Multidisciplinary versus physiotherapy-only weekend rehabilitation: A prospective cohort study

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TITLE PAGE

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Multidisciplinary versus physiotherapy-only weekend rehabilitation: A prospective cohort study

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ABSTRACT

Background: This study aims to investigate the impact of multidisciplinary Saturday rehabilitation (MSR) on length of stay, functional independence, gait and balance when compared to a 6-day physiotherapy-only service in a pragmatic setting. An economic evaluation of the intervention conducted from the perspective of the healthcare provider is included.

Methods: A prospective cohort study with a historical control was conducted in an Australian private mixed rehabilitation unit to compare a multidisciplinary and physiotherapy-only 6-day rehabilitation service. Clinical outcomes included the Functional Independence Measure (Motor, Cognitive, Total), gait speed (10 Meter Walk test) and five balance measures (Timed Up and Go test, Step test, Functional Reach, Feet Together Eyes Closed and the Balance Outcome Measure of Elder Rehabilitation). Economic outcomes were rehabilitation unit length of stay and additional treatment costs.

Results: A total of 366 patients were admitted to the rehabilitation unit over two 20-week periods. The prospective cohort (MSR) had 192 participants and the historical control group (physiotherapy Saturday rehabilitation) had 174 participants). Participants in the historical control group had lower total and cognitive Functional Independence Measure scores ($p < 0.078$), and generally performed at a lower level on admission gait and balance measures compared to the prospective cohort. More participants in the prospective cohort attended weekend therapy, attending more sessions and spending more time in therapy compared to those in the historical control group ($p < 0.012$). After controlling for differences in admission Functional Independence Measure scores, length of stay was reduced by

1.39±0.77 days. The economic evaluation estimated cost savings of $1,536 per patient. The largest savings were attributed to neurological patients $4,854. Traumatic and elective orthopaedic patients realised cost savings per admission of $2,668 and $2,180, respectively.

Conclusions: Implementation of MSR results in a more efficient service, enabling a greater amount of therapy to be provided over a shorter length of stay. The provision of a multi-disciplinary Saturday rehabilitation is potentially cost reducing for the treating hospital.

Trial registration: not applicable.

Keywords: Multidiscipline, rehabilitation, economic evaluation

BACKGROUND

Rehabilitation aims to improve the functional status of people with health conditions leading to impairments, activity limitations or participation restrictions.[1] Multidisciplinary rehabilitation (including physical therapy (PT) and occupational therapy (OT)) optimizes patient outcomes, and is beneficial for geriatric patients,[2] people following hip fracture[3, 4] and those with Parkinson's Disease.[5] The Australasian Faculty of Rehabilitation Medicine recommends that rehabilitation be delivered by multidisciplinary teams[6] and the Consultative Committee on Private Rehabilitation recommends service delivery should extend to weekends.[7]

Randomised controlled trials have shown improvement in functional independence and health related quality of life with 6-days of PT only[8] and for multidisciplinary (PT and OT) rehabilitation[9] compared to 5-days. Interestingly, though no reductions in length of stay (LOS) were found.[8, 9] However, the external validity of randomised controlled trials that strictly control intervention delivery could be questioned.[10] More recently, a systematic review combining weekend rehabilitation delivered over six and seven days has highlighted reductions in LOS.[11] One reason for the inconsistent effect on reduction in LOS maybe in the referral of a heterogeneous mix of patients for rehabilitation. Pragmatic implementation of a 6-day multidisciplinary rehabilitation service in an inpatient clinical setting would likely prioritise patients likely to benefit from[12-14] and motivated to engage in additional rehabilitation.[15, 16]

Providing weekend rehabilitation will likely incur additional costs for facilities. However, economic evaluations have suggested that Saturday multidisciplinary rehabilitation may reduce costs per quality-adjusted life year gained[17, 18] with potential reductions also found in incremental cost-effectiveness ratios at 30 days[17] and 12 months[18] post discharge. An economic analysis of a pragmatic implementation of weekend rehabilitation is required. This study aimed to evaluate the efficacy of a pragmatic implementation of a multidisciplinary Saturday rehabilitation (MSR) service on patient function at completion of rehabilitation, with economic evaluation conducted from the perspective of the healthcare provider integrated into the study.

METHODS

Participants

A pragmatic prospective cohort study with historical control was performed of all patients admitted for rehabilitation at St Andrew's War Memorial Hospital, Brisbane, Australia. In total, 366 patients admitted to a 20-bed rehabilitation were included; 174 patients admitted from October 2015 to April 2016 were the control group and 192 patients admitted from October 2016 to April 2017 were the intervention group. Ethical approval was granted by UnitingCare Health Human Research Ethics Committee (HREC#2014000752; 2011.16.38) and conforms to the Helsinki Declaration. Individual patient consent to participate in the study was not required by the ethics committee as the service was deemed usual practice.

Intervention

The rehabilitation unit services a mixed adult caseload. Participants in both groups received usual weekday (Monday to Friday) rehabilitation consisting of nursing, medical, and individualised PT and OT (one hour each, per weekday) care, with speech pathology and dietetic involvement as required. The control group were eligible to receive a Saturday PT service consisting of 3.5 hours of PT on Saturday, delivered as group or individual sessions in the therapy gym or ward, staffed by a PT and an Assistant-in-Nursing who provided porterage and therapy assistance. Participants were deemed eligible by their treating physiotherapist if they were likely to deteriorate over the weekend without PT input, were making functional improvements and would benefit from weekend PT input, were admitted on a Thursday or Friday, or admitted for a stay of less than one week. Patients were excluded from Saturday therapy if they consistently refused usual weekday PT.

The intervention group were offered a MSR service, consisting of four hours each of PT and OT, with an allied health assistant providing porterage and therapy assistance. There was no change to PT service and eligibility criteria. The intervention group were eligible to attend the Saturday OT service if they were admitted on a Friday, required an initial assessment (activities of daily living, cognitive or neurological assessment), required compression therapy, were neurological patients who would benefit from weekend OT, or required additional OT prior to discharge. A maximum of two activities of daily living assessments could be scheduled each Saturday. OT was provided in group or individual sessions, in the therapy gym or ward. Participants could receive both PT and OT Saturday services.

Data Collection

Patient demographic data collected included age, sex, primary diagnosis, discharge destination, rehabilitation inpatient LOS and nine indicators of patient capability (clinical measures of functional independence, gait speed and balance), measured on admission and discharge to the rehabilitation unit. Functional independence was recorded using Functional Independence Measure (FIM) Motor (FIM_{Motor}), Cognitive ($FIM_{Cognitive}$) and Total (FIM_{Total}) scores.[19, 20] Gait speed was measured using the 10 Meter Walk Test (10MWT).[21, 22] Five valid and reliable measures of balance with older populations were used: the Timed Up and Go (TUG) test,[23, 24] Step test,[25, 26] Functional Reach,[27, 28] maximum Feet Together Eyes Closed (FTEC) test[29], and the Balance Outcome Measure of Elder Rehabilitation (BOOMER).[30, 31] Distributions for the 9 dependent variables of interest are reported in Figure A.1 in the Appendix.

The economic evaluation was conducted with financial data obtained from St Andrew's War Memorial Hospital's human resources department to estimate the costs of providing 20 weeks of Saturday rehabilitation for both groups. Estimates of variable costs (e.g., wages) and fixed costs (e.g. hospital overheads & ward expenses) were included. Allied health and nursing staffing costs were based on wage rates per hour (inclusive of weekend loading and on-costs). Estimates of average cost per bed-day published by the Hospital Pricing Authority[32] were used to monetise potential savings due to reduced LOS. All rehabilitation costs were collected in 2017 Australian dollars and adjusted to 2020 Australian dollars using the Australian consumer price index.[33]

Statistical Analysis

First, to explore the effect of MSR on patient health at discharge, the following multivariate regression model was estimated:

$$Cap_{DC} = \alpha_0 + \alpha_1 MSR + \alpha_3 fem + \alpha_4 age + \alpha_2 \mathbf{Dx} + \varepsilon_i \quad \text{Eq. 1}$$

The dependent variable Cap_{DC} denotes one of nine indicators of patient capabilities measured at discharge, which were three measures of functional independence, gait speed and five indicators of balance. The explanatory variable of interest MSR is a dummy variable that takes the value of one if the patient was enrolled in the intervention group and zero if enrolled in the control group. Controls for sex (= 1 if female) and age (years) were also included. The vector **D** consists of a set of dummy variables that control for admitting diagnosis (neurology, amputation, musculoskeletal, orthopaedic-trauma, orthopaedic-elective, reconditioning) and ε_i is a random error term. The null hypothesis; MSR has no effect on Cap_{DC}, $(H_0\!: \alpha_1 = 0)$, is rejected if α_1 has a *p*-value<0.05. Specifications with continuous dependent variables were estimated using ordinary least squared and specifications with dependent variables that were count data were estimated using Poisson regression and the marginal effects (dy/dx) reported.

Second, to test the effect of receiving MSR on rehabilitation LOS, the following multivariate regression was estimated, to isolate the impact of the intervention on LOS:

$$LOS = \alpha_0 + \alpha_1 MSR + \alpha_2 FIM_{Motor}A + \alpha_3 FIM_{Cognitive}A + \alpha_4 \mathbf{A} + \alpha_5 \mathbf{D} + \alpha_6 fem + \alpha_7 age + \varepsilon_i \quad \text{Eq. 2}$$

The dependent variable *LOS* is a count of the number of days the patient stayed in the rehabilitation unit, *MSR* a binary variable that takes the value of one if participants received MSR. Variables, $FIM_{Motor}A$ *and* $FIM_{Cognitive}A$, are FIM sub-scales measured on admission to the rehabilitation unit. Two sets of binary variables for day of admission (A) and day of discharge (D) were included to control for the effect that day of admission may have on LOS. Sundays were the omitted reference category from the model. Controls for sex and age are included and ε_i is a random error term. LOS are count data, and therefore Eq. 2 was estimated using Poisson regression and the marginal effects are reported.

Equation 3 specifies a sub-analysis, which includes a set of dichotomous variables for medical diagnosis (neurology, musculoskeletal, orthopaedic-trauma, orthopaedic-elective, reconditioning) and their interactions with the binary treatment variable MSR. The interaction terms enable the effect of the MSR to be differentiated by clinical diagnosis (*Dx*).

$$LOS = \beta_0 + \beta_1 MSR + \beta_2 FIM_{Cognitive} + \beta_3 FIM_{Motor} + \beta_4 FIM_{Total} + \beta_5 \mathbf{A} + \beta_6 \mathbf{D} + \beta_7 fem + \beta_8 age + \beta_9 Dx + \beta_{10} Dx * MSR + \eta_i \quad \text{Eq. 3}$$

RESULTS

There was no statistically significant difference between the intervention and control groups in age, sex, medical diagnosis, acute inpatient care or discharge destination (Table 1). A greater percentage of the intervention group attended MSR (83% vs 72%), attending 0.7 more sessions (95%CI 0.40 to 0.99) and 72 more minutes (95%CI 52 to 91) of therapy than the control group. A greater number of Saturday occasions of service were provided during the intervention period (7.1, 95%CI 5.50 to 8.80) than the control, including 1.5 more occasions of PT service (95%CI 0.45 to 2.56). The average LOS in the rehabilitation unit for the intervention group was 2.4 days (95%CI 0.5 to 4.3) less than the control group. Participants attending Saturday OT services received one assessment intervention lasting 54.2±12.0 minutes and 1.2 treatment sessions lasting 59.6±30.6 minutes during their rehabilitation stay. In the intervention period, six participants received only OT, 63 participants received only PT and 91 participants received both PT and OT on a Saturday during their rehabilitation stay.

Table 1: Clinical and demographic data for intervention and control groups

Variable	Control n=174	Intervention n = 192	*P-values from tests of means, proportions & distributions*
Age, mean ± SD	77.7±12.92	78.8±10.57	0.35
Female, n (%)	110 (63.2)	130 (67.7)	0.37
Diagnosis, n (%)			0.12
Stroke	7 (4)	4 (2.1)	
Neurology	28 (16.1)	16 (8.3)	
Amputee	5 (2.9)	-	
Musculoskeletal	6 (3.4)	11 (5.7)	
Orthopaedic – Trauma	30 (17.2)	40 (20.8)	
Orthopaedic – Elective	35 (20.1)	47 (24.5)	
Reconditioning	63 (36.2)	74 (38.5)	
LOS in acute inpatient care*,* mean ± SD	11.9±12.25	11.1±8.51	0.46
LOS in rehabilitation, mean ± SD	16.4±11.17	14.0±6.98	<0.01
Discharge destination, n (%)			0.48
Home	140 (80.5)	163 (84.9)	
Low Level Care	3 (1.7)	2 (1)	
High Level Care	16 (9.2)	14 (7.3)	
Transition care or another hospital ward	10 (5.7)	11 (5.7)	
Participants attending Saturday therapy, n (%)	126 (72)	160 (83)	0.01
Saturday sessions attended, mean ± SD			
Total	1.6±1.1	2.3±1.4	<0.01
Physiotherapy	1.6±1.1	1.6±1.0	0.88
Occupational therapy	n.a.	1.2±0.6	
Minutes in Saturday therapy, mean ± SD			
Total	85±53	157±99	<0.01
Physiotherapy	87±52	86±47	0.88
Occupational therapy	n.a.	64±30	
Occasions of Saturday service, mean ± SD			
Total	10.4±1.2	17.5±3.2	<0.01
Physiotherapy	10.6±1.1	12.1±1.9	<0.01
Occupational therapy	n.a	6.0±1.8	

Notes: Differences in means, proportions and distributions were determined using independent *t-tests*, equality of proportions test and Mann–Whitney U-tests, respectively. Abbreviations: LOS, Length of stay; n.a., not applicable.

Table 2 compares outcomes at admission and discharge for the control and intervention groups. There was no difference between groups in FIM_{Total} or FIM_{Motor} scores, however the intervention group had higher $FIM_{Cognitive}$ scores on admission and discharge. Participants in the control group had a significantly greater FIM change compared to the intervention group. When admission FIM was controlled as a covariate, greater changes in TUG were found in the intervention group compared to the control.

Table 2: Comparison of outcome measures for all participants

	Cont. Period		Interv. Period		Cont. Period	Interv. Period	Interv. Period - Cont. Period
Variables	ADM	DC	ADM	DC	DC - ADM	DC - ADM	
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean Diff. (95% CI)
Independence							
FIM_{Motor} [13-91]	53. 8±17.47	77.4±13.28	57.1±14.73	77.7± 13.26	23.7± 11.13	20.6±9.96	-3.0(-0.81 to -5.21)
$FIM_{Cognitive}$ [5-35]	28.9±6.47	31.0±4.89	31.2±4.9	32.2±4.05	2.1±3.18	1.0±2.06	-1.1(-1.65 to -0.54)
FIM_{Total} [18-126]	82.7±21.66	108.5±16.89	88.0±17.43	109.9±15.71	25.8±12.64	21.9±10.71	-3.9(-1.44 to -6.31)
Gait							
10MWT [m/s]	0.64±0.27	0.74±0.33	0.63±0.34	0.77±0.32	0.17±0.22	0.17±0.24	-0.004(-0.08 to 0.07)
Balance							
TUG test [s]	30.2±27.66	26.2±29.01	37.0±28.25	23. 9±16.28	-7.8±13.3	-15.8±21.3	7.9 (1.94 to 13.91)
Step test [avg. n]	2.4±0.36	6.4±0.57	2.8±0.31	5.9±0.39	-3.4±4.6	-5.2±13.5	1.8(-2.04 to 5.59)
FR test [cm]	6.2±9.2	13.7±13.28	11.8±10.84	18.1±10.20	6.7±10.3	5.3±8.0	1.4(-1.71 to 4.46)
FTEC test [0-30]	11.2±13.14	19. 5±13.58	14.1±14.07	22.6±11.78	7.8±12.6	7.7±12.2	-0.1(-3.66 to 3.53)
BOOMER [0-16]	2.7±4.44	6.1±5.56	5.4±4.3	9.0±4.21	2.5±3.8	3.0±2.7	-0. 5(-1.62 to 0.73)

Abbreviations: FIM, Functional Independent Measure; 10MWT, 10 Meter Walk Test; TUG, Timed Up and Go; FR, Functional Reach; FTEC, Feet Together Eyes Closed; BOOMER, Balance Outcome Measure of Elder Rehabilitation

Clinical Efficacy

After controlling for differences in sex, age and medical diagnosis, some measures of patient function at discharge were marginally greater in the intervention group (see Table 3). Intervention group participants scored one point better on the $FIM_{Cognitive}$ (1.056, *p*=0.022) but there was no difference in the FIM_{Total}. The intervention group had a faster 10MWT (0.078, *p*=0.042) and a slightly better BOOMER score (1.141, *p*=0.094), although the Step Test was worse (-3.940, *p*=0.017). The number of observations in the regression models which analysed gait and balance were reduced due to incomplete data collection (Table 3).

Table 3: Regression results for indicators of patient capabilities at discharge

Dependent variables on Discharge	FIM_{Motor}	$FIM_{Cogntive}$	FIM_{Total}	10MWT	TUG	Step Test	FR	FTEC	BOOMER
Estimation method	Poisson (dy/dx)	Poisson (dy/dx)	Poisson (dy/dx)	OLS	OLS	Poisson (dy/dx)	OLS	OLS	Poisson (dy/dx)
Explanatory variables									
Intervention (1/0)	-0.195	1.056**	0.871	.078**	-2.722	-3.940**	1.927	1.3	1.142*
Female (1/0)	0.813	0.882*	1.769	-.196***	6.76**	5.034***	-2.197	-1.443	-0.628
Age (years)	-0.159**	-0.070***	-0.226***	-.003*	.094	0.051	-.338***	-.103	-0.054**
Stroke (1/0)	-9.855	-4.624***	-14.522*	.488***	omitted	-5.218**	14.118**	11.562**	-2.484
Neuro (1/0)	-5.262*	-1.603**	-6.902**	.258***	15.374**	-2.145	13.083***	17.593***	-1.322
Amputation (1/0)	-4.497	0.422	-4.097	omitted	omitted	omitted	omitted	omitted	-8.209***
Arthritis (1/0)	-6.483*	-2.205*	-8.778**	omitted	22.496**	1.979	11.411***	14.936***	-2.635**
Orthopaedic Traumatic (1/0)	-5.220***	-1.154*	-6.375***	.159**	12.928***	0.210	19.98***	23.591***	-0.677
Orthopaedic Elective (1/0)	2.658*	0.429	3.024*	.222***	7.1**	-2.622	24.418***	26.112***	0.593
Reconstruction (1/0)	n.a.	n.a.	n.a.	.248***	10.244**	omitted	21.251***	23.435***	omitted
Constant	n.a.	n.a	n.a.	.894***	3.767	n.a.	24.121***	7.521	n.a.
n	356	356	356	265	266	259	186	230	164
R^2 or Pseudo R^2 ǂ	0.026ǂ	0.031ǂ	0.031ǂ	.164	0.058	0.060ǂ	0.266	0.145	.0128ǂ

Notes: (1/0) denotes a binary variable (=1 if true & =0 if otherwise). All dependent variables measured on discharge from the rehabilitation ward. Abbreviations: 10MWT, 10 Meter Walk Test; BOOMER, Balance Outcome Measure of Elder Rehabilitation; dy/dx, Marginal effects; FIM, Functional Independent Measure; FR, Functional Reach; FTEC, Feet Together Eyes Closed; OLS, Ordinary least squares; TUG, Timed Up and Go. Variables omitted because of collinearity. Levels of statistical significance are *** *p<.01, ** p<.05, * p<.1*

Table 4: Poisson regression, Coefficients and marginal effects LOS in Rehabilitation

	Model 2			Model 3		
	Coef.	SE	dy/dx	Coef.	SE	dy/dx
MSR (1/0)	-.096*	.052	-1.387	.044	.048	0.626
Female (1/0)	-.029	.059	-0.411	-.002	.031	-0.035
Age (years)	-.006**	.003	-0.093	-.006***	.001	-0.082
$FIM_{Cognitive}$ on admission	-.002	.005	-0.031	.001	.003	0.009
FIM_{Motor} on admission	-.019***	.002	-0.267	-.018***	.001	-0.251
Discharged on Monday (1/0)	-.248*	.151	-3.291	-.206**	.092	-2.753
Discharged on Tuesday (1/0)	-.252*	.144	-3.378	-.217**	.09	-2.921
Discharged on Wednesday (1/0)	-.278*	.145	-3.689	-.205**	.091	-2.760
Discharged on Thursday (1/0)	-.38**	.148	-4.866	-.327***	.092	-4.231
Discharged on Friday (1/0)	-.479***	.167	-5.941	-.441***	.093	-5.500
Discharged on Saturday (1/0)	-.138	.233	-1.858	-.097	.121	-1.328
Admitted on Monday (1/0)	.198**	.085	3.012	.197***	.042	2.976
Admitted on Tuesday (1/0)	.094	.095	1.387	.063	.048	0.912
Admitted on Wednesday (1/0)	.067	.089	0.981	.06	.047	0.872
Admitted on Thursday (1/0)	.096	.14	1.449	.094	.105	1.409
Admitted on Friday (1/0)	-.006	.275	-0.086	.078	.157	1.159
Admitted on Saturday (1/0)	.029	.095	0.418	.044	.044	0.639
Diagnosis						
Neurology (1/0)	n.a.	n.a.	n.a.	-.147**	.075	-1.989
Musculoskeletal (1/0)	n.a.	n.a.	n.a.	-.444***	.128	-5.226
Orthopaedic-traumatic (1/0)	n.a.	n.a.	n.a.	-.186**	.078	-2.505
Orthopaedic-elective (1/0)	n.a.	n.a.	n.a.	-.395***	.08	-5.087
Reconditioning (1/0)	n.a.	n.a.	n.a.	-.407***	.072	-5.550
Interaction (Diagnosis x MSR)						
Stroke * MSR (1/0)	n.a.	n.a.	n.a.	-.148	.132	-1.965
Neurology * MSR (1/0)	n.a.	n.a.	n.a.	-.366***	.096	-4.442
Musculoskeletal * MSR (1/0)	n.a.	n.a.	n.a.	-.106	.147	-1.439
Orthopaedic-traumatic * MSR (1/0)	n.a.	n.a.	n.a.	-.182**	.074	-2.418
Orthopaedic-elective * MSR (1/0)	n.a.	n.a.	n.a.	-.146*	.082	-1.976
Reconditioning * MSR (1/0)	n.a.	n.a.	n.a.	0	.	.
Constant	4.58***	0.337	n.a.	4.601***	.165	n.a.
Pseudo R^2	0.20			0.22		
Observations	365			365		

Notes: (1/0) denotes a binary variable (=1 if true & =0 if otherwise). The diagnosis “Stroke” omitted from

Model 2 because of multi-collinearity. Abbreviations: Coef, Coefficient; dy/dx, Marginal Effect; FIM, Functional Independence Measure; LOS, Length of Stay; MSR, Multidisciplinary Saturday Rehabilitation; n.a., Not Applicable; SE, Standard error. Levels of statistical significance are *** $p<.01$, ** $p<.05$, * $p<.1$.

Table 4 reports the coefficients with robust standard errors and marginal effects obtained from Equation 2 using Poisson regression. Conditional upon controls for FIM on admission, days of admission and discharge to the rehabilitation unit, age and sex, the MSR service was associated with statistically significant reduction in LOS. The marginal effect of the intervention on LOS was estimated to be a reduction of 1.39 days.

Economic Evaluation

The costs of providing 20 weeks of rehabilitation to the control and intervention groups were estimated to be $12,784 and $23,180, respectively (Table 5). All relevant cost categories were captured. The principal cost category was wages; 85% and 90% of total costs for the control and intervention treatments, respectively (Table A.1). Our estimates did not include equipment depreciation and allocated floor space, though these are reported as minor in comparable economic analyses.[17] Approximately, 2.4% of the ward overheads were allocated to the interventions on the basis that the rehabilitation service was delivered in 4 of the 168 hours that the ward was operational (Table A.2).

A reduced LOS of 1.39 days per patient would equate to a total saving 267 bed-days for the intervention group. Given a cost of AUD$1,144 per rehabilitation bed-day[32, 33] the implied savings are AUD$1,536 per patient (see Table 5 for details). A two-way sensitivity analysis of the parameters, reduced LOS (1.39±0.77) and cost per bed-day ($1,144±$305), using Monte

Carlo simulation (n=1000) indicated cost effectiveness (i.e., >$0) in approximately 95% of simulations.

Table 5: Cost Analysis; Multidisciplinary Saturday rehabilitation

Parameters	Values
Patients in intervention group	192
Reduction in mean LOS, days (mean±SD)	1.39±0.77
Reduction in total LOS for Intervention group, (days)	266.9
Cost per rehabilitation bed-day, (AUD, mean±SD)[32, 33]	$1,144±$305
Total savings (Cost per bed-day x Reduction in total LOS)	$305,328
Costs for Saturday Rehabilitation	
Intervention group	$23,180
Control group	$12,784
Net Cost (Intervention – Control)	$ 10,396
Net Savings (Total savings – Net cost)	294,932
Net Savings per patient	$1,536

Notes: Cost per rehabilitation bed-day was reported in 2014 AUD[32] using DRG code Z60Z from "Cost weights for AR-DRG Version 7.0 Round 18 (2013-14) Public Sector Sample DRG" (mean cost / mean LOS) and adjusted to 2020 Australian dollars (AUD) using the Australian consumer price index[32, 33]. Treatment costs were reported as 2016 AUD (see Appendix A.1 and A.2) and adjusted to 2020 AUD using the Australian consumer price index.[33] Abbreviations, LOS, length of stay; SD, standard deviation.

Model 3, which includes a set of binary variables that interacted medical diagnoses with MSR, found that within the treatment group only neurologic and orthopaedic patients had a statistically significant reduction in LOS. The marginal effect for neurological patients was a reduction of 4.4 days (Table 3). Hence the implied cost savings for patients with a neurological diagnosis is $4,854 per treated patient. Both traumatic and elective orthopaedic patients also benefited from MSR with a reduced LOS resulting in implied cost savings of $2,668 and $2,180 per patient, respectively.

DISCUSSION

This paper used a pragmatic prospective cohort study design to analyse the effect of MSR on patient outcomes admitted to a 20-bed rehabilitation ward in a private hospital located in Brisbane, Australia. The aim was two-fold, first to analyse the impact on LOS and functional status, and second to conduct an economic evaluation from the perspective of the healthcare provider. Outcome measures of functional status included functional independence, gait and balance. LOS and hospital cost data were obtained for the economic evaluation.

Controlling for age, sex and admitting diagnosis identified minor improvements in cognition and the composite balance measure (BOOMER) scores. After controlling for admission FIM, age, sex and days of admission and discharge, LOS for the intervention group was estimated to be 1.39 days less than the control group. Published costs per rehabilitation bed-day[32] and treatment costs estimates obtained from the hospital billing accounting department identified cost savings of $1,536 per patient in the intervention group. This multidisciplinary rehabilitation service consisting of PT and OT met the published Standards for the Provision of Inpatient Adult Rehabilitation Medicine Services in Public and Private Hospitals[6] providing rehabilitation a minimum of five days per week. However, the service did not meet the Guidelines for Recognition of Private Hospital Based Rehabilitation Services[7] which state that specialist rehabilitation services should be provided seven days per week[7]. While the benefits of additional rehabilitation services outside of usual business hours seems established,[34] Australian guidelines provide inconsistent advice for service providers. Providing rehabilitation therapy across six days (at least in stroke populations) appears to

result in better patient outcomes compared to seven-day rehabilitation.[35] Additionally, providing rehabilitation across six days seems to be prevalent in Australian rehabilitation facilities.[35] This current study adds to the evidence that rehabilitation six days a week is beneficial for patients and service providers alike.

Interestingly, until this current study, greater reductions in LOS have been found with facilities providing PT[8, 35] compared to multidisciplinary weekend services.[9, 14, 36, 37] As this has been one of the few studies investigating weekend therapy to find a significant difference in LOS, this multidisciplinary service provision model warrants further pragmatic investigation to determine if these results are reproducible in different service models and settings. This reduction in LOS may have far reaching effects, not just for patient outcomes and health service costs, but in terms of improved patient flow through both rehabilitation units and hospitals. Certainly allied health managers perceive improved patient flow and quality of care are benefits associated with weekend services, at least in acute care.[38] An associated increase in throughput occurred in this rehabilitation unit with approximately 10% more patients admitted during the intervention period compared to the control period. This may have led to an improved flow of patients through the hospital and possibly reduced rehabilitation waiting lists.

Participants in the intervention group in this current study had higher scores on measures of functional independence, and some balance measures on admission. At discharge, largely both groups had similar functional independence, balance and gait. It is reasonable to suggest that discharge is likely determined by patient readiness, functional performance and preparedness of the home environment.[38] Previous studies have reported similar discharge

function from inpatient rehabilitation.[12, 39] Interestingly differences in cognitive function were noted between the two groups at discharge. The intervention group had better cognitive function at discharge compared to the control group, though both groups scores would suggest discharge home would be likely. Results obtained from observational data are always subject to the *ceteris paribus* caveat, and causal inferences should be drawn with caution. Although our statistical models have controlled for some important observed differences between the control and the intervention groups, it is always possible that unobserved differences could confound our results.

Cost savings identified in the economic evaluation corroborate an evolving literature that suggests the provision of weekend rehabilitation services may deliver an economic dividend. Previous randomised controlled trials have reported that weekend rehabilitation may reduce hospital LOS.[8, 9] A cost utility analysis has also reported probable cost effectiveness at 30 days[17] and 12 months[18] post-discharge. We found that rehabilitation LOS reduced on average by 1.39 days, with long-stay inpatients appearing to benefit most from the intervention. Additionally, diagnosis also appeared to be important with sub-analyses confirming larger LOS reductions for neurological and orthopaedic patients. It is perhaps not surprising that those who stay longer and have complex conditions would show greater benefit from the additional therapy offered through a MSR service; perhaps further validating the need for this service.

Limitations

A potential limitation of the cost analysis was that the average cost of a rehabilitation bed-day was used as proxy for the marginal cost of a rehabilitation bed-day. This can result in an overestimation of cost-savings when the cost of the final day of admission is substantially less than the cost of an average bed-day.[40] This can frequently occur with acute inpatient admissions. However, our cost modelling has assumed that the costs of a rehabilitation bed-day did not significantly decline over the duration of the admission. A second limitation is that the economic evaluation was restricted to the perspective of the healthcare provider. Conducting an economic evaluation from a societal perspective, which included improvements in the FIM and BOOMER scores, may capture relevant improvements in patient health not included in this analysis. Finally, the assessors were not blind to group allocation as it was considered usual care, however they were not aware of the focus of the study at the time of data collection, thus minimising the potential for assessor bias.

CONCLUSION

The provision of a MSR service comprising PT and OT leads to a greater reduction in LOS compared a to a 6-day PT service, even when controlling for discrepancies in admission function. More participants attended weekend therapy and received a greater amount of therapy with multidisciplinary Saturday rehabilitation. The provision of a service is potentially cost reducing for the treating hospital.

LIST OF ABBREVIATIONS

10MWT = 10 meter Walk Test

BOOMER = Balance Outcome Measure for Elder Rehabilitation

FIM = Functional Independence Measure

FTEC = feet together eyes closed

LOS = length of stay

MSR = multidisciplinary Saturday rehabilitation

OT = Occupational Therapy

PT = Physical Therapy

TUG = Timed Up and Go

DECLARATIONS

Ethics approval and consent to participate: Ethical approval was granted by UnitingCare Health Human Research Ethics Committee (2011.16.38) and University of Queensland's Human Research Ethics Committees A and B (HREC# 2014000752) and conforms to the Helsinki Declaration. The need for informed consent was waived by UnitingCare Health Human Research Ethics Committee (2011.16.38) and the University of Queensland's Human Research Ethics Committee because the intervention was deemed usual practice."

Consent for publication: Not applicable.

Availability of data and materials: The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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Authors' contributions: EC, SB and SK developed the study design. EC completed data collection, analysis and interpretation of patient data. SB, SK and DR assisted in data analysis and interpretation of patient data. EC, SB, SK and DR contributed to writing these sections of the manuscript. DR analysed and interpreted the economic data and completed this section of the manuscript. All authors contributed to, read and approved the final manuscript.

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