

The Cost-Effectiveness of a Stroke Unit in Providing Enhanced Patient Outcomes in an Australian Teaching Hospital

Shaun Zhai, MBChB,* Fergus Gardiner, BMSc, MBA, PhD(c),†‡ Teresa Neeman, PhD,§
Brett Jones, BN,|| and Yash Gawarikar, MBBS, MD†§

Background: Stroke is one of the leading causes of disability and mortality. Patients who receive organized inpatient care in a stroke unit (SU) have better clinical outcomes. However, evidence on the cost analysis of an SU is lacking. The objective of this study was to assess the performance and analyze the cost-effectiveness of an SU. *Methods:* A retrospective observational study was conducted comparing the acute stroke patient care in a 6-month period before and after the establishment of an acute SU at Calvary Hospital in 2013-2014. *Results:* There were 103 patients included in the pre-SU period, as compared to 186 patients in the post-SU period. In the pre- and post-SU groups, 54 and 87 patients, respectively, had ischemic stroke, with significant trends in improved morbidity and mortality in the post-SU group ($P = .01$). The average length of stay (LOS) for patients was reduced from 9.7 days to 4.6 days in the post-SU group ($P = .001$). There was a reduction of cost per admission from \$6382 Australian dollars (AUD) with conventional ward care as compared to \$6061 (AUD) with SU care. *Conclusion:* This study confirmed that the establishment of an SU not only improves treatment outcomes but also shortens LOS, thereby achieving cost-effectiveness. **Key Words:** Stroke—stroke unit—length of stay—cost-effectiveness—stroke management—Australia.

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Introduction

Stroke is a common and a potentially debilitating condition. It is the second leading cause of mortality and the third leading cause of morbidity.^{1,2} One in six people will have a stroke during their lifetime.³ In Australia, currently, there are around 470,000 people living with this condition; this is projected to reach 709,000 people in 2032.⁴

From the *St Vincent's Hospital, Sydney, Australia; †Calvary Hospital, Bruce, Canberra, Australia; ‡Charles Sturt University, Bathurst, Australia; §Australian National University, Canberra, Australia; and ||The Canberra Hospital, Canberra, Australia.

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Address correspondence to: Fergus Gardiner, BMS, MBA, PhD(c), Calvary Hospital, Bruce, Canberra, Australia. E-mail: gus_gardiner@hotmail.com.

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The financial cost of stroke is substantial and amounts to \$5 billion (AUD) per annum in Australia.⁵

Stroke unit (SU), which is an organized inpatient service for stroke patients provided by a multidisciplinary team specializing in stroke management, has become an important part of stroke care.⁶ From its inception approximately 4 decades ago,⁷ there have been increasing evidence to suggest the efficacy of SU in reducing mortality and morbidity in acute stroke patients by about 20%.⁸⁻¹⁰ Acute SUs are generally considered more costly than conventional care in a general hospital ward.¹¹ However, there is limited literature associated with reviewing the financial costs of an SU compared with conventional hospital care.

This study was designed to measure patient outcomes before and after the SU implementation at an Australian teaching hospital. This included demographic information, medical investigations, treatments, patient outcomes, and health economics. To the researchers' knowledge, this research focus has not been completed before. This study has been designed to corroborate previous research findings to show that SUs improve patient

outcomes, and, more importantly, to concurrently analyze the financial cost of the operation of an SU in real life, thereby assessing its cost-effectiveness. It was hypothesized that the SU will provide a cost-effective improvement in patient outcomes. It was hoped that this study may provide further justification on the implementation of SUs in the Australian health system.

Methods

The researchers conducted an observational study, comparing stroke patients who have been admitted to Calvary Public Hospital, Canberra, before and after the establishment of the local SU from October 2013 to October 2014 (52 weeks). The hospital ethics committee approval was received for data collection, analysis, and publication (reference number 24-2014).

The pre-SU patients were identified retrospectively by matching International Classification of Diseases-10 (ICD-10) codes for cerebrovascular diseases (ICD-10: I60-I69). On reviewing physical and electronic clinical records, patient files were retrieved and their diagnoses reviewed. Specifically, investigators evaluated all pre- and post-SU clinical notes to ensure the accuracy of the diagnosis. The investigators adjudicated cases where the ICD-10 coding was incorrect based on clinical documentation, imaging, and other investigation findings. The disease characteristics, investigations, treatment, and outcomes were recorded. The data of the post-SU patients were collected prospectively by the stroke neurologists and stroke nurse specialist.

Study Population

The SU is on a dedicated ward in the hospital and has 4 beds equipped with continuous cardiac monitoring. There is a computed tomography (CT) scanner and a magnetic resonance imaging (MRI) scanner on site for neuroimaging support. The SU is staffed by a stroke neurologist, a stroke nurse specialist, and specially trained nurses. The SU also receives input from the allied health team for speech therapy, dietary therapy, occupational therapy, and physiotherapy. The SU was established on April 28, 2014; therefore patients presented to Calvary Hospital in the 6-month period between October 28, 2013 and April 27, 2014 were referred to as the pre-SU group, whereas for the 6 months between April 28, 2014 and October 27, 2014, it was referred to as the post-SU group. In the post-SU period, all stroke patients were admitted to the SU in the first instance. Once stabilized the patient could be discharged directly from the SU or stepped down to a conventional ward. The stroke service provided the entire acute care.

In the pre-SU period, stroke patients were treated by various general physicians (internists). These physicians often had various specialty interests (but not neurology). Under these physicians, there was a registrar and a resident

or intern doctor. The neurologist may have been consulted for the patient's care during the admission; however, this practice was highly variable. A general ward physiotherapist, occupational therapist, or a speech therapist was involved in the patient care, upon referral from the treating team.

Patients were eligible for inclusion in the study if they had any type of stroke, including hemorrhagic or ischemic, as well as transient ischemic attacks (TIAs) (defined as <24 hours neurologic deficit caused by a focal lesion in areas including the brain, the retina, and the spine). In the post-SU phase, as data were prospectively recorded, any presentation that resembled a stroke with subsequent admission to the SU was included. For some of the stroke-like presentations, an alternative diagnosis than stroke was identified eventually. These were classified as stroke-mimics and were included in the analysis. If the patient was transferred to another facility after presenting briefly to Calvary Hospital (i.e., less than 24 hours) and was not admitted to the local SU, they were excluded from the study. Patients who were transferred to Calvary Hospital from another health institution for rehabilitation or placement purposes after a stroke were also excluded.

Study Endpoints

The primary endpoint for the study was to compare the modified Rankin Scale (mRS) at 90 days after the stroke in pre- and post-SU patients. Patients were identified retrospectively by ICD-10 code, and as such, the 90-day mRS outcomes were obtained via the following measures:

- Neurology/stroke follow-up clinic at 90 days;
- If patients were inpatients at day 90 either for the same admission, for rehabilitation purposes, or for readmission purposes, their mRS scores were evaluated based on clinical notes;
- If patients had died within a 90-day period;
- If patients came for a clinic appointment and the clinical documentation was adequate for an mRS evaluation;
- Delayed follow-up visits, with patient recollection of their neurologic status at the 90-day mark after a stroke.

The main secondary endpoint was to compare the length of stay (LOS) and the in-hospital cost of each stroke patient during the pre- and post-SU periods. Other secondary endpoints included the timeliness and completeness of investigations, adherence to best medical therapy, thrombolysis rates, and allied health involvement. Outcomes at discharge from the stroke service (stroke service is different from SU, it includes whole period patient in hospital for SU and subsequent conventional ward care) and nosocomial infections were also analyzed. The discharge destination involved the patient's transfer location upon departure from the stroke service. In regard to the

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