruments which have been validated; locate validated measurement scales for qualitative variables.

(b) Define population to be studied.

(c) Establish method to obtain sample.

7.2.3 *Target Group*

Assess the value of a particular subgroup of the population as the target group for the conduct of data collection. Hospital in-patients form the sub-group considered.

(a) Advantages:
. ease of location;
. a 'captive' group if interviewed in hospital;
. covers a major cost group of crash victims.

(b) Disadvantages:
. excludes non-hospitalised crashes, e.g. minor crashes;
. post-traumatic amnesia;
. some victims too badly injured to be interviewed;
. effect of guilt on responses by victims;
. pending legal/police proceedings.

7.3 *Procedure for a Particular Group of Crash Victims*

Example: Hospital Inpatients

7.3.1 *Sample*

(a) Determination of sample size and sampling method. Assessment of variables sufficiently important to warrant stratification of sample, e.g. age, sex, driving experience, type of crash, class of road user.

7.3.2 *Ethical Considerations*

(a) Consider and evaluate problems of ethics and confidentiality; establish criteria for satisfying these requirements.

(b) Specify how data will be used. Demonstrate: usefulness of the data; how this project will further current knowledge; dissemination of information; procedures to preserve confidentiality.

(c) Ascertain and protect legal position of interviewers and data collected in the course of the study.

(d) Draft consent letter.

(e) Approach Ethics Committees to obtain approval to enter hospitals. This approach has to justify the reason why patients should be disturbed, given (b) above. It is likely to be necessary, at this stage, to submit a draft questionnaire for approval.

(f) Establish procedure to locate sample members (e.g. emergency ward books, ward and doctor approval procedures).

7.3.3 *Interviewing Procedures Development*

Development of interviewing procedures would require action under the following headings:

(a) design interviewing schedule;
(b) train staff to handle potentially difficult interview situations;
(c) undertake pilot testing;
(d) establish data scoring and collation procedures. The data collected will be primarily qualitative. Careful assessment of scales used in data collation; reference to comparison data;
(e) evaluate and revise questionnaire;
(f) print questionnaire schedule;

(g) introduce quality control/validation procedures (e.g. reinterview some patients); and
(h) establish long-term follow-up procedures for outcome data.

7.3.4 *Data Collation and Analysis*

The actual data collection and analyses involve the following steps:

(a) locate and interview persons to be included in the sample;
(b) code results;
(c) conduct quality control checks;
(d) enter initial data for processing;
(e) undertake periodic updating of data;
(f) analyse results of interviews;
(g) compare data collected by interview with that available from other sources;
(h) provide feedback to participants and collaborators;
(i) evaluate results; and
(j) prepare report on this section of overall study.

7.4 *Evaluation*

The following points became evident in developing the design for the research strategy.

1. Established procedures, validated measuring scales and comparative studies are scarce.

2. A worthwhile study would have to be pioneering in nature and need to be prefaced by extensive background research.

3. Much of the data to be gathered would be qualitative and subjective in nature, with associated problems for collation, validation and analysis.

4. Data collected would refer to patients' own perception of events only. Validation of these data by reference to other sources, e.g. other witnesses, as well as medical records, police records, etc., is a research project in its own right.

5. Useful outcome data requires long-term follow-up of patients, which is both costly and beset with practical difficulties (e.g. as people move from the area).

6. Great consideration and care is required to conduct patient interviews in a manner which is ethical to patients and will, at the same time, generate reliable data. Highly-trained, specialised interviewing skills would have to be developed.

7. Costs in terms of time, input and staffing required could take up a major part of the budget available for the total study.

8. Patient interviews are a low priority component in the present study. Their conduct is not crucial either to the linking of existing computerised data collections or to the collation and more efficient use of routinely collected data.

7.5 *Conclusion*

It would not be practical in terms of time or cost to procede with patient interviews within the framework of the present study.

8. SAMPLE RESULTS

8.1 *Introduction*

The linked files give the ability to access the traffic related fields on the police file and the medical outcome fields on the hospital file. This allows a wide range of possibilities for multivariate analysis. A limited selection of tables produced from the linked file are presented in section 8.2 to demonstrate the uses of this data base. Only tabulations involving fields from both the police and hospital files are given since analyses involving fields from only one of the files should be done on the unlinked files. Analysis of the severity score (ISS) and crash and hospital data is also provided in section 8.3, using the data obtained from part B of the study and the hospital and crash files.

8.2 *Tabulations Involving Crash and Hospital Data*

The linked file recommended on the restricted basis proposed in Section 5.4.2 above (i.e. with agreement scores in excess of 185 and hence approximately 10% false links) consists of 296 admissions for the first half of 1985. The tabulations presented below describe the outcome variables the length of stay in hospital and the principle diagnosis against possible predictor variables such as type of vehicle, year of manufacture, impact category, weather and surface condition. The results cannot reveal significant associations due to the small sample size used in this pilot study. However, by linking the files for years 1979 to 1985 for all of NSW more than 20,000 cases could be obtained; a large enough sample to determine any associations between medical outcome and traffic variables.

Table 8.1 shows the length of stay for injured persons by type of vehicle involved. The average length of stay varies from a minimum of 3.3 days for persons in heavy trucks to a maximum of 13.9 for the 'other' category (predominantly pedestrians). Motor cycles are also high with 12.5 days. Figure 8.1 shows that motor cycle and pedestrian crashes cause the majority of admissions for length of stay greater than 30 days.

TABLE 8.1 Length of Stay (LOS) by Type of Vehicle.

LOS (days)	car	light truck	heavy truck	motor cycle	pedestrians	Total
0-5	99	9	5	27	22	162
6-10	31	3	1	13	7	55
11-20	23	0	0	8	10	41
21-30	6	1	0	3	5	15
31-40	1	1	0	4	2	8
41-50	2	0	0	2	1	5
50+	3	0	0	3	4	10
Total	165	14	6	60	51	296
average length of stay *	7.7	7.6	3.3	12.5	13.9	9.7

* Average length of stay is calculated by truncating length of stay to 51 days.

Table 8.2 provides frequencies for length of stay and make of vehicle. The numbers are small, but with a larger sample, differences in length of stay and motor cycle manufacturer may be detected.

(figure 8.1 about here)

Figure 8.1 Length of stay and type of vehicle.

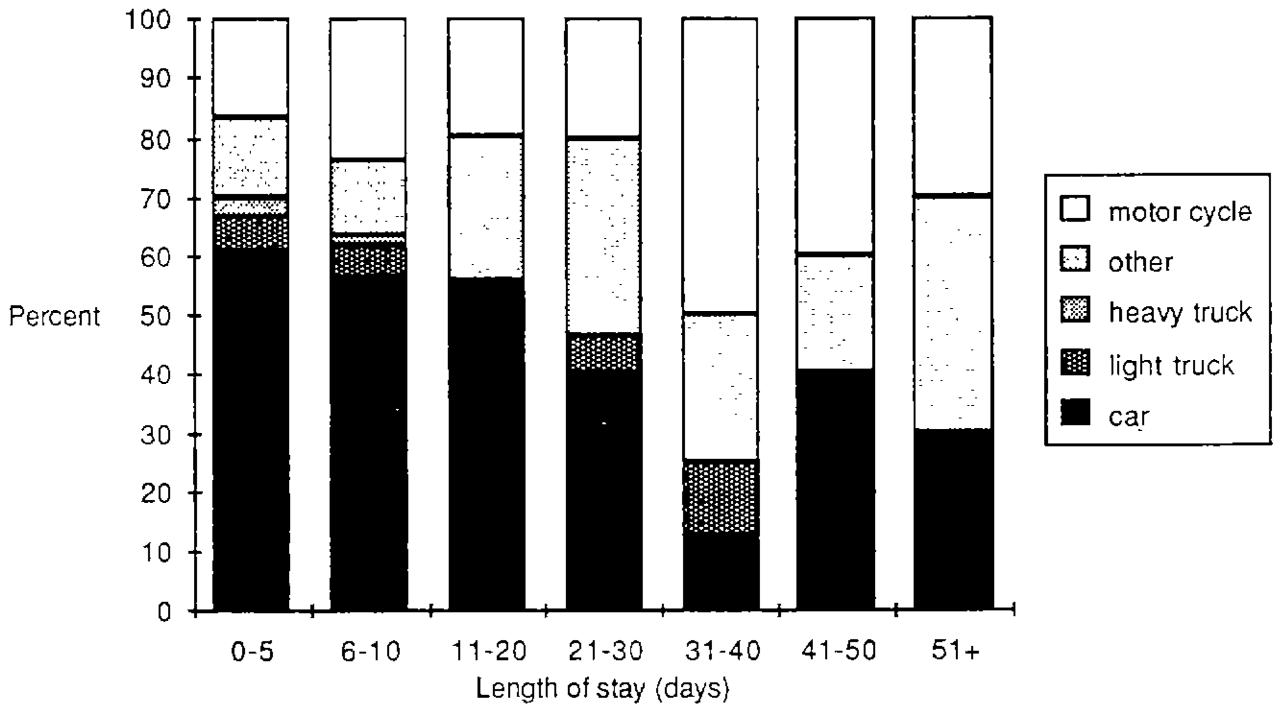


TABLE 8.2 Length of Stay (LOS) by Vehicle Manufacturer.

Make	Length of stay 0-5	6-10	11-20	21-30	31-40	41-50	51+	Total	average LOS
Other	54	18	14	6	3	2	6	103	11.1
Holden	36	10	2	3	0	0	2	53	7.1
Ford	20	3	6	1	0	0	0	30	6.4
Chrysler	2	3	1	1	1	1	1	10	20.1
Datsun	4	3	1	0	0	0	0	8	6.0
Mitsubishi	7	1	2	0	0	0	0	10	5.6
Toyota	13	7	6	1	0	0	0	27	7.5
Mazda	8	1	2	0	0	0	0	11	5.3
Honda	6	3	3	2	0	1	0	15	12.0
Yamaha	4	2	2	0	3	0	0	11	14.8
Suzuki	5	1	1	0	1	1	1	10	16.8
Kawasaki	1	3	1	0	0	0	0	5	8.1

Table 8.3 indicates a difference in length of stay in hospital and the year of manufacture with the older and newer vehicles having the shorter lengths of stay. There is no major difference in length of stay controlling for driver's age.

TABLE 8.3 Average Length of Stay (LOS) by Year of Manufacture and Driver's Age.

Year of manufacture	<1974	1974-77	1978-81	1982+	unknown	Total
Av. LOS	5.4	9.3	10.3	7.2	12.8	9.7

Driver's age	15-19	20-24	25-30	30-39	40-49	50+
Av. LOS	8.9	10.1	10.5	8.4	5.8	8.1

Table 8.4 gives the principle diagnosis against type of vehicle. There is a difference between motor cycle and car, with motor cycles having predominantly more fractured limbs (43%) than fractured skull, neck or intercranial diagnoses (20%). The percentages for cars were reversed, being 26% and 35% respectively. If these figures are confirmed with a larger sample there may be implications for future safety measures; protection for limbs on motor cycles and for the head in cars.

TABLE 8.4 Principle Diagnosis by Type of Vehicle.

	Type of vehicle					
Diagnosis	car	light truck	heavy truck	motor cycle	other	Total
other	27	3	1	7	13	51
Associated conds.	7	0	1	3	0	11
Fractured skull	11	0	1	2	5	19
Fractured neck	19	0	2	4	6	31
Fractured upper limb	16	1	0	8	1	26
Fractured lower limb	18	4	0	17	11	50
Disloc., sprains	10	0	0	3	0	13
Intercranial	30	3	0	6	13	53
Internal injury	8	1	0	4	0	13
Open wound	19	2	0	6	2	29
Total	165	14	6	60	49	296

Tables 8.5 to 8.8 provide frequencies for tables in which there is no association, but which would be of interest with a larger sample size.

TABLE 8.5 Principle Diagnosis by Speed Limit.

	Speed Limit (km)				
Diagnosis	60	80	100	other	Total
other	29	4	17	1	51
Associated conds.	6	0	5	0	11
Fractured skull	10	4	3	2	19
Fractured neck	17	3	11	0	31
Fractured upper limb	18	1	7	0	26
Fractured lower limb	33	1	12	4	50
Disloc., sprains	4	1	8	0	13
Intercranial	31	6	16	0	53
Internal injury	8	2	3	0	13
Open wound	15	3	11	0	29
Total	171	25	93	7	296

TABLE 8.6 Length of Stay (LOS) by Impact Category, 1985 January -June.

LOS (days)	head-on	right-angle	other vehicle	vehicle object	other	Total
0-5	11	23	33	57	38	162
6-10	6	9	18	10	12	55
11-20	7	6	12	8	8	41
21-30	1	3	3	5	3	15
31-40	2	0	2	3	1	8
41-50	0	0	2	2	1	5
50+	1	1	1	3	4	10
Total	28	42	71	88	67	296

TABLE 8.7 Length of Stay (LOS) by Weather and Surface Condition, 1985 January -June.

LOS (days)	Fine	Rain/ fog/mist	Dry	Wet/ flooded	Total
0-5	129	33	119	43	162
6-10	48	7	45	10	55
11-20	37	4	32	9	41
21-30	13	2	13	2	15
31-40	6	2	5	3	8
41-50	3	2	3	2	5
50+	7	3	7	3	10
Total	243	53	224	71	296

8.3 *Relationship between ISS and Length of Stay*

There were 325 cases for which injury severity scores (ISS) were obtained from the medical records (Section 6). The relationship between ISS and length of stay (LOS) would be expected to be positive, with the more severe cases spending more time in hospital. The distribution of LOS and ISS has a positive skew and contains some extreme values. There were 19 cases with LOS greater than 50 days and 11 cases with ISS greater than 25. These two sets of cases of 19 and 11 each were disjoint, (no cases in common) indicating that for the extreme values there was no relationship between ISS and LOS. This is partly due to the fact that high ISS scores result in death or transfer to another hospital thus causing a short LOS, while long LOS may represent an unusual admission with unexpected complications. Table 8.8 gives summary statistics for LOS and ISS with and without the extreme cases.

TABLE 8.8 Mean, Standard Deviation and Range for LOS and ISS:
(a) all cases and (b) cases after excluding LOS > 50 and ISS > 25

		Mean	Stand. Dev.	Range
(a)	N = 325			
	LOS	13.5	20.2	1 - 194
	ISS	8.2	6.9	0 - 41
(b)	N = 295			
	LOS	9.3	9.4	1 - 48
	ISS	7.3	5.5	0 - 25

Using the cases with the outliers excluded, a regression model was used to predict ISS in terms of LOS. The R^2 value was 34% indicating that 66% of the variation in ISS was not accounted for by LOS. A slightly better fit was obtained using the logarithm of the LOS (R^2 = 43%). Although the relationship was statistically significant ($p < 0.0001$), the explained variance was lower than expected. The above data set contained cases that were transferred to another hospital or died in hospital and to exclude these cases and control for other traffic variables a data file consisting of linked records from the traffic, hospital morbidity and the ISS data file was made. The number of records successfully linked was 170. Using only admissions that were discharged home (147), the values of the R^2 statistics were 17% and 27% for LOS and the logarithm of LOS respectively. Thus, similar results were obtained with this data set. The number of diagnoses is also positively related to the ISS score and when combined with LOS explains 34% of the variation in ISS. Thus, the use of LOS and the number of diagnoses as outcome measures can be justified provided the following limitations are noted:

- extreme values (>50 days) are not reliable indicators of severity;
- mode of discharge should be used to indicate deaths or transfers.

TABLE 8.9 Regression Models Obtained when Predicting ISS as a Linear or Log Function of LOS and the Number of Diagnoses.

dependent var	N	constant	beta coeff.	(S.E.)	R^2
LOS	295	5.40	0.20	0.03	34.2%
LOS	147	5.22	0.24	0.04	17.1%
No. diag.	147	3.13	1.68	0.25	23.3%
Log of LOS	295	2.84	2.48	0.31	42.6%
Log of LOS	147	2.40	2.86	0.39	27.1%
LOS &	147	1.94	0.19	0.04	
No. diag.			1.46	0.24	34.1%

Rural/urban differences can be obtained by considering the speed-limit applying at the crash site, which usually has values of 60, 80 or 100 km. per hour. An analysis was carried out on the above file (N= 170) to determine whether ISS, LOS, age, years of experience and year of manufacture were related to the designated speed-limit. Table 8.10 summarizes the results which indicate differences in the number of diagnoses (the higher the speed limit the more diagnoses recorded), although LOS and ISS declined with increasing speed limit. None of the results were statistically significant.

Table 8.10 Average Age of Person, LOS, ISS and Number of Diagnoses for Three Speed-limits. ANOVA was used to determine the statistical significance.

speed limit	average age	LOS	ISS	No. Diag.
60	25.7	10.9	9.01	2.5
80	27.6	8.7	9.46	3.2
100	32.0	6.8	7.65	3.0
N =	165	146	165	165
p =	0.08	0.07	0.49	0.15

The positive association found between ISS and the two variables recorded on the morbidity data file (LOS and number of diagnoses) suggest that they can be used to estimate the severity score for admitted patients who are discharged home. For those who are transferred or die in hospital it can be assumed that their ISS score would be high.

9. SUMMARY

The main conclusions drawn are, firstly, that a computerized linking of records in the NSW traffic crash file and the NSW hospital morbidity collection can be achieved, despite the problems posed by the absence of a unique personal identifier in either file. Secondly, there is a trade-off between the proportion of records linked and the level of confidence that the records linked refer to the same person. If 10% of the false links are acceptable, over 50% of the records in the regional files can be linked by the procedure described above. Twenty-eight percent of the records can be linked with a high probability (99%) that the links are correct. Finally, application of this technique over a wider time span, e.g. 1979-1985 would generate a useful data base for the analysis of personal injury in road traffic crashes. At the highest level of confidence in the correctness of the links (1% error) this data base could be expected to contain 2,000 records in the Hunter or more than 10,000 in NSW. The linked records can be regarded as a sample from the population of all hospitalised cases, and appropriate sampling weights for the strata defined by age and sex categories would need to be determined. This sample should be large enough to determine any associations between medical outcome and the traffic variables.

The costs involved in producing the linked data set are the design of the linking procedure, computer software development, computing time and disk space, analyses and testing of linkage. To produce a hospital traffic crash file and the corresponding linked file for a six year period (1979-85) for all of NSW and analyse the results would require at least a full time computer / statistican for one year ($30,000), plus $15,000 for computing time and part-time research staff.

While this study has demonstrated the feasibility of linking (by computer) hospital morbidity and traffic crash files, the particular matching procedure used applies specifically to New South Wales data. Although the methodology may be used elsewhere, the linking procedures will depend upon the nature of the relevant data bases. In some States, identifiers may be available to ensure a more efficient, accurate linkage while in others the necessary identifiers may be missing. A recent study in Scotland [20] has just been published which linked files using similar identifiers as in the Hunter study. They also obtained a satisfactory linking of the crash and hospital files, with 70% of the hospital records having a unique matching, 6.6% with multiple matching and 24% unmatched. 28% had a unique match with maximum scores, the same percentage as was obtained in the Hunter study. Both studies have now demonstrated the feasibility of linking hospital and road crash records by computer.

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11. APPENDICES

Appendix A

Appendix A includes the following forms:-

1. Public Hospital Morbidity Form
2. Police P4 Traffic Collision Report
3. Ambulance Report
4. Autopsy Report
5. Hunter Region Traffic Accident Study Abstraction Forms

HEALTH COMMISSION OF NEW SOUTH WALES

PUBLIC HOSPITAL MORBIDITY FORM

HOSPITAL | HOSPITAL CODE No | MEDICAL RECORD No

SEX: 1 M, 2 F

MARITAL STATUS: 1 M, 2 S, 3 W, 4 D, 5 SEP, 8 NK

USUAL ADDRESS (PLEASE PRINT): STREET No, STREET NAME, SUBURB, TOWN OR LOCALITY, POST CODE

COUNTRY OF BIRTH | ABORIGINE: 1 Y, 2 N | BIRTH DATE | AGE

PSYCHIATRIC ADMISSIONS ONLY

PREVIOUS INPATIENT PSYCHIATRIC TREATMENT IN NSW: 1 THIS CALENDAR YEAR, 2 PREVIOUS YEARS, 3 NONE

DATE OF LAST SEPARATION

LEGAL CLASSIFICATION

ON ADMISSION: 1 INFOR-MAL, 2 VOLUN-TARY, 3 FORM RECOM, 4 FOREN-SIC

SOURCE OF REFERRAL: X BORN IN HOSPITAL, 0 CAS, 1 CHS, 2 OPD, 3 PSYCH HOSP/UNIT, 4 NURS HOME, 5 OTH HOSP, 6 MED PRACT, 7 SELF/REL, 8 LAW ENFORC AGENCY, 9 OTHER AGENCY

ADMISSION DATE: 19

PATIENT CLASSIFICATION: 1 HOSPITAL (STANDARD), 2 PRIV SINGLE, 3 PRIV SHARED

WORKERS COMP: 1 Y, 2 N | M V 3RD PARTY: 1 Y, 2 N | HOSPITAL INSURANCE: 3 Y, 4 N

DATE OF SEPARATION: 19

ON SEPARATION: 1 INFOR-MAL, 2 VOLUN-TARY, 3 FORM RECOM, 4 FOREN-SIC

REFERRED TO: 1 OPD, 2 CHS, 3 ONS, 4 MED PRACT, 5 OTHER, 6 NOT REF, 7 NOT KNOWN

MODE OF SEPARATION

DISCH HOME: 1 BY HOSP, 2 OWN RISK

TRANSFER/DISCH. TO.—: 3 NURSING HOME, 4 PSYCH HOSP/UNIT, 5 OTHER HOSP, 8 OTH HEALTH CARE ACCOM

DEATH: 6 AUTOPSY, 7 NO AUTOPSY

PRESENTING PROBLEM *

PRINCIPAL DIAGNOSIS * (i.e. THE CONDITION WHICH BEST ACCOUNTS FOR STAY IN HOSPITAL)

OTHER CONDITIONS PRESENT *

CODE FOR AETIOLOGY OF PRINCIPAL DIAGNOSIS (IF APPLICABLE) †

PRINCIPAL OPERATION OR MAJOR PROCEDURE

OTHER OPERATIONS OR PROCEDURES

EXTERNAL CAUSE OF INJURY OR POISONING (IF APPLICABLE) | PLACE OF OCCURRENCE | E

SELECTED COMPLICATIONS OF HOSPITALISATION: 1 ADVERSE EFFECTS ANTIBIOTICS, 2 ADVERSE EFFECTS OTH DRUGS, 3 PULMONARY EMBOLUS, 4 DEEP VENOUS THROMBOSIS, 5 BED SORES, 6 WOUND HAEMORR/HAEMATOMA, 7 WOUND INFECTION, 8 URINARY TRACT INFECTION, 9 BLOOD TRANSFUSION REACTION

A MORBIDITY FORM MUST BE COMPLETED FOR EACH SEPARATION AND FORWARDED TO THE HEALTH STATISTICS UNIT, BOX 796, G.P.O. SYDNEY 2001

MD CODES | OPTION CODE | PSYCH UNIT

* NOTE: CANCER CASES MUST ALSO BE NOTIFIED ON SCHEDULE 13A

P4 TRAFFIC COLLISION REPORT

ALL INFORMATION SUPPLIED WITHOUT PREJUDICE

LOCATION

TIME | DATE | DAY 1 SUN 3 TUE 5 THU 7 SAT 2 MON 4 WED 6 FRI | LATE REPORT YES NO | PARTICULARS EXCHANGED YES NO

No VEHS | No. KILLED | No INJ | MUNIC | NEAREST STATION

STREET | TYPE | SCENE VISITED 1 YES 2 NO

TOWN SUBURB | INTERSECTION YES NO

KMS METRES | or | TYPE

FEATURES

CLASS
1. FREEWAY
2. HIGHWAY
3. TRUNK
4. MAIN
5. OTHER

SPEED LIMIT KPH

FEATURES
1. STRAIGHT
2. CURVE
3. CREST
4. LEVEL
5. GRADE
6. BRIDGE
7. TUNNEL
8. ROADWORKS
9. LEVEL CROSSING

TRAFFIC LIGHTS
BOX No
1 ON 3 NIL
2 OFF

1 PEDESTRIAN CROSS
2 STOP SIGN
3 GIVE WAY
4 POLICE
5 NIL

SURFACE
1 SEALED
2 UNSEALED
3 WET
4 DRY
5 SNOW/ICE

VIEW
1 OPEN
2 OBSCURED

INTERSECTION TYPE
1. X
2. Y
3. T
4. MULTIPLE
5. ROUNDABOUT
6. NOT INTERSECTION

WEATHER
1 FINE
2 RAINING
3 OVERCAST
4 FOG
5 SNOWING
6 OTHER

LIGHTING
1 ON 3 NIL
2 OFF
4 DAWN
5 DAYLIGHT
6 DUSK
7 DARKNESS

TRAFFIC DENSITY
1 LIGHT
2 MEDIUM
3 HEAVY

1. DIVIDED
2. NOT DIVIDED

SKETCH (SHOW NORTH POINT WITH ARROW)

IF COLLISION AT DRIVEWAY INDICATE IF VEH. – 1 ENTERING 2 LEAVING | STREET No | PROPERTY NAME | TYPE OF PREMISES 1 RESID 2 INDUST 3 RETAIL 4. RURAL

PERSONS – VEHICLES INVOLVED

No. 1 VEHICLE 2 OBJECT 3 PEDESTRIAN 4 ANIMAL	No. 1 VEHICLE 2 OBJECT 3 PEDESTRIAN 4 ANIMAL
DRIVER	DRIVER
ADDRESS	ADDRESS
POST CODE	POST CODE
LIC No / STATE / CLASS / TYPE / EXPERIENCE YRS MTHS	LIC No / STATE / CLASS / TYPE / EXPERIENCE YRS MTHS
D.O.B. / SEAT BELT 1 WORN 2 NOT WORN 3 NOT FITTED / HELMET 4 OPEN 5 FULL FACE 6 NOT WORN	D.O.B. / SEAT BELT 1 WORN 2 NOT WORN 3 NOT FITTED / HELMET 4 OPEN 5 FULL FACE 6 NOT WORN
1. MALE 2 FEM	1 MALE 2 FEM
BREATH TEST 1. POS 2 NEG 3 NO TEST / REASON NO TEST / ANALYSIS 0.	BREATH TEST 1 POS 2 NEG 3 NO TEST / REASON NO TEST / ANALYSIS 0.
OWNER (USE O/D IF DRIVER)	OWNER (USE O/D IF DRIVER)
ADDRESS	ADDRESS
REG No / STATE / YEAR / MAKE	REG No / STATE / YEAR / MAKE
BODY / LOAD / WEIGHT 1 UNDER 4.5 TONNE 2 OVER 4.5 TONNE	BODY / LOAD / WEIGHT 1 UNDER 4.5 TONNE 2 OVER 4.5 TONNE
TOWED AWAY 1 YES 2 NO / DAMAGE CODE	TOWED AWAY 1 YES 2 NO / DAMAGE CODE
VEH LIGHTS 1 ON 2. OFF / NUMBER OF OCCUPANTS / SPEED KPH	VEH LIGHTS 1 ON 2 OFF / NUMBER OF OCCUPANTS / SPEED KPH
STREET OF TRAVEL / DIRECTION	STREET OF TRAVEL / DIRECTION

SUMMARY

RESP PARTY | POLICE ACTION (INC INF NOTICE No.)

WITNESS NAME	WITNESS NAME
ADDRESS	ADDRESS

PERSONS INJURED

INJURY No FROM VEHICLE No	INJURY No FROM VEHICLE No
NAME	NAME
ADDRESS	ADDRESS
1 MALE 2. FEM / AGE / EJECTED 1 YES 2 NO / POSITION	1 MALE 2 FEM / AGE / EJECTED 1 YES 2 NO / POSITION
SEAT BELT/HELMET / HELMET TYPE / CHILD RES WORN 1 YES 2 NO	SEAT BELT/HELMET / HELMET TYPE / CHILD RES WORN 1 YES 2 NO
INJURIES	INJURIES
HOSP / 1 TREAT 2 ADMIT	HOSP / 1 TREAT 2. ADMIT
BLOOD SAMP No / 1 POS 2 NEG / ANALYSIS 0.	BLOOD SAMP No / 1 POS 2 NEG / ANALYSIS 0.
TIME OF DEATH / DATE OF DEATH	TIME OF DEATH / DATE OF DEATH

REPORTING OFFICER | SIGNATURE | STATION | RANK | DATE | CHECKING OFFICER SIGNATURE | RANK | DATE

OFFICE COPY

DEPARTMENT OF HEALTH, N.S.W.
AMBULANCE SERVICE
AMBULANCE OFFICER ☐
PARAMEDIC ☐

AMBULANCE REPORT

DATE	JULIAN	CASE No.	PATIENT OF	SEX	AGE

AUTHORITY	STN. No.	RADIO No.	RESPONSE	CATEGORY

TIME BOOKED	TIME OUT	LOCATION	DEPART	DESTINATION	CLEAR

ODO IN		FROM	TO
ODO OUT		CODE	CODE
TRIP KM			

☐ W/COMP ☐ 3rd PARTY DEBTOR DETAILS

CHG. CODE	AMOUNT	CHG. KM	CODE	TITLE	SURNAME/BUSINESS	INITIALS

WARRANT No. ADDRESS CODE

OCCUPATION EMPLOYED BY

PATIENT DETAILS

CODE	TITLE	SURNAME	FIRST NAME	D.O.B

ADDRESS CODE

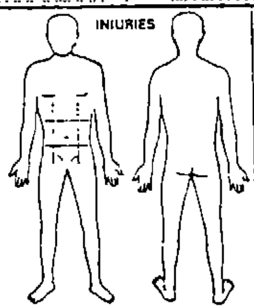
STRETCHER S
WALKING W
W/CHAIR C ☐

HISTORY (State chief complaint first)

EXAMINATION

AIRWAY ☐ Clear ☐ Obstructed
BREATHING ☐ Present ☐ Absent ☐ Shallow ☐ Deep
CIRCULATION ☐ Present ☐ Absent
Buccal Mucosa ☐ Pink ☐ Blue ☐ Pale
Skin temp. ☐ Normal ☐ Cold ☐ Hot
Sweating ☐ Nil ☐ Mod. ☐ Profuse
Vomiting ☐ Nil ☐ Small ☐ Large
Fitting ☐ Nil ☐ Yes Number
Burns ☐ Nil ☐ Superficial % ☐ Deep %
Blood Loss (External) ☐ Nil ☐ Under 500ml ☐ Over 500ml
Site ....

INJURIES

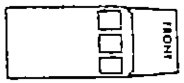


F Fracture H Haemorrhage B Burn
L Laceration T Tenderness P Pain
A Abrasion C Contusion
S Swelling D Dislocation

Specific observations ☐ Nil

Breath Sounds

X Position of Patient
→ Point of Impact
▨ Damaged Area



Seat Belt Not / Worn
Estimated Impact Speed High Medium Low
ROAD USER- 1 Driver 2 Passenger 3 Motorcyclist 4 Pillion 4 Pedal Cyclist 5 Pedestrian 6 Others

	Time	Pulse	Blood Pressure	Skin Colour	Respiration Rate	Respiration Effort	Level of Cons.	Total Score	Pupils Size T	Pupils Size R	Pupils Size L	React. R	React. L

Vital Signs Points		Add Vital Sign Points					
	First	+	+	+	+	=	
	Final	+	+	+	+	=	
		Difference Between Total Score ±					

Larger >
Smaller <
Equal =

LEGEND
LEVEL OF CONSCIOUSNESS
5 Speaking sensibly
4 Speaking confused
3 Obeys commands
2 Responds only to pain
1 No response to pain

PUPILS
● Dilated
○ Normal
• Constricted
+ Reaction present
— Reaction absent

TREATMENT BEFORE ARRIVAL
0 Nil 1 CPR within 3 mins.
2 First Aid 3 Medical

Patient's state prior to arrival
A Conscious C Unknown
B Unconscious Mins. ....

PREVIOUS ILLNESS
☐ Nil ☐ Renal
☐ Unknown ☐ Stroke
☐ Hypertension ☐ Epilepsy
☐ Cardiac ☐ Psychiatric
☐ Respiratory ☐ G.I.T.
☐ Diabetes
☐ Other ....

Allergies ☐ Nil ☐ Unknown

Present Drugs ☐ Nil ☐ Unknown

Comments ....

TREATMENT

AIRWAY 1 Suction 1 Oral Airway 2 Nasal Airway ☐ ETT

BREATHING 1 RM 2 RS 3 .... (other) 1 IPPV

CIRCULATION 1 Cardiac Compression

POSTURE 1 Lateral 2 Supine 3 Sitting 4 Legs Elevated

O_2 THERAPY 1 High Conc. Mask 2 Nasal Prongs 3 28% Ventimask 1 14L 2 8L 3 4L 1 Demand Valve

HAEMORRHAGE CONTROL ☐ Dressing ☐ Elevation ☐ Pressure

IV CANNULATION 1 Type .... 2 Unsuccessful 3 In Situ
Local given ☐ No ☐ Yes

INTUBATION 1 Type .... 2 Unsuccessful 3 In Situ

ANALGESIA
E Entonox 1 Effective
N Narcotic 2 Not Effective

SPLINTS
1 Hare 4 Cervical Collar
2 Thomas 5 KED
3 Air 6 Other

MAST Suit
1 Under 500ml 2 Over 500ml (External blood loss)

TOURNIQUETS
1 Rotating
2 Arterial
3 Lymphatic
Time On ....

STRETCHER
1 Carry Chair 4 Carry Sheet
2 Back Board 5 Other
3 Jordan Frame

KITS
1 Poison
2 Burns
3 Maternity
4 Other

BLOOD SAMPLE TAKEN
Dextrose Est. ....
Blood Type & Cross Match ....

TYPENEX No.

RHYTHMS MONITORED
(Abbreviations in heavy print)
1 Sinus Rhythm
2 Sinus Bradycardia
3 Sinus Tachycardia
4 Prem. Atrial Cont.
5 SupraVent. Tachy
6 Atrial Fib/Flut.
7 IdioVent. Rhythm
8 Asystole
9 Pacemaker Rhythm ☐
10 Prem. Vent. Cont. Frequency .... Runs ☐ R on T ☐ Multifocal ☐
11 Vent. Tachycardia
12 Vent. Fibrillation
13 1° Heart Block
14 2° Heart Block
15 3° Heart Block
16 Junctional
17 Multiple Arrhythmia
18 Elect. Mech. Dissn. ☐

TIME	ECG	TREATMENT	DOSE	ROUTE	SHOCK	RESULT	AUTH

COMMENTS, MEDICAL ASSISTANCE, PROBLEMS, INSTRUCTIONS, ETC.

Dr's Signature ....

Condition at Destination ☐ Improved ☐ Unchanged ☐ Deteriorated

SIGNATURES
Officer 1 Driving Officer 2

ATTACH ECG STRIPS HERE

TRANSTAT
BYSTANDER
Effect
ROAD USER
Severity
TREATMENT before arrival
Conscious/Unconsc.
SUCTION
AIRWAY
BREATHING
IPPV
CIRCULATION
POSTURE
O_2 THERAPY
Litre
DEMAND VALVE
CANNULATION
INTUBATION
ANALGESIA
Effects
SPLINTS
SPLINTS
MAST SUIT
TOURNIQUETS
STRETCHER
KITS
ECG
ECG
ECG
D.C. SHOCK
FLUID/DRUG
Units
FLUID/DRUG
Units
FLUID/DRUG
Units
FLUID/DRUG
Units
FLUID/DRUG
Units
PROTOCOL
PROTOCOL
PROTOCOL
PROTOCOL
RESCUE
COMPLICATIONS
HAZARDS
TENS PNEUM RELIEF
COMMENTS
MEDICAL REVIEW

AUTOPSY REPORT

PATIENT'S ADDRESS

D.O.B. :   AGE :   SEX :   M.S. :

DATE OF ACCIDENT :

TIME OF ACCIDENT :

ADDRESS OF ACCIDENT :

DATE OF DEATH :

TIME OF DEATH :

PLACE OF DEATH :

NATURE OF ACCIDENT :

PATIENT DRIVER OF CAR :   YES   NO   OTHER - SPECIFY :

REFERRED TO HOSPITAL :   NO   YES   SPECIFY :

BLOOD ALCOHOL :

DIAGNOSIS :

HUNTER REGION TRAFFIC ACCIDENT STUDY

SECTION A

Hospital code number	Patient's unit record number	Postcode
Q		

Sex M F	Date of birth	Age

Admission date	Admission time (24 hour clock)
	:

Separation date

10A Was patient referred from other hospital 1 - yes , 2.- no

B Code number of referral hospital

11. Transport to hospital.

1 Ambulance (complete SECTION C)
2 Private transport
3. Public transport
4. Helicopter
5 Other (specify ______________)
9 Not known

SECTION B Medical Record Details

12 Provisional diagnosis

	ICD	AIS
______	______	______
______	______	______
______	______	______
______	______	______
______	______	______
______	______	______
	ISIS	______

SECTION B (cont'd)

13 Vital signs - Time recorded

Place recorded - 1 Casualty , 2 Ward , 3 Theatre

Temperature (C) - 1 >= 41, 2. 39 0 - 40.9, 3 38 5 - 38 9, 4 36.0 - 38 4, 5 34 0 - 35 9, 6 32 0 - 33 9, 7 30 0 - 31 9, 8 < 30, 9 not recorded

Pulse - 1 >= 160, 2 140 - 179, 3. 110 - 139, 4 70 - 109, 5 55 - 69, 6 40 - 54, 7 <40, 9 not recorded

Systolic Blood Pressure - 1 >= 190, 2. 150 - 189, 3. 80 - 149, 4. 55 - 79, 5 <55, 9 not recorded

Respirations - 1 >= 50, 2 35 - 49, 3 25 - 34, 4. 12 - 24, 5 10 - 11, 6 6 - 9, 7 <6, 9 not recorded

14 Were neurological observations recorded - 1 yes, 2 no (go to Q15)

Neurological observations - Time recorded

Eye - 1 open spontaneously, 2 opens to verbal command, 3. opens to pain, 4 no response, 9 not recorded

Motor - 1 obeys verbal command, 2. response to painful stimuli-localize, 3. flexion to pain, 4 decorticate rigidity, 5 decerebrate rigidity, 6 no response, 7 movement without control, 9. not recorded

Verbal - 1. orientated & converses, 2 disorientated & converses, 3 inappropriate words, 4. incomprehensible sounds, 5 no response, 9. not recorded

14 (cont'd)

Was patient intubated 1 yes
2 no (go to Q15)

If intubated - 1 patient was generally unresponsive
2 patient appears to converse

15 Admitted to special care wards - 1 yes
2 no (go to Q16)

Ward	ICU	CCU
Days stay		

16 Treatment on arrival 1 yes, 2 no

Observation		Analgesia - Oral	
Investigations		I M	
X-rays/CT scan		I V	
Dressings/Sutures		I V infusion	
Theatre		Resuscitation	
Intubation			

Stabilizing musculoskeletal injuries

Blood transfusion - volume(units in 1st 24 hrs) = ________

Other (specify ______________________________)

17 Past medical history - 1 yes, 2 no

Nil		Unknown	
Hypertension		Cardiac	
Respiratory		G I T	
Diabetes		Renal	
Stroke		Epilepsy	
Psychiatric		Other (specify ____________)	

SECTION B (cont'd)

18. Patient - uses alcohol 1 yes 9 unknown
2 no

- uses tobacco 1 yes 9 unknown
2 no

- uses other drugs 1 yes 9. unknown
2 no

If yes, specify ____

____

____

19 Surgical procedures

	ICPM

20 Complications - 1 yes, 2 no

Post-op wound infection		Chest infection	
Renal failure		Haemorrhage	
Malunion of fracture		Pulmonary embolism	
D V T		Respiratory failure	
Cardiac failure		Intra-abdominal sepsis	
Coagulopathy		Other (specify ____________)	

SECTION B (cont'd)

21. Specialist services involved in treatment 1 yes; 2. no

General surgeon
Thoracic surgeon
Physician
Physiotherapist
Other
(specify ____________)

Orthopaedic surgeon
Neurosurgeon
Psychiatrist
Occupational therapist

22. Final diagnosis ICD AIS

ISIS ________

23 Follow-up - 1 yes, 2 no

Specialist - own rooms
- O.P.D
G P
Other hospital (| | |)

Rehabilitation service
C H C
No follow-up
Not recorded

SECTION C Ambulance report details

24 Is ambulance report filed 1.- yes, 2 - no

Ambulance booked		Time ambulance at	
Date	Time	Accident	Hospital

26. Patient attended by - 1.- ambulance officer; 2.- paramedic

27 History ____________

1 nil, 2. medical; 3. accident, 4. both

28 Area of body affected - 1 yes, 2 no

Face
Head/neck
Chest

Abdomen
Extremities - upper
- lower

29. Type of injury noted - 1 yes; 2. no

Fracture
Lacerations
Rupture
Penetrating injury

Burns
Haemorrhage - internal
- external
Other
(specify ____________)

SECTION C (cont'd)

30 Examination

a) Airway - 1. clear
2 obstructed

f) Sweating - 1 nil
2 moderate
3 proguse

b) Breathing - 1 present
2 absent
3 deep
4 shallow

g) Vomiting - 1. nil
2 small
3 large

c) Circulation - 1 present
2 absent

h) Fitting - 1 nil
2 yes -
(no of fits ____)

d) Buccal Mucosa - 1 pink
2 blue
3 pale

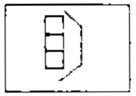
i) Burns - 1 nil
2. superficial (____ %)
3 deep (____ %)

e) Skin temp - 1 normal
2 cold
3 hot

31 Vital signs

		Time	Pulse	B P	Skin colour	Respirations rate	Respirations effort	Level of cons	Total score	Pupils
First recorded										
Last recorded										
Vital signs Points	First									
	Last									

X - position of patient
--> - point of impact
- damaged area



Impact recorded
1 - yes, 2.- no

Seat belt - 1 worn
2 not worn
9. unknown

SECTION C (cont'd)

32 Transtat

Bystander		Intubation		Units	
Effect		Analgesia		Fluid/Drug	
Roaduser		Effects		Units	
Severity		Splints		Fluid/Drug	
Treatment		Splints		Units	
Consc/Uncons		Mastsuit		Fluid/Drug	
Suction		Tourniquets		Units	
Airway		Stretcher		Protocol	
Breathing		Kits		Protocol	
IPPV		ECG		Protocol	
Circulation		ECG		Protocol	
Posture		ECG		Rescue	
O2 therapy		D/C Shock		Complications	
Litre		Fluid		Hazards	
Demandvalve		Units		Tens Pneum Relief	
Cannulation		Drug		Comments	
				Medical Review	

33 Additional notes

Appendix B

Table B1

List of Items Included in Traffic Crash Files

General Information File

Variable

Quarter code
Crash number
Day of week
Date of crash
Time of crash
Principal traffic route number
Section number
Speed limit
Local government area
* Police at scene
Street number
Street name
Street type
Identifying object
Identifying object type
Town or place
Direction from identifying object
Distance from identifying object
*** Location code
Type of location
* Road surface
Surface condition
Feature of road
Road markings
Signs/signals
Pedestrian controls
* Traffic signal number
Traffic signals
Alignment of road
* Road grade
Street lighting
* Street lights type
Weather
Natural lighting
* Visibility
1st impact category
1st impact item 1
1st impact item 2
2nd impact category
2nd impact item 1
2nd impact item 2
3rd impact category
3rd impact item 1
3rd impact item 2
* Subsequent impacts
Number of traffic units
Number killed

TABLE B1 (cont'd)

Number injured

Traffic Unit Information File

	Variable
	Quarter code
	Crash number
	Traffic unit number
# **	Initials of driver
# **	Surname of driver
**	Postcode of driver/rider
	Sex of driver/rider
	Age of driver/rider
	Experience of driver/rider
	Status of licence
# **	Licence number
**	State of licence
	Sobriety of driver/rider
	Seatbelt/Helmet for driver/rider
	Year of manufacture
	Make of traffic unit
#	Registration number
	State of registration
**	Status of registration
	Type of traffic unit
**	Type of traffic unit towed
**	Loading
*	Area of damage 1
*	Area of damage 2
*	Area of damage 3
	Was vehicle towed away
**	Vehicle headlights
*	Attended
	Number of occupants
	Direction of travel of vehicle
	Street of travel
	Manoeuvres of traffic unit
	Factors/Errors
**	Other traffic unit a factor
**	Legal action
*	Other legal action

Casualty Unit Information File

Variable

Quarter code
Crash number
Casualty number
Degree of casualty
Sex of casualty

	Age of casualty
	Casualty traffic unit number
	Position in vehicle
	Class of road user
*	Injury data fields
***	Blood alcohol concentration
	Treated/Admitted
	Hospital
	Hospital unit record number
***	Date of death
***	Time of death
	Seatbelt/Helmet for casualty
	Ejection

NOTE:
* * No longer coded, filled with blanks.
* ** No longer coded for non casualty crashes, filled with blanks.
* *** Only coded for fatal crashes, filled with zeros.
* \# Privacy information, filled with blanks.

TABLE B2

List Of Data Contained In Ambulance Reports

Variable

Date
Day of year
Sex
Age
Time: booked
 ambulance out
 at patient location
 depart patient location
 arrive destination
 ambulance clear
Origin
Destination
Debtor details (confidential items)
Patient details (confidential items)
Mobility
Vital signs points: (first and last)
 pulse
 blood pressure
 skin colour
 respiration rate
 respiration effort
 level of consciousness
 total score
Pupils
Bystander assistance
Effect
Road user
Severity
Treatment before arrival
Conscious/Unconscious
Suction

Airway
Breathing
IPPV
Circulation
Posture
O_2 Therapy
Cannulation
Intubation
Analgesia
Splints (max. 2)
Mastsuit
Tourniquets
Stretcher
Kits
ECG (max. 4)
Fluid/Drugs (max. 5)
Protocol (max. 4)
Rescue
Complications
Hazards
Tens pneum relief

TABLE B3

Fields Coded In The Hospital Morbidity Collection

Variable

Hospital code
Medical record number
Sex
Marital status
Postcode
Birthdate
Aboriginal status
Source of referral
Admission date
Patient classification
Insurance
Separation date
Referred to
Mode of separation
Principal diagnosis
Secondary diagnosis (max. 4)
Aetiology of principal diagnsosis
Principal procedure
Secondary procedures (max. 3)
External cause (traffic crashes coded here)
Complications
Medical officers' code (max. 2)