Paraplegia **26** (1988) 380–388

Costs of Spinal Cord Injury in Australia

J. Walsh, BSc, AIA, FIAA, ASA
1 Rook Street, Hunter's Hill, 2110 NSW, Australia.

Summary
Available data on spinal cord injury in Australia has been synthesised. An investigation and discussion has been made into the major financial costs involved in the acute management and ongoing life support systems required by people who have sustained spinal cord injury. The costs are projected to give an estimate of the potential for dollar savings in Australia in reducing the impact of spinal cord injury, either by lowering its incidence or by reducing the resulting devastation. Allowance has been made in these projections for severity of disability, rates of survival, re-employment, hospitalisation and relative use of various aids and appliances. It is estimated that based on an incidence rate of 25 new cases of spinal cord injury per million of population per annum the annual cost by the year 2006 will exceed $250m. As the spinal cord injury population ages the propensity of cost is expected to move from acute and medical care to less acute, community based care. Mention is also made of the non-economic human costs which cannot be quantified in terms of dollars and cents.
Key words: *Spinal cord injury; Costs.*

Awareness of the value of information systems on spinal cord injury has increased progressively in the past few years in all parts of the world including Australia. Indeed a number of initiatives have been taken to formalise and make compatible the methods and structure of such systems (Burke *et al.*, 1986; DeVivo and Fine, 1980). In Australia, 1987 witnessed a formal exchange of views on this subject and part of this exchange involved an analysis of the costs (both economic and non-economic) caused by spinal cord injury; participants in the debate were representative of Medical opinion, Epidemiology, Government, and actuarial science (Menzies Foundation, 1987).

The process involved first of all a series of papers written by participants at the conference. Each paper was discussed by all participants, and amended appropriately by the editorial committee. The edited chapters were then included in the published manuscript co-authored by all participants. In this way we were able to first of all present a first approximation to the costs involved in

Table I Initial and ongoing costs of spinal cord injury

	Paraplegic	Tetraplegic
Initial costs ($'000 once only)		
Acute care	50	70
Home modifications (including appliances etc.)	46	70
Rehabilitation	14	40
Ongoing costs ($'000 per annum)		
Income support	6·0	6·0
Accommodation	no specific additional cost	
Transport	3·0	3·0
Ongoing medical and surgical	3·0	3·0
Home nursing care	—	5·0
Attendant care	1·5	6·0
Equipment and pharmaceuticals	3·0	5·0
Home maintenance	1·0	1·0

spinal cord injury as contained throughout the literature and from personal experience; we were then able to fine tune our figures using the collective experience of Australian experts from both Medicine and from Government. This paper summarises and highlights some features of the analysis.

Methodology

The financial costs of spinal cord injury were conveniently partitioned into three major headings:

1. Initial hospitalisation.
2. Income support.
3. Ongoing care.

The second and third items were grouped as 'ongoing' costs and the first as 'initial' costs and the major contributing items to each heading are presented below, together with the costs agreed to be consumed by each item by a 'typical' paraplegic and tetraplegic casualty (Table I).

The average amount in dollars consumed by each spinal cord injury on each item was established through a consensus as described above. The figures are the best estimates of a group of experts and are supported by the literature. All figures in this paper are in 1987 Australian dollars (i.e. inflation has been ignored) and they err no doubt on the side of conservatism when viewed beside the heads of claim granted to claimants at common law actions (e.g. Donovan, 1987). Our objective was to estimate the actual costs of what is routinely purchased rather than what may be projected as justifiable in pursuit of an adequate settlement.

In order to establish the total cost of spinal cord injury in the Australian community it was necessary firstly to estimate the numbers and ages of paraplegics and tetraplegics living in Australia (so as to estimate ongoing costs) and secondly to project the likely numbers of new spinal cord injuries each year so as to project initial costs and also to gradually supplement the total picture of ongoing costs as new paraplegics and tetraplegics graduate into community life. These figures could be confidently extrapolated from a number of studies on the prevalence

Table II Baseline prevalence of spinal cord injury and new injuries in each future year

Baseline prevalence			New injuries (% at each age)		
Age	Paraplegics	Tetraplegics	Age	Paraplegics	Tetraplegics
22	450	330	20	50	50
27	560	400	30	20	20
32	450	540	40	15	15
37	480	250	50	10	10
45	700	480	60	5	5
55	480	300	Total	100	100
70	360	220			
Total	3480	2520			

and incidence of spinal cord injury in Australia (Burke *et al.*, 1986; Walsh, 1986; Paraplegic & Quadriplegic Association of NSW, 1985). The model for both baseline prevalence and additions in each future year is shown in Table II.

The projections described in Table II were carried out taking account of the heavier mortality experienced by people who have sustained spinal cord injury both in the acute stages and also in the long term. The algorithm for calculating the population in year 'n' is as follows: $P(n) = P(n - 1) + N(n) - D(n)$, where $P(n + 1)$ is the starting population in year $(n + 1)$, $P(n)$ is the starting population in year n, $N(n)$ is the total number of new injuries in year n and $D(n)$ is the number of deaths in year n. Both $N(n)$ and $D(n)$ are composite figures derived from a model of age distribution of paraplegic and tetraplegic casualties to which are applied age specific incidence rates and age and duration specific mortality rates respectively.

The results of the projections are presented in Tables III and IV and graphically in Figure 1. The two projections presented represent:

1. The approximate current situation in Australia (400 new spinal cord injuries per annum).
2. An idea of the potential for cost savings if the incidence was reduced to 200 new cases per year.

Explanations of column headings in Tables III and IV are set out below:

$P(n)$, $D(n)$ and $N(n)$ as explained above

$$T(n) = P(n) + N(n)$$

$CP(n)$, $CN(n)$ and $CT(n)$ represent costs incurred during year n by (respectively) those people alive at the beginning of year n, those new spinal cord injuries during year n, and the total of these two.

For each of $P(n)$, $N(n)$ and $T(n)$ an average cost per person is obtained, and finally an investigation is made into the relative importance of initial costs ($CN(n)$) and recurrent costs ($CP(n)$).

Results

Spinal cord injury is a significant drain on community resources both through the Social Security system and also through compensation by insurance.

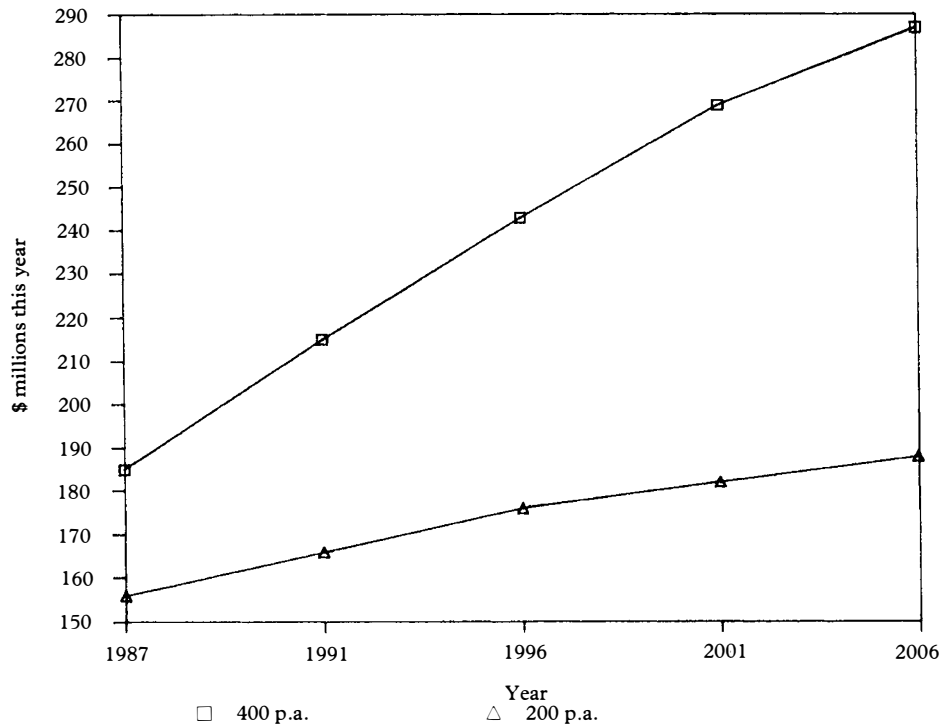


Figure 1 Total future costs of spinal cord injury.

It is estimated that the total cost of spinal cord injury in Australia will rise from $127m per annum in 1987 (excluding new injuries) to $287m or $188m in 2006 based on two projection models (one at 400 new cases of spinal cord injury per year, or 25 per million of population, and alternatively at 200 new cases of spinal cord injury per year or about 12.5 million of population).

It is a valuable planning exercise to further analyse total costs into initial costs and ongoing costs in order to estimate the relative needs in the future. There is no doubt that in Australia we have an expanding spinal cord injury population (that is people are sustaining spinal cord injury at a greater rate than people with spinal cord injury are expiring), and as a result the 'relative needs' pendulum is swinging heavily towards community care. This trend is consistent with experience overseas (Eisenberg and Tierney, 1985; Van Laire and Duyvejonck, 1986) and will continue, particularly as the rate of incidence of spinal cord injury stops rising (Fig. 2, Tables III and IV). There is a suggestion that the rate has already plateaued in Australia but much more information is required before a definitive statement can be made.

Further evidence of the heavy weight contributed by ongoing costs is presented in Figures 3A and 3B. Clearly for both paraplegia and tetraplegia in particular the costs of initial hospitalisation are a minor part in the total cost of spinal cord injury.

The figures on which Figures 3A and 3B are based are presented in Table V.

Table III 400 new injuries per annum

	Projection SCI 1987			Projection future SCI			Projection total SCI			Nature of costs		
Year of expense n	No. surviving P(n)	Total cost $m CP(n)	Average cost $'000	No. this year N(n)	Total cost $m CN(n)	Average cost $'000	Total no. alive T(n)	Total cost $m CT(n)	Average cost $'000	Initial (1)	Recurrent (2)	2 — 1
1987	6000	127	21	400	58	145	6400	185	29	58	127	2·2
1988	5921	125	21	767	67	87	6688	192	29	58	134	2·3
1989	5840	123	21	1131	74	65	6971	197	28	58	139	2·4
1990	5755	121	21	1493	82	55	7247	203	28	58	145	2·5
1991	5669	119	21	1851	90	49	7520	209	28	58	151	2·6
1992	5580	117	21	2206	98	44	7786	215	28	58	157	2·7
1993	5498	116	21	2558	106	41	8056	222	28	58	164	2·8
1994	5417	114	21	2907	113	39	8324	227	27	58	169	2·9
1995	5333	112	21	3253	121	37	8585	233	27	58	175	3·0
1996	5247	110	21	3595	128	36	8841	238	27	58	180	3·1
1997	5157	108	21	3933	135	34	9090	243	27	58	185	3·2
1998	5064	106	21	4268	143	34	9332	249	27	58	191	3·3
1999	4967	104	21	4599	150	33	9567	254	27	58	196	3·4
2000	4867	102	21	4927	157	32	9794	259	26	58	201	3·5
2001	4767	100	21	5252	164	31	10019	264	26	58	206	3·6
2002	4665	98	21	5572	171	31	10236	269	26	58	211	3·6
2003	4562	96	21	5888	178	30	10450	274	26	58	216	3·7
2004	4457	93	21	6199	184	30	10656	277	26	58	219	3·8
2005	4349	91	21	6506	191	29	10855	282	26	58	224	3·9
2006	4243	89	21	6808	198	29	11051	287	26	58	229	3·9

Table IV 200 new injuries per annum

	Projection SCI 1987			Projection future SCI			Projection total SCI			Nature of costs		
Year of expense n	No. surviving P(n)	Total cost $m CP(n)	Average cost $'000	No. this year N(n)	Total cost $m CN(n)	Average cost $'000	Total no. alive T(n)	Total cost $m CT(n)	Average cost $'000	Initial (1)	Recurrent (2)	2 — 1
1987	6000	127	21	200	29	145	6200	156	25	29	127	4·4
1988	5921	125	21	384	34	89	6305	159	25	29	130	4·5
1989	5840	123	21	566	37	65	6405	160	25	29	131	4·5
1990	5755	121	21	746	41	55	6501	162	25	29	133	4·6
1991	5669	119	21	925	45	49	6594	164	25	29	135	4·7
1992	5580	117	21	1103	49	44	6683	166	25	29	137	4·7
1993	5498	116	21	1279	53	41	6777	169	25	29	140	4·8
1994	5417	114	21	1454	57	39	6871	171	25	29	142	4·9
1995	5333	112	21	1626	61	38	6959	173	25	29	144	5·0
1996	5247	110	21	1797	64	36	7044	174	25	29	145	5·0
1997	5157	108	21	1966	68	35	7124	176	25	29	147	5·1
1998	5064	106	21	2134	72	34	7198	178	25	29	149	5·1
1999	4967	104	21	2300	75	33	7267	179	25	29	150	5·2
2000	4867	102	21	2464	79	32	7331	181	25	29	152	5·2
2001	4767	100	21	2626	82	31	7393	182	25	29	153	5·3
2002	4665	98	21	2786	86	31	7451	184	25	29	155	5·3
2003	4562	96	21	2944	89	30	7506	185	25	29	156	5·4
2004	4457	93	21	3100	92	30	7557	185	25	29	156	5·4
2005	4349	91	21	3253	96	30	7602	187	25	29	158	5·4
2006	4243	89	21	3404	99	29	7647	188	25	29	159	5·5

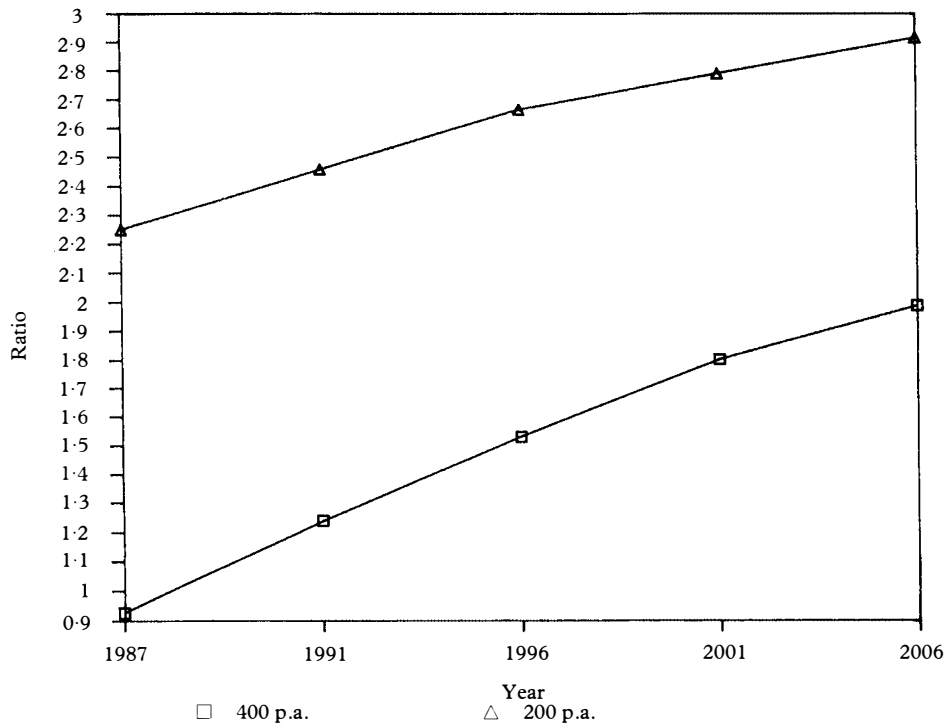


Figure 2 Ratio of recurrent to initial costs.

Table V Capital values of typical costs

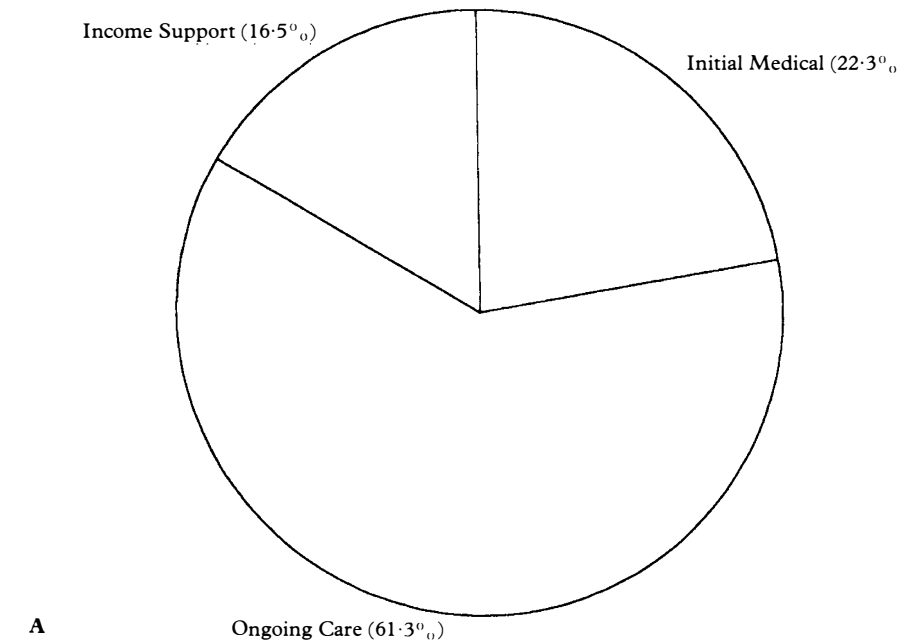
Age	Initial cost		Income replacement		Ongoing costs	
20	110.0	180.0	132.9	132.9	261.0	495.1
30	110.0	180.0	118.8	118.8	242.4	455.3
40	110.0	180.0	98.5	98.5	213.8	395.5
50	110.0	180.0	69.4	69.4	179.2	326.8
60	110.0	180.0	27.4	27.4	132.9	252.3

Costs are as set out in Methodology, projected for lifetime and discounted by an effective 2% per annum.

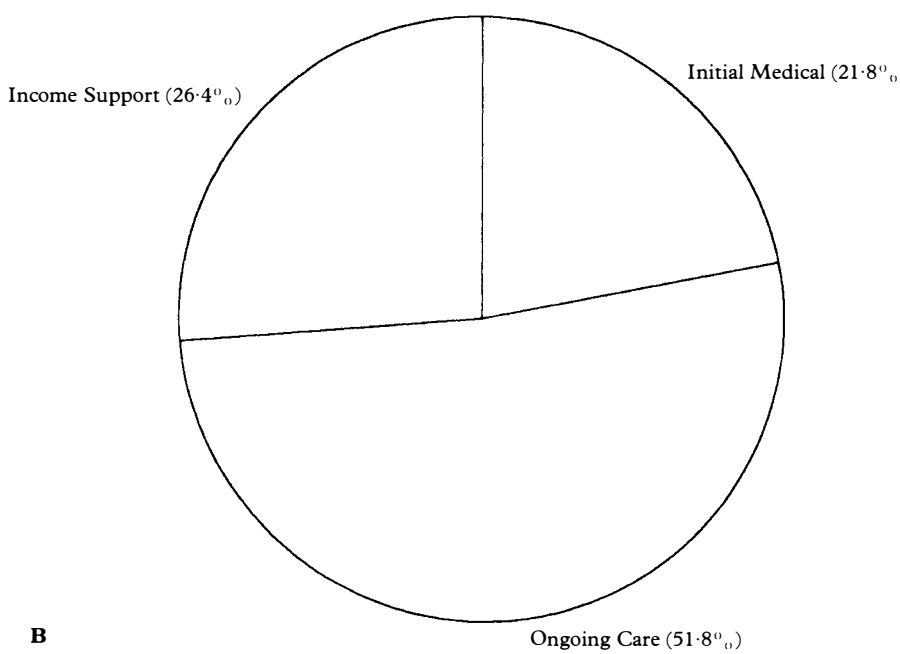
Discussion

Improving longevity and persistent incidence of spinal cord injury will cause ever increasing costs to the community, both in economic 'dollar' terms and also in terms of the pain and suffering and loss of quality of life suffered by people who have sustained this disability.

In particular the application of funds will progressively be channelled into long term care as the population of paraplegics and tetraplegics ages. This progression has obvious implications for control of the escalation in costs. In the first place costs can obviously be contained by achieving *prevention* of spinal cord injury. Just as important, however, is the prevention of the 'handicaps' which result from spinal cord injury: by controlling long term community costs through rehabilitation (e.g. Ikata, 1987) and application of improving tech-



A



B

Figure 3 Analysis of costs of **A** 20-year-old tetraplegic patient, **B** 20-year-old paraplegic patient.

nology (e.g. Van Laire and Duyjevonck, 1986) we should be able to reduce the dollar costs and at the same time reduce the non-economic costs by improving the quality of life.

Clearly there is a need for sophisticated and compatible data and information systems to evaluate the progress of any active programmes in prevention and/or rehabilitation.

References

BURKE DC, BROWN DJ, BURLEY HT, *et al.* 1986 Data collection. Knowing what we are talking about. Presented at conference '10 Years of Spinal Research', Hobart (in press).

DEVIVO MJ, FINE PR 1980 The prevalence of spinal cord injuries. A re-estimation based on life-tables. *Spinal Cord Injury Digest:* **1**.

DONAVAN WH 1987 Medical-legal issues concerning spinal trauma. *Paraplegia* **25**:305–307.

EISENBERG MG, TIERNEY DO 1985 Changing demographic profile of the spinal cord injured population: Implications for health care support systems. *Paraplegia* **23**:335–343.

IKATA T 1987 Resettlement and employment of paraplegic patients in Japan. *Paraplegia* **25**:308–309.

MENZIES FOUNDATION 1987 Technical report No. 1: Towards prevention of spinal injury. Menzies Foundation, Melbourne.

PARAPLEGIC & QUADRIPLEGIC ASSOCIATION of NSW 1985 A Survey of Members 1984–5.

VAN LAIRE M, DUYVEJONCK R 1986 Environment control and social interaction. *Paraplegia* **24**:322–325.