

# A multifaceted health-service intervention in remote Aboriginal communities: 3-year follow-up of the impact on diabetes care

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Indigenous Australians experience both high rates<sup>1</sup> and early age of onset<sup>2</sup> of type 2 diabetes. Interventions to improve the medical management of diabetes in primary care have been shown to improve process and outcomes of care.<sup>3</sup> However, there is limited research on the long-term effectiveness of such interventions,<sup>4</sup> or on the impact of broader healthcare system reforms on specific aspects of care. Recent health reform initiatives — the “coordinated care trials” (CCTs) — in two remote regions of the Northern Territory aimed to enhance governance and funding arrangements. A health board was established in each region with the responsibility for planning and purchasing a wide range of healthcare services for the population, and government funds were transferred to these health boards.<sup>5,6</sup> Improved coordination of care for chronic illness was also a major aim of the trials, with the implementation of locally developed clinical-practice guidelines supported by an electronic-care planning, recall and reminder system.<sup>7</sup>

We report on changes in levels of compliance with diabetes-care guidelines, processes of care, and participant outcome measures before and after implementation of the multifaceted health-service intervention.

## METHODS

### Study setting and population

The trial was conducted in two remote regions of the Northern Territory which differ significantly — the Tiwi Islands and the Katherine West region (Box 1). The Tiwi Islands cover 7900 km<sup>2</sup> and are located about 60 km north of Darwin. An estimated 90% of the population of 2000 are Aboriginal.<sup>6</sup> The two islands contain three main

## ABSTRACT

**Objective:** To examine the trends in processes of diabetes care and in participant outcomes after an intervention in two remote regions of Australia.

**Design:** Follow-up study over 3 years.

**Setting:** Seven health centres in the Tiwi Islands and the Katherine West region of the Northern Territory.

**Participants:** 137 Aboriginal people with type 2 diabetes.

**Intervention:** Implementation of a multifaceted trial, including transfer of purchasing and planning responsibility to local health boards, the development and dissemination of clinical guidelines supported by electronic registers, recall and reminder systems and associated staff training, and audit and feedback.

**Main outcome measures:** Trends in the proportion of Aboriginal people receiving services in accordance with clinical guidelines and in the proportion for whom specified levels of blood pressure and glycosylated haemoglobin (HbA<sub>1c</sub>) were achieved; health staff perceptions of barriers to effective service delivery.

**Results:** An initial improvement in overall service levels from 40% to 49% was not fully sustained over the 3-year period. The overall proportion of services delivered varied from 22% to 64% between communities and over time. The proportion of participants whose most recent HbA<sub>1c</sub> level was less than 7% improved from 19% to 32%, but there was little change in blood pressure control. Perceived barriers to service delivery included discontinuities in staffing, lack of work-practice support and patients' acceptance of services.

**Conclusions:** Multifaceted interventions can improve quality of care in this environment, but achieving sustainable, high-quality care in a range of services and local conditions presents particular challenges. Developing and testing strategies for consistent and sustained improvement should be a priority for service providers and researchers.

MJA 2004; 181: 195–200

communities and a number of smaller settlements. The Katherine West region covers 162 000 km<sup>2</sup> and includes several large Aboriginal communities and smaller outstations, a number of cattle stations, and a small township. The southernmost community is about 890 km from Darwin. About 85% of the regional population of 2800–3000 are Aboriginal, drawn from 10 language groups.<sup>5</sup> By Australian standards, the health

and socioeconomic profiles of both regions are very poor.

The nature of the intervention meant that everyone using the healthcare services in these regions was subject to the intervention. Signed consent was required from individuals to use their health records for trial evaluation purposes. At the end of the first, intensive recruitment phase of the trial, 1205 people in the Tiwi Islands (about 60% of the population) and 1340 people in the Katherine West region (about 45% of the population) had provided consent. The study was approved by the local formally constituted ethics committee in accordance with National Health and Medical Research Council guidelines.

### Intervention

The clinical guidelines, electronic systems to support the guidelines, and associated staff

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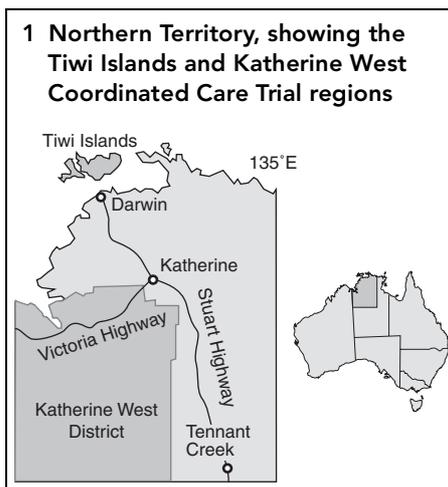
training were introduced progressively, starting in late 1998. Three aspects of the intervention and associated evaluation were expected to directly affect clinical practice. Firstly, each health centre received a comprehensive set of evidence-based clinical guidelines, including specific guidelines on diabetes management.<sup>7</sup> Services and service intervals specified in the guidelines are shown in Box 2 (columns 1 and 2).

Secondly, the guidelines were incorporated into a computerised information system, which was installed in all participating community health centres. The system provided the facility for scheduling guideline services for individual participants, for identification of people due for scheduled services, and reminders to clinicians. Two non-Indigenous health department staff were engaged to visit the health centres to train health centre staff in using the software packages.

Thirdly, a "clinical audit cycle"<sup>8</sup> was implemented, with audits conducted at baseline, and 6, 12, 24 and 36 months after commencement of the trials. Findings from the audits were fed back to, and their interpretation discussed with, health centre clinicians and managers. This usually occurred within a few months of each audit, and within a timeframe which allowed a response to feedback to influence the next audit.

### Study design and sampling

The population sample was followed up over 3 years to assess changes in clinical practice after the intervention. Of people who consented, 188 were identified from health centre records as having a diagnosis of type 2 diabetes. A stratified sampling design was used to ensure the sample included participants from each community. Because of small numbers in each of the five smaller communities, all people with diabetes living in these communities who consented were included in the sample ( $n = 57$ ). In each of the two larger communities, a random sample of consenting people with diabetes was drawn ( $n = 83$ ). The total sample at baseline therefore included 140 people. The records of three were not available for the baseline audit because of flooding. Out-migration and death resulted in a loss to follow-up of four members of the sample at the Year 1 audit, another 10 at the Year 2 audit, and 16 at the Year 3 audit. The sample at the Year 3 audit was supplemented with the recruitment of an additional 39 consenting participants from six of the communities, giving a total sample at the Year 3 audit of 146.



### Audit method

Clinical records of the participants were audited for a record of delivery of each service specified in the guidelines. Baseline audits conducted around the same time as the introduction of the guidelines recorded services delivered over the preceding 12 months (before the introduction of the guidelines could have had an effect).

Both the paper and electronic record of each participant were checked for the most recent record of delivery of each service according to a schedule specified in the clinical guidelines. A service was recorded as delivered if there was a record of delivery within 3 or 6 months (in line with recommended service intervals) preceding each audit, except where service intervals were more than 6 months (yearly for influenza vaccination, and every 5 years for pneumococcal vaccination).

Information on attendance at health centres within the last 3 and 6 months for each participant was also collected at Year 1, Year 2 and Year 3 audits to determine the proportion of the population attending the health centre within specified times, and the extent of possible missed opportunities for delivery of preventive services at times when participants were attending for other reasons.

### Process and outcome measures

Processes of care were measured by assessing adherence to guideline service schedules for each audit period. Two types of process measures were determined for each participant:

- each service was recorded as delivered or not; and
- the percentage of delivered services was calculated (with delivered services as numerator and scheduled services as denominator).

Data on current medication were also collected at each audit.

Four outcomes were assessed:

- most recent blood pressure level during the 12 months preceding each audit;
- proportion of participants with "controlled blood pressure" (< 140/90 mmHg) and "target blood pressure" (130/80 mmHg);
- most recent glycosylated haemoglobin (HbA<sub>1c</sub>) level in the 12 months preceding each audit; and
- proportion of participants with "controlled glycaemia" (HbA<sub>1c</sub> level < 8%) and "target glycaemia" (HbA<sub>1c</sub> level < 7%).

### Statistical analyses

Multilevel analysis<sup>9</sup> was conducted with the participant and the health centre defined as Level 1 and Level 2 units, respectively. The regression coefficient of the time variable (value of 0, 0.5, 1, 2, 3 for each audit respectively) was used to indicate the average magnitude of improvement in delivery of scheduled services per year from baseline, with the associated *P* value indicating a significant increasing or decreasing trend in delivery of services from year to year across the full period of follow-up.

A logistic (random-effects) model was used for the dichotomous outcome for each process outcome and participant outcome in terms of, for example, the percentage of the sample with "controlled blood pressure" and "controlled glycaemia". A linear random-effects model was used for participant-based continuous outcome measures (systolic and diastolic blood pressure and HbA<sub>1c</sub> levels). Separate analyses were conducted for each community. Mean values for the continuous outcome measures (and associated confidence intervals), where appropriate, were also calculated. All multilevel analyses were performed using Stata version 7.0<sup>10</sup> (commands *xtlogit* and *xtreg* with defined *iis* for Level 2 and *tis* for Level 1 identifiers).

### Qualitative research

In-depth interviews and observation of management and health staff meetings over the course of the trials and follow-up period provided insights into the management of health centres and processes of service delivery.<sup>5,6,11</sup>

## RESULTS

### Demographic characteristics and health-centre attendance

The sample comprised 52 men and 85 women (age range, 23–86 years, 70% < 55

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### 2 Proportion of scheduled services delivered to participants with diabetes (%)\*

Scheduled services	Scheduled frequency (months)	Percentage of services delivered					Odds ratio (95% CI) <sup>†</sup>	P for trend <sup>‡</sup>
		Baseline (n = 137)	Month 6 (n = 137)	Year 1 (n = 133)	Year 2 (n = 123)	Year 3 (n = 146)		
<b>Basic measurements</b>								
Weight	3	77	72	70	59	51	0.64 (0.55–0.75)	< 0.001
Blood pressure	3	88	80	81	76	76	0.80 (0.67–0.95)	<b>0.01</b>
Waist circumference	3	34	34	40	42	32	0.97 (0.84–1.13)	0.74
Body mass index	6	29	25	19	27	28	1.02 (0.86–1.20)	0.86
Blood glucose (test strip)	3	85	79	73	70	71	0.78 (0.66–0.91)	<b>0.002</b>
Urine dipstick testing	6	63	60	62	42	45	0.73 (0.63–0.84)	< 0.001
<b>Clinical examinations</b>								
Heart auscultation	6	22	31	12	15	12	0.69 (0.57–0.85)	< 0.001
Peripheral pulses	6	9	31	34	17	33	1.24 (1.05–1.45)	<b>0.009</b>
Visual acuity	6	31	37	56	49	57 (145) <sup>§</sup>	1.38 (1.19–1.60)	< 0.001
Cataracts	6	28	34	47	46	52 (145) <sup>§</sup>	1.36 (1.18–1.58)	< 0.001
Optic fundi	6	29	39	49	46	56 (145) <sup>§</sup>	1.38 (1.19–1.60)	< 0.001
Feet: sensation	6	8	18	40	27	38	1.58 (1.34–1.86)	< 0.001
Feet: reflexes	6	4	6	28	24	19	1.49 (1.23–1.80)	< 0.001
Feet: pressure areas	6	6	7	33	23	27	1.61 (1.34–1.93)	< 0.001
Feet: infection	3	17	9	37	22	29	1.30 (1.10–1.54)	<b>0.002</b>
Ophthalmologist	24	39	39	59	53	67 (145) <sup>§</sup>	1.45 (1.25–1.68)	< 0.001
<b>Vaccinations<sup>¶</sup></b>								
Pneumococcal	60	–	–	74 (69) <sup>¶</sup>	91	91	1.77 (1.14–2.74)	<b>0.01</b>
Influenza	12	–	–	71 (69) <sup>¶</sup>	84	81	1.07 (0.74–1.53)	0.73
<b>Counselling/inquiry<sup>**</sup></b>								
History of personal or family illness	3	74	31	50	33	1	0.35 (0.28–0.42)	< 0.001
Diet	3	45	37	56	41	27	0.79 (0.68–0.92)	<b>0.002</b>
Activity	3	29	31	41	31	19	0.80 (0.68–0.95)	<b>0.01</b>
Weight loss	3	23	18	21	28	4	0.70 (0.57–0.86)	<b>0.001</b>
Smoking	3	31	29	39	30	24	0.85 (0.71–1.01)	0.06
Alcohol	3	34	26	38	30	18	0.75 (0.63–0.89)	<b>0.001</b>
Vaccinations <sup>††</sup>	6	44	65	67 (64) <sup>††</sup>	– <sup>††</sup>	– <sup>††</sup>	2.43 (1.25–4.71)	<b>0.009</b>
Diabetes control and medications	6	73	65	71	71	48	0.74 (0.64–0.86)	< 0.001
<b>Investigations</b>								
Albumin to creatinine ratio	6	53	46	65	46	50	0.92 (0.80–1.07)	0.29
Urea level	6	53	54	61	57	69	1.22 (1.06–1.42)	<b>0.007</b>
Creatinine level	6	57	56	61	58	69	1.15 (0.99–1.33)	0.07
HbA <sub>1c</sub> level	3	56	58	62	56	70	1.16 (1.00–1.35)	<b>0.04</b>
Fasting lipid levels	6	16	27	41	42	52	1.65 (1.42–1.93)	< 0.001

\* Proportions were calculated using *n* as denominator, unless otherwise indicated by an alternative denominator shown in parentheses.

† Odds ratios represent the average changing of probability for the delivery of each service with the increase of one unit of time (1 year), using two-level logistic random-effect model.

‡ P values significant at the 0.05 level are shown in bold.

§ Clinical examinations of visual acuity, cataracts and optic fundi, and ophthalmologist examination were not applicable to one participant who was blind.

¶ Records of providing pneumococcal and influenza vaccines were considered as evidence for vaccinations at Year 2 and Year 3 audits; these audits were introduced at Year 1 in Katherine West.

\*\* Counselling/inquiry refers to a record of discussion of, or inquiry about, significant personal or family history of, for example, illness, dietary habits, physical activity.

†† Audits of counselling/inquiries about vaccinations were replaced by audits of vaccination records at Year 1 in Katherine West and at Year 2 and Year 3 elsewhere.

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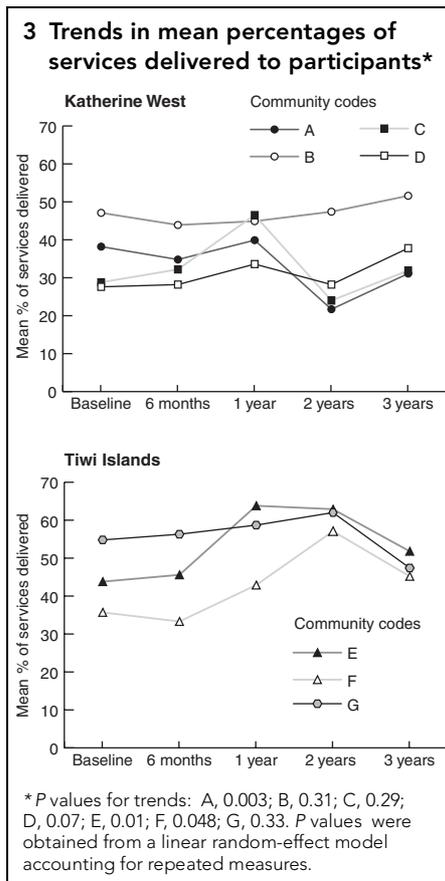
years and 18% <35 years). There was a record of attendance at the health centres for 93%–96% of the sample within 6 months, and 86%–94% within 3 months preceding each of the audits.

### Trends in service delivery

During the first 6 months of the intervention, there was little change in the percentage of overall delivered services (40% to 39%). This was followed by a significant improvement at Year 1 (49%), with subsequent decline in Years 2 and 3 to close to baseline (44% in each year). There was no significant linear trend across the full study period (*P* for trend, 0.16). This pattern was the same for male and female participants. There was a significant increase in the proportion of people in the sample taking oral hypoglycaemic agents (75% at baseline to 79% at Year 3; *P* for trend, 0.001), insulin (4.4% to 6.8%; *P* for trend, 0.001), and angiotensin-converting enzyme (ACE) inhibitors (70.8% to 83.6%; *P* for trend, 0.0001).

There were wide variations in the trends for specific services over the study period (Box 2). Delivery of almost all services in the categories of clinical examination, laboratory investigation and vaccination increased significantly.

Delivery of most services relating to basic measurements tended to decrease. Delivery of counselling about diet, activity, weight, smoking, alcohol and medication fluctuated from baseline to Year 2, but declined substantially at Year 3. Rates of delivery of services that were being delivered at low levels at baseline tended to improve across the study period, while those being deliv-



ered at higher levels at baseline tended to decline.

Trends in service delivery varied between communities (Box 3). In all three Tiwi communities there was an increasing trend to Years 1 and 2, followed by a decline to Year 3. In two of these communities, the overall increasing trend was statistically significant. In Katherine West there was more variation

between communities. A striking feature of the patterns was the sharp decline in two communities between Year 1 and Year 2. For one of these communities, the overall trend was a statistically significant decline.

### Participant outcomes

There were no statistically significant trends in the mean systolic or mean diastolic blood pressures, or in the proportion of participants in whom targeted levels of blood pressure control were achieved across the study period (Box 4). There was also no statistically significant trend in mean HbA<sub>1c</sub> level or in the proportion of participants with HbA<sub>1c</sub> level <8%. However, the proportion in whom a target HbA<sub>1c</sub> level <7% was achieved increased significantly from 19% at baseline to 32% at Year 3.

Interviews with health centre staff and health service managers identified that the following factors were the main barriers to delivering and sustaining best-practice chronic disease care:

- discontinuities in staffing;
- lack of ongoing training and support for the care coordination process;
- lack of development of relevant work practices;
- lack of capacity to monitor service activity through timely analysis of service data; and
- reluctance on the part of patients to accept offered services when presenting for acute, non-scheduled services.

## DISCUSSION

An initial improvement in overall service delivery after implementation of the health services intervention was not sustained over

### 4 Trends in control of blood pressure and glycosylated haemoglobin (HbA<sub>1c</sub>) levels over 3-year follow-up\*

Outcomes <sup>†</sup>	Baseline	Month 6	Year 1	Year 2	Year 3	<i>P</i> for trend <sup>‡</sup>
<b>Blood pressure (BP)</b>						
Mean systolic BP (mmHg)	128 (124–131)	130 (126–133)	129 (125–133)	126 (122–130)	128 (125–131)	0.60
Mean diastolic BP (mmHg)	78 (76–80)	80 (78–82)	78 (76–81)	77 (74–79)	80 (78–82)	0.80
% with BP < 140/90 mmHg	66 (57–74)	60 (51–68)	57 (48–66)	63 (53–72)	66 (57–74)	0.65
% with BP < 130/80 mmHg	39 (31–48)	35 (27–44)	31 (23–40)	39 (30–49)	28 (20–36)	0.13
<b>HbA<sub>1c</sub></b>						
Mean HbA <sub>1c</sub> (%)	9.0 (8.6–9.4)	9.2 (8.8–9.7)	9.2 (8.7–9.6)	8.9 (8.3–9.4)	8.8 (8.3–9.2)	0.23
% with HbA <sub>1c</sub> < 8.0%	39 (29–49)	37 (28–47)	37 (30–47)	44 (34–55)	44 (35–53)	0.24
% with HbA <sub>1c</sub> < 7.0%	19 (12–28)	16 (10–24)	17 (10–26)	29 (21–40)	32 (23–41)	<b>0.002</b>

\* Data in parentheses are 95% confidence intervals.

† Blood pressure and HbA<sub>1c</sub> levels were from the most recent measures within the 12 months preceding each audit.

‡ *P* values for trends of continuous outcomes were calculated using a two-level linear random-effect model. *P* values for trends of dichotomous outcomes were obtained using a two-level logistic random-effect model. *P* value significant at the 0.05 level is shown in bold.

**5 Some challenges and strategies for sustaining improvement in chronic illness care**

**Challenge:** The local impact of clinical interventions is likely to be mediated by an array of contextual factors, including governance arrangements, remoteness, staffing issues, and quality of transportation and communications infrastructure.

**Strategy:** Tailor strategies to address local mediating factors. Overarching strategies include:

- providing strong systemic support from central agencies to buffer the effects of mediating factors on regional and local organisations;
- providing transparent work-practice systems backed by written protocols and manuals and appropriate staffing and training policies at regional and local levels; and
- recognising local knowledge and interest and using this to address local problems.

**Challenge:** A range of practitioner types (eg, general practitioners, registered nurses and Aboriginal health workers) are involved in delivery of care. Specific interventions may reach some categories of health staff more effectively than others.

**Strategy:** Operationalise care processes through development of work practices; delineate roles and practices for all practitioner types and support these with appropriate aids and specific in-service training.

**Challenge:** People may be unwilling to take up health services even when they are offered, limiting the intensification of care.

**Strategy:** Raise awareness in communities of appropriate care through developing and implementing education and health-promotion strategies with strong local participation.

**Challenge:** Response to demands for acute care may interfere with effective chronic illness care.

**Strategy:** Provide sustained institutional support and protected staff time for core chronic illness care functions. Develop acute-care processes to maximise potential for opportunistic chronic illness care.

3 years of follow-up. There was significant variation in trends between different services and between different communities. Importantly, the increase in monitoring of HbA<sub>1c</sub> level and use of hypoglycaemic agents and insulin was associated with an increase in the proportion of participants achieving HbA<sub>1c</sub> level < 7%. Monitoring of blood pressure declined, but there was little change in blood-pressure control. Our qualitative findings suggest that there are difficulties in maintaining systems designed to improve practice, as well as in ensuring that health staff continue to respond to these systems.

Political constraints and the extent of health service reforms implemented through the CCTs precluded a randomised study, leaving a time-series design as the best alternative.<sup>12</sup> The inclusion of several communities over an extended period before and after the intervention enhanced validity and generalisability. However, relatively low rates of consent, particularly in Katherine West, mean that the possibility of bias in the estimates of the level of service delivery cannot be excluded. Comparison between regions and generalisability of the findings to other populations should be made with caution.

A more focused diabetes intervention in the Torres Strait reported greater positive impacts on processes of care, intermediate

outcomes and diabetes-related admissions.<sup>13</sup> In contrast, the diffusion of energy across the broad reform agenda of the CCTs may have limited the potential for sustained impact on a specific condition such as diabetes, which, in the context of these trials, was used as an indicator of expected impact on chronic illness care more generally. Nevertheless, the importance of the design and implementation of focused interventions is highlighted by the failure to sustain improvement in blood-pressure control in a specialised treatment program in the Tiwi Islands after integration of the program into routine services.<sup>14,15</sup>

The failure to demonstrate sustained impacts on a number of aspects of diabetes care should be considered in the context of high levels of care relative to national<sup>16</sup> and international<sup>17</sup> reports. It should also be considered in the context of the environment in which the trials took place, which is characterised by heavy burdens of chronic and acute illness, pervasive social disadvantage and geographic isolation. At the same time, evaluations of the trials themselves demonstrated that the trials have contributed to increased resources for healthcare services in both the Tiwi Islands and Katherine West regions, and have focused commitment on the part of local health services to prevention and management of chronic dis-

ease.<sup>18</sup> A priority in chronic illness care is for policymakers and researchers to develop and test strategies to sustain improvements in care within the context of enhanced community control. Local challenges for achieving sustained improvement and possible strategies for overcoming these challenges identified through this research (Box 5) complement and are consistent with international models for improving chronic illness care.<sup>19,20</sup>

**COMPETING INTERESTS**

RB, GR, ST and P d'A have conducted contract evaluations and follow-up studies of the Coordinated Care Trials on behalf of the local Health Boards of Katherine West and the Tiwi Islands. The funders of the evaluations on which this work is based had no influence on the preparation of the manuscript or the decision to publish.

**ACKNOWLEDGEMENTS**

We would like to acknowledge the assistance of the Health Boards and staff of the health centres where the study was conducted. We also gratefully acknowledge the constructive comments of five anonymous reviewers. The article is based on work conducted for evaluations of the Coordinated Care Trials. These evaluations were funded by the Australian Department of Health and Ageing.

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(Received 3 Dec 2003, accepted 4 May 2004)



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