Evaluation of Rural Stroke Services
Does Implementation of Coordinators and Pathways Improve Care in Rural Hospitals?

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Background and Purpose—The quality of hospital care for stroke varies, particularly in rural areas. In 2007, funding to improve stroke care became available as part of the Rural Stroke Project (RSP) in New South Wales (Australia). The RSP included the employment of clinical coordinators to establish stroke units or pathways and protocols, and more clinical staff. We aimed to describe the effectiveness of RSP in improving stroke care and patient outcomes.

Methods—A historical control cohort design was used. Clinical practice and outcomes at 8 hospitals were compared using 2 medical record reviews of 100 consecutive ischemic or intracerebral hemorrhage patients ≥12 months before RSP and 3 to 6 months after RSP was implemented. Descriptive statistics and multivariable analyses of patient outcomes are presented.

Results—Sample: pre-RSP n=750; mean age 74 (SD, 13) years; women 50% and post-RSP n=730; mean age 74 (SD, 13) years; women 46%. Many improvements in stroke care were found after RSP: access to stroke units (pre 0%; post 58%, P<0.001); use of aspirin within 24 hours of ischemic stroke (pre 59%; post 71%, P<0.001); use of care plans (pre 15%; post 63%, P<0.001); and allied health assessments within 48 hours (pre 65%; post 82% P<0.001). After implementation of the RSP, patients directly admitted to an RSP hospital were 89% more likely to be discharged home (adjusted odds ratio, 1.89; 95% confidence interval, 1.34–2.66).

Conclusions—Investment in clinical coordinators who implemented organizational change, together with increased clinician resources, effectively improved stroke care in rural hospitals, resulting in more patients being discharged home. (Stroke. 2013;44:2848-2853.)

Key Words: coordinator ■ quality ■ stroke care ■ stroke delivery ■ stroke units

Stroke is a leading cause of death and major cause of disability. Inconsistent access to evidence-based interventions, such as stroke units (SUs), has been shown to have detrimental effects on patient outcomes. Being able to provide evidence-based stroke care consistently remains a challenge, particularly in rural locations. This is because rural hospitals are less likely to offer coordinated and dedicated services for stroke care in comparison with metropolitan hospitals. Geographic location may also influence patient outcomes, with greater levels of death or dependency reported for patients with stroke in rural communities.

Australia is geographically a large continent with a population of ≈22 million who reside mostly along the eastern seaboard. In 2011, it was estimated that ≈9% of acute stroke admissions in Australia were treated in rural hospitals (eg, hospitals where the population was <25 000 people). Furthermore, only 4% to 5% of the 91 rural hospitals that responded to a national survey had an SU or access to neurologists, <50% used a care pathway, and only 32% had a clinical nurse specialist for stroke. With ≈7 million residents, New South Wales (NSW) is the most populated state in Australia, and almost a third of this population live in rural areas. Similar to many locations, variability in the provision

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2848
of stroke care and patient outcomes exists among hospitals in NSW. In the national survey, 42% of the 60 NSW hospitals that responded were in rural areas. It is also estimated that one quarter of stroke admissions in public hospitals are in rural NSW, with hospitalization rates greater for stroke in rural NSW compared with metropolitan regions.

In rural areas of Australia, the types of hospital services range from rural referral hospitals, district health services, and multipurpose services based on the number of beds and available resources, with rural referral hospitals being the largest and most resourced. A rural referral hospital generally offers a range of acute care services, such as emergency care, maternity services, and general medical and surgical services. At the time this research was conducted, there were 16 rural referral hospitals in NSW (managing ≈2400 strokes per annum), whereby 14 provided acute care and 12 of these reported no coordinated or dedicated services for stroke. There were also 121 smaller district hospitals (that had >10 stroke admissions within a 3-year period) in NSW. None of the acute care rural referral hospitals had specialist nurses employed for stroke. These findings led the NSW government to fund the Rural Stroke Project (RSP) to improve access to organized stroke care in rural referral hospitals and their surrounding district hospitals based on a hub and spoke approach. The 8 rural referral hospitals that were funded as part of the RSP had a median 115 stroke admissions per year (min, 36; max, 134), were between 70 and 450 km from the nearest metropolitan-based hospital, and had a total number of beds ranging from 86 to 272 (Table 1 and Figure 1). Each of these hospitals was provided with funds to employ a stroke clinical coordinator to establish the protocols and care pathways as part of implementing a hub and spoke model.

The hub and spoke model has been successfully implemented in rural areas and third world countries to maximize available resources across various health domains and has been integrated within comprehensive stroke centers in the United States and hyperacute SUs in the United Kingdom to improve access to intravenous thrombolysis. In hospitals with low volumes of stroke admissions, a model where a clinical coordinator services potentially a group of hospitals in reasonable geographic proximity, may prove practical and pragmatic, potentially with some economies of scale in terms of planning and some resources. This was part of the business rationale used for the RSP.

Historically, the evidence base for improved outcomes associated with implementation of organized stroke care is derived mostly from research in metropolitan or large city-based hospitals. Even considering the potential lack of resources, infrastructure, and specialist personnel in rural settings, there is some suggestive evidence that implementing service improvement initiatives, such as peer support and use of protocols, in rural areas can improve the quality of stroke care. However, it is still unclear whether introducing elements of organized stroke care, such as clinical coordinators and SUs, within rural settings can reduce evidence-practice gaps as found with metropolitan hospitals. As part of this

| Table 1. Description of Stroke Services Before and After the Rural Stroke Project |
|---------------------------------|-------------------------------|-------------------------------|
| Human resources                 | H1  H2  H3  H4  H5  H6  H7  H8 | H1  H2  H3  H4  H5  H6  H7  H8 |
| Rural stroke care coordinator   | ✓    ✓    ✓    ✓    ✓    ✓    ✓    ✓ |
| Access to neurologist*          | ✓    ✓    ✓    ✓    ✓    ✓    ✓    ✓ |
| Organizational                  |                               |                               |
| No. of stroke admissions annually| 126  36  60  119  110  81  122  134 | 168  49  88  133  127  211  168  201 |
| No. of beds allocated for stroke | 0    0    0    0    0    0    0    0 | 5    0    4    2    4    4    4    4 |
| Thrombolysis service (with formalized protocols) | ✓    ✓    ✓    ✓    ✓    ✓    ✓    ✓ |
| Had administered thrombolysis previously | ✓    ✓    ✓    ✓    ✓    ✓    ✓    ✓ |
| Implementation of hub-and-spoke system of care | ✓    ✓    ✓    ✓    ✓    ✓    ✓    ✓ |
| Onsite CT                        | ✓    ✓    ✓    ✓    ✓    ✓    ✓    ✓ |
| Stroke care pathway†              |                               |                               |

Sources: Clinician interview data and clinical audit data from Rural Stroke Project evaluation, Gill et al., unpublished data, NSW Ministry of Health, Health Information Exchange Financial year 2008/2009 provided April 23, 2013. CT indicates computed tomography.

*Consultation basis only.
†Stroke care pathway, a plan of care that aims to promote organized and efficient stroke care based on evidence and guidelines but is adapted to local services.
current study, the selected RSP rural referral hospitals were required to use funds to employ a clinical coordinator to facilitate improvements in the organization and delivery of recommended stroke care, including the establishment of an SU, development of protocols and standardized care plans, provision of education across their region, and formalizing appropriate patient transfer pathways with the smaller district hospitals within the same region to create a hub and spoke system of care. Funds were also used to employ additional allied health or medical staff for the management of patients with stroke at the regional referral (hub) hospitals.

**Aims**

We aimed to measure the effectiveness of the RSP in improving acute stroke care by comparing adherence to recommended clinical care indicators and health outcomes pre- and postimplementation of the RSP.

**Methods**

We used a pre-post historical control research design. The predata were collected ≥12 months before the employment of RSP stroke clinical coordinators. Many of the hospitals chose to do the preimplementation audits at different periods before the RSP was funded, and these data were used to show government which hospitals needed support to improve their stroke care in providing a business case for the RSP to be established. The postdata were collected ≥3 months after ≥1 RSP initiatives had been implemented by the clinical coordinators (eg, implementation of an acute care pathway or opening of an SU). The time needed to establish the infrastructure at each hospital varied, and data were collected in the post-RSP period to capture a more business-as-usual activity to avoid over- or underestimating impacts. In the post-RSP period, hospital staff also participated in semi-structured, focus group interviews to explain what they had achieved, ongoing barriers, and future plans (data not presented).

**Data Collection**

The NSW Stroke Audit tool was developed in 2002 and predates clinical guidelines for stroke, which were first released for Australia in 2003. Nevertheless, the audit tool did cover the majority of recommendations outlined in these guidelines. Audit variables include the following: (1) demographic characteristics (including age, sex, country of birth, premorbid functional level, and risk factors); (2) stroke type and severity measures (eg, ability to walk on admission, incontinence within 72 hours of admission); (3) hospital care, including access to diagnostic investigations; (4) adherence to important clinical process indicators considered likely to influence patient outcome, for example, brain imaging within 24 hours, and care in an SU; and (5) stroke outcomes at time of discharge from acute care or 7 to 10 days from admission, including level of independence using the modified Rankin score, discharge destination, and adverse events during hospitalization. No personal identifying variables are collected.

In 2008, the audit tool was modified with input from an advisory committee to include additional clinical process indicators relevant to assessing the quality of care promoted in the updated national clinical guidelines. This included questions on the commencement of a statin and use of intravenous thrombolysis in patients with ischemic stroke and prescription of antihypertensive medications before discharge. Additional questions relevant to describing the impacts of the RSP were also included to capture patient transfer information between hub and spoke rural hospitals. This information was only available for the post-RSP period where this updated audit tool was used. Data were collected by trained hospital staff who were provided with a data dictionary to ensure standardized data collection on the paper-based forms designed for electronic scanning.

At each hospital, data from 100 consecutive patients, with a discharge **International Classification of Diseases, Tenth Revision** code for stroke, were obtained for each study period. The sample size per hospital was based on use of equal-sized groups with the minimal group size for a stated 20% increase in adherence to clinical process indicators based on an assumed 80% power and 2-sided $P=0.05$, giving a minimum sample size per hospital of 100. The study was approved by the Hunter New England Human Research Ethics Committee (project reference 08/11/194/01).

**Data Analysis**

Grouped data for all hospitals by study period are presented. Because the number of clinical process indicators included in the audit tool is >45, for this article, we provide results for a selection of indicators that have a strong association with improved patient outcomes or were relevant to key features of the RSP, such as employment of allied health staff.

Data were analyzed using Intercooled *STATA* version 10.0 for Windows (Stata Corporation, http://www stata.com stata10/). $\chi^2$ tests were used to analyze categorical variables. For continuous variables, the nonparametric Mann–Whitney test was used for 2-group comparisons. Level of significance was $P=0.05$. Bivariable and multivariable logistic regression models were used to evaluate stroke outcomes. Demographic variables found to differ between the pre- and post-samples were included in multivariable logistic regression models. In addition, published variables commonly used to adjust for stroke severity were included in these statistical models. Adjustments were also made for patient clustering within hospitals. Multivariable comparisons of outcomes between pre- and post-periods were made consistent by only including cases in the post-RSP period who were direct admissions to the hub hospital.

**Results**

The pre-RSP sample of 750 cases was from admissions between February 2000 and August 2007, reflecting the period when hospitals chose to do a preimplementation audit before the RSP was funded. The post-RSP sample of 730 was from admissions between December 2007 and December 2010.

Patient demographic characteristics, stroke type, and severity were similar on admission (Table 2). The mean age of the patients was 74 (SD, 13) years, about half were men, and the majority were ischemic strokes. Patients in the pre-RSP period were more likely to be independent before their stroke. In contrast, the post-RSP sample had a larger proportion of patients born in Australia, and there was a greater prevalence of high cholesterol and hypertension. Thirty-four percent of patients in the post-RSP period had been transferred from another hospital to the hub site.

**Differences in Care Practices Between Time Periods**

None of the rural referral hospitals in this study had an SU before the RSP funding (Table 1). Four hospitals had established an SU after implementation of the RSP. Overall, ~60% of patients in the post-RSP period were admitted directly to an SU. The other 4 sites reported having established prioritized beds for stroke in either medical or cardiovascular wards. However, these beds were generally not collocated in the same room. Compared with pre-RSP estimates, significant improvements were found for almost all other clinical process indicators (Figure 2). In the post-RSP period, there was a 13-fold increase in documentation of regular neurological observations within 24 hours of admission (odds ratio [OR], 13.7; 95% confidence interval [CI], 9.9–19.1). Patients were almost 7× more likely to have a documented clinical care plan to avoid urinary incontinence and complications (OR, 6.9;
Effect of the RSP on Discharge Processes and Patient Outcomes

Similar numbers of patients were discharged in each time period (Table 3). When the modified Rankin score was dichotomized, the odds of being independent on discharge (modified Rankin score, 0–1) in the post-RSP period improved (OR, 1.4; 95% CI, 1.04–1.77). After adjusting for age, sex, country of birth, stroke severity, independence before stroke, risk factors, and patient clustering, the odds of being independent at discharge if the patient was a direct admission to an RSP hub hospital increased by 86% (adjusted OR, 1.86; 95% CI, 1.10–3.17).

A 1-day reduction in the median length of stay post-RSP was found (P=0.017), and more patients were discharged directly home. Results of the multivariable analysis provided evidence that patients directly admitted to the RSP hub hospitals had an 89% greater chance of being discharged home after adjustment for stroke severity and patient clustering (adjusted OR, 1.89; 95% CI, 1.34–2.66).

Compared with pre-RSP estimates, there was an increased use of discharge strategies (OR, 7.3; 95% CI, 5.60–9.54), self-management plans (OR, 2.6; 95% CI, 1.62–4.50), and more than a 2-fold increase in the prescription of antiplatelet/anti-thrombotic medication on discharge for patients with ischemic stroke (OR, 2.3; 95% CI, 1.77–2.91) in the post-RSP period.

Investigation of Potential Secular Trends in Care Improvements During the Pre-RSP Time Frame

Adherence to clinical indicators in the pre-RSP period remained constant for the majority of indicators depicted in Figure 2 when we compared 2001–2004 to the later period of 2005–2006 (Table I in the online-only Data Supplement). For the indicators where adherence increased within the pre-RSP implementation period, the improvements were small compared with the overall pre-post RSP differences found. For example, use of care plans increased from 11% in 2001–2004 to 17% in the 2005–2006 period, and then increased to 63% in the post-RSP period.

Discussion

Although the extent of organizational change at each hospital varied, there were notable improvements in clinical care and patient outcomes identified using pooled data from all 8 rural referral hospitals after the RSP service enhancements were implemented. In particular, the study provides evidence of better access to organized care consistent with clinical practice guideline recommendations. These included improved access to SUs,
more timely allied health assessments, appropriate use of aspirin, and improved use of diagnostic investigations and clinical pathways. Although the use of thrombolysis also increased post-RSP, the total number of patients who received thrombolysis was small. Therefore, the use of this treatment is unlikely to explain all the differences in outcomes found. We found little evidence of secular improvements in adherence to clinical indicators during the preimplementation audit time frame (2000–2006). For the few indicators where adherence increased within the preimplementation period, much larger improvements occurred after the RSP implementation. Therefore, the RSP was the main contributor to the improvements found in clinical care.

Overall, the increased access to SU care and improvements in evidence-based care resulted in more than three quarters of patients having improved health outcomes compared with the pre-RSP cohort. Although it is difficult to make direct comparisons, these findings are consistent with stroke service redesign programs in metropolitan hospitals.1 Although establishing a hub and spoke model of care was also an important component of the RSP, describing the effect of this model on clinical process indicators was not a primary aim of this article.

Previous studies used to examine the effectiveness of programs to improve rural stroke care using audit or self-reported surveys18,19 have shown similar improvements in adherence to clinical process indicators consistent with our study. Strengths of the current study are that we included detailed patient characteristics for case-mix adjustment in multivariable models, a large range of clinical process indicators that have reliably been collected and a range of important patient outcomes after hospitalization for stroke. This provided increased support that these enhancements in the quality of stroke care, such as establishing SU and formalizing protocols and pathways, can impact positively on health outcomes in the rural setting.

Several potential sources of reporting bias arise in this study. Processes of care may have been undertaken but not routinely recorded, which could possibly underestimate adherence by ≤10%.26 The potential for this is greater in the pre-RSP period because care plans were not used as often. Although studies in the field have been used to show that data collected from medical records are reproducible,1,27 implicit judgment may be required. To minimize bias, comprehensive training and a data dictionary were supplied to hospital staff collecting data, and researchers not employed by these hospitals analyzed the data. In addition, changes to clinical practice may have occurred, regardless of the service enhancements. However, because most of the improvements found were significantly large, it may be asserted that these potential sources of bias cannot explain all the differences found. There is overwhelming evidence in the literature that SU care can reduce death and disability by ≥20% compared with conventional care.17 The results of the meta-analysis of randomized controlled trials are difficult to contextualize with the current study where a historical control was used. In addition, we were only able to provide level of independence at days 7 to 10 or discharge rather than at a later time period.17 Nevertheless, better adherence to important clinical process indicators as a consequence of the RSP resulted in more patients achieving independence in the post-RSP period and an 89% greater chance of being discharged directly home. The 1-day reduction in median length of stay is important, given the demands for beds in acute hospitals. These findings provide important evidence to show the feasibility of investing in these initiatives for rural hospitals, whereby the costs of additional staff, such as clinical coordinators, can be offset by the reductions in bed days within acute and inpatient rehabilitation wards. Our study provides evidence that it is feasible to implement the approaches used for the RSP in rural hospitals that admit ≥50 strokes per year.

Despite the significant improvements found after the RSP and employment of stroke clinical coordinators, the results highlight areas for further improvement. For example, the management of incontinence and the number of family meetings occurring remained low. Recognizing the importance of these results, each hospital was given an individualized report comparing their data with the total pool. Providing direct feedback on quality of care is an effective means of changing conventional care.17 The results of the meta-analysis of randomized controlled trials are difficult to contextualize with the current study where a historical control was used. In addition, we were only able to provide level of independence at days 7 to 10 or discharge rather than at a later time period.17 Nevertheless, better adherence to important clinical process indicators as a consequence of the RSP resulted in more patients achieving independence in the post-RSP period and an 89% greater chance of being discharged directly home. The 1-day reduction in median length of stay is important, given the demands for beds in acute hospitals. These findings provide important evidence to show the feasibility of investing in these initiatives for rural hospitals, whereby the costs of additional staff, such as clinical coordinators, can be offset by the reductions in bed days within acute and inpatient rehabilitation wards. Our study provides evidence that it is feasible to implement the approaches used for the RSP in rural hospitals that admit ≥50 strokes per year.

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A major explanatory factor for achieving better care and outcomes in this study was the employment of the clinical coordinators, although it is difficult to determine the impact.

### Table 3. Summary of Discharge Outcomes

<table>
<thead>
<tr>
<th>Discharge Outcome Variable</th>
<th>Pre (n=750)</th>
<th>Post (n=730)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharged</td>
<td>681 (91)*</td>
<td>655 (90)*</td>
<td>0.6</td>
</tr>
<tr>
<td>Discharge outcome variable</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length of stay median (Q1, Q3; all cases)†</td>
<td>7 (4, 11)‡</td>
<td>6 (3, 10)‡</td>
<td>0.017</td>
</tr>
<tr>
<td>Discharge delay</td>
<td>80 (12)§</td>
<td>65 (10)ll</td>
<td>0.3</td>
</tr>
<tr>
<td>Independent at discharge (modified Rankin score 0–1)</td>
<td>125 (17)‡</td>
<td>155 (22)‡</td>
<td>0.02</td>
</tr>
<tr>
<td>Readmissions at 28 d</td>
<td>40 (6)§</td>
<td>44 (8)ll</td>
<td>0.1</td>
</tr>
<tr>
<td>Complications</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Severe complications¶</td>
<td>$63 (8)</td>
<td>52 (7)</td>
<td>0.4</td>
</tr>
<tr>
<td>Deep vein thrombosis</td>
<td>5 (1)*</td>
<td>3 (1)§</td>
<td>0.5</td>
</tr>
<tr>
<td>Aspiration pneumonia</td>
<td>33 (4)*</td>
<td>30 (4)§</td>
<td>0.9</td>
</tr>
<tr>
<td>Discharge destination</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Home</td>
<td>235 (35)§</td>
<td>248 (43)#</td>
<td>0.002</td>
</tr>
<tr>
<td>Rehabilitation</td>
<td>311 (46)§</td>
<td>210 (37)#</td>
<td>0.001</td>
</tr>
<tr>
<td>Aged care facility</td>
<td>133 (20)§</td>
<td>117 (20)#</td>
<td>0.7</td>
</tr>
</tbody>
</table>

Q1 indicates first quartile; and Q3, third quartile. 
*<1% missing. 
†No adjustments for outliers were made. 
‡<3% missing. 
§≤10% missing. 
ll≤20% missing. 
¶Severe complication is one that is incapacitating, life threatening and prolongs hospital admission and patient acuity. 
#≤22% missing.
of this position directly. There is no clear evidence in the literature that a coordinator role directly improves patient outcomes after stroke. However, a dedicated coordinator may be influential in the continuing success of providing evidence-based stroke care.11 There is also the suggestion that a stroke coordinator can assist in reducing the length of hospital stay and emergency department representations.29 Our results provide indirect evidence that a stroke clinical coordinator, who is able to provide leadership, education, and has nonclinical time to focus on project work such as development of care plans, may be considered an important attribute to ensure an evidence-based approach to care for stroke. The clinicians we interviewed across all health services were consistent in stating that the clinical coordinator role was the main driver of the changes to stroke care as part of the RSP.

Conclusions
The results of this study provide evidence on a successful approach to improving stroke care in rural locations. Investment in stroke clinical coordinators who implemented organizational change, together with increased clinician resources, effectively improved stroke care in rural hospitals, resulting in more patients being discharged home. These findings are relevant to countries that do not have universal access to SUs and show that investment in leadership roles is worthwhile.

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Disclosures
None.

References
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SUPPLEMENTAL MATERIAL

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**Supplementary Table I: Assessment of potential secular trends for process indicators during the pre-Rural Stroke Project audit data collection phase**

<table>
<thead>
<tr>
<th>Process indicator</th>
<th>Pre-audit period</th>
<th>Overall comparison results</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2001-2004*</td>
<td>2005-2006*</td>
</tr>
<tr>
<td></td>
<td>(N=267)</td>
<td>(N=434)</td>
</tr>
<tr>
<td>Within 24 hours of arrival at hospital:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brain scan</td>
<td>221 (83%)</td>
<td>399 (92%)</td>
</tr>
<tr>
<td>Documentation of swallowing ability</td>
<td>124 (48%)</td>
<td>235 (54%)</td>
</tr>
<tr>
<td>Aspirin if an ischemic stroke</td>
<td>138 (57%)</td>
<td>226 (58%)</td>
</tr>
<tr>
<td>Within 48 hours of arrival at hospital</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physiotherapy assessment</td>
<td>114 (43%)</td>
<td>227 (52%)</td>
</tr>
<tr>
<td>Occupational therapy assessment</td>
<td>39 (15%)</td>
<td>131 (30%)</td>
</tr>
<tr>
<td>Speech pathologist assessment</td>
<td>133 (50%)</td>
<td>214 (50%)</td>
</tr>
<tr>
<td>Use of clinical pathway</td>
<td>29 (11%)</td>
<td>73 (17%)</td>
</tr>
<tr>
<td>Commencement of an anti-platelet or anti-thrombotic agent if</td>
<td>125 (53%)</td>
<td>177 (51%)</td>
</tr>
<tr>
<td>an ischemic stroke</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*excluded 18 cases from year 2000 and 31 cases from year 2007.