

# Is screening for microalbuminuria in patients with type 2 diabetes feasible in the Cape Town public sector primary care context? A cost and consequence study

Ibrahim HO, MBChB, MMed, Family Physician; Stapar D, MBChB, MMed, Family Physician  
Mash B, MBChB, DRCOG, DCH, MRCGP, FCFP, PhD, Professor and Head  
Division of Family Medicine and Primary Care, Stellenbosch University  
Correspondence to: Bob Mash, e-mail: rm@sun.ac.za

**Keywords:** microalbuminuria, diabetes, nephropathy, kidney disease, cost analysis, Cape Town, primary care

## Abstract

**Background:** Type 2 diabetes contributes significantly to the burden of disease in South Africa. Proteinuria is a marker for chronic kidney and cardiovascular disease. All guidelines recommend testing for microalbuminuria because intervention at this stage can prevent or delay the onset of disease. Currently, none of the community health centres (CHCs) in Cape Town test for microalbuminuria, and there are concerns about its costs and feasibility.

**Objectives:** The aim of this study was to assess the practicality, costs and consequences of introducing a screening test for microalbuminuria into primary care.

**Design:** Chronic care teams were trained to screen and treat all patients with diabetes ( $n = 1\ 675$ ) over a one-year period. The fidelity of screening, costs and consequences was evaluated.

**Setting and subjects:** Patients with type 2 diabetes and chronic care teams at two community health centres in the Cape Town Metro district.

**Outcome measures:** Data to evaluate screening were extracted from the records of 342 randomly selected patients. Data to evaluate treatment were taken from the records of all 140 patients diagnosed with microalbuminuria.

**Results:** Of the patients with diabetes, 14.6% already had macroalbuminuria. Of the eligible patients, 69.9% completed the screening process which led to a diagnosis of microalbuminuria in another 11.7%. Of those who were positively diagnosed, the opportunity to initiate angiotensin-converting enzyme (ACE) inhibitors was missed in 20%, while 49.2% had ACE inhibitors initiated, or the dosage thereof increased. It would cost the health system an additional R1 463 to screen 100 patients and provide additional ACE inhibitor treatment for a year to the 12 that were diagnosed.

**Conclusion:** The study demonstrated the feasibility of incorporating microalbuminuria testing into routine care. The costs involved were minimal, compared to the likely benefits of preventing end-stage renal failure and the costs of dialysis (estimated at R120 000 per year per patient).

© Peer reviewed. (Submitted: 2012-08-21. Accepted: 2012-11-20.) © SAAFP

S Afr Fam Pract 2013;55(4):367-372

## Introduction

Diabetes is a significant contributor to the burden of disease in South Africa and its prevalence in Africa is expected to increase by 80% over the next 15 years.<sup>1,2</sup> Self-reported prevalence rates for diabetes of 2.4% in men and 3.7% in women have been reported in South Africa.<sup>3</sup> However, studies in the Western Cape suggest rates in Cape Town that are as high as 33%.<sup>4</sup>

Diabetes is associated with the development of chronic kidney disease and cardiovascular complications. According to the World Health Organization, approximately 50% of patients with diabetes mellitus will die from cardiovascular disease.<sup>5</sup> Proteinuria is recognised as an indicator of

nephropathy and possible future deterioration in kidney function.<sup>6</sup> The link between proteinuria or early kidney disease as an independent risk factor for cardiovascular morbidity and mortality has also been established.<sup>7,8</sup> Early intervention can prevent the progression of kidney disease, reduce cardiovascular risk and improve quality of life.<sup>6</sup>

Microalbuminuria is defined as an increase in urinary albumin levels to between 20 and 200 mg/l and is a reliable indicator of early kidney damage. Detection of macroalbuminuria, defined as urinary albumin levels above 200 mg/l, is often too late in the disease process to permit an effective intervention as nephropathy is already established.<sup>9</sup> It is of significance that microalbuminuria is potentially reversible if diagnosed early and correct interventions are commenced.<sup>10,11</sup>

Currently, public sector health centres only test patients for macroalbuminuria, even though all the national, regional and international guidelines recommend testing annually for microalbuminuria.<sup>12-14</sup> The Western Cape District Health Services has struggled to provide an adequate standard of care for patients with diabetes and there have been doubts as to whether microalbuminuria testing is both feasible and affordable in our context.<sup>15,16</sup> Therefore, this study aims to explore the feasibility and costs of introducing the test in the primary care context and to provide practical information for a policy decision on this issue.

The aim of this study was to assess the practicality of introducing a screening test for microalbuminuria and the associated costs and consequences at two community health centres (CHCs) in the Cape Town metropolitan district.

The objectives were:

- To assess the feasibility of implementing the test in this context.
- To assess any additional cost to the health services.
- To assess any measurable benefits in the quality of care for the patients who tested positive.

## Method

### Study design

The design comprised a cost and consequence study that described the implementation of microalbuminuria testing on a group of patients with type 2 diabetes in public sector CHCs, and evaluated the consequences with regard to quality of care and the immediate costs involved.

### Setting

The study was conducted at Elsies River and Kraaifontein CHCs. These sites were chosen as the postgraduate students who conducted the study were working at these CHCs at the time of the study. Both CHCs are 24-hour facilities, led by family physicians, and serve large numbers of patients with diabetes from the uninsured population of Cape Town. Patients are mostly from low socio-economic backgrounds and historically disadvantaged black Xhosa-speaking and coloured Afrikaans or English-speaking communities. Patients with diabetes are seen on specific days by a chronic care team consisting of a doctor, nurses, clinical nurse practitioners (CNPs) and a health promoter. Routine tests, such as urinalysis, are performed in a preparation area by nurses. Once patients have been assessed, they are consulted by either a CNP or a doctor.

### Study population

Disease registers at the health centres listed 581 patients with diabetes at Elsies River, and 1 094 at Kraaifontein, CHCs. The screening test was offered to all patients with diabetes who attended over a one-year period.

### The screening test, training and intervention

Equipment for screening of microalbuminuria consisted of a point-of-care portable diagnostic machine (Status

Analyser<sup>®</sup>) and urine testing strips. Equipment and strips were donated by Siemens Medical Solutions Diagnostics. According to the manufacturer, the status analyser machine has a specificity of 98.2% and a sensitivity of 96.9%. The equipment calibrates itself automatically at intervals. It has an average lifespan of five years.

The chronic care teams were trained in the use of the equipment and in how to interpret and act on the results. A researcher helped the teams to plan a realistic organisational framework for testing, interpreting, recording and acting on the results at clinic level. A standard operating procedure was provided.

If the macroalbuminuria test result was negative, then urine testing for the albumin to creatinine ratio (microalbuminuria) was performed using the Status Analyser. If the ratio was normal, the test was scheduled to be repeated after one year. If the ratio was abnormal, a repeat urine test was performed at the second visit when the patient next returned for a routine visit after 3-6 months, and if the second test result was negative, a third test was performed at the third visit. Single testing is unreliable, but with multiple testing, reliability improves to 98%. False positives may be seen in those with recent (over the last 24 hours) vigorous exercise, fever, heart failure, urinary tract infection, and prostatitis (in men) and menstruation (in women). The possibility of false positives is accounted for by repeated testing.

If there was an abnormal result in two out of the three tests, then the result for microalbuminuria was said to be positive. The results of the microalbuminuria tests were recorded in a test register which was kept with the Status Analyser machine and the printed result was placed in the patient's folder. Testing was performed in the preparation room by a staff nurse. Patients who tested positive for microalbuminuria were further managed by the CNP. The staff then attempted to improve overall diabetic control (glycaemia, lipids, weight and blood pressure), and if the patient was not on an angiotensin-converting enzyme (ACE) inhibitor, this was then started by the doctor. If the patient was already on an ACE inhibitor, the need to increase the dose was considered.

Initially, ongoing support was provided to the CHCs. Supervisory visits were carried out by the researcher weekly for one month, and then fortnightly for two months. Once testing was established, the researcher only visited monthly, and as required. At these visits, the researcher received feedback on the feasibility of performing the tests and on the interpretation of the results, listened to the responses to the test from the clinic staff, and then ensured that the protocol was correctly followed.

### Data collection

The disease register and the test register were used to select patients for different aspects of the assessment. At the end of the study period, a random sample of 171 patient records was selected from each disease register to evaluate the fidelity and results of the screening process.

This sample size was calculated to give 5% precision with 95% confidence intervals. Additional treatment was determined by examining the records of all those diagnosed with microalbuminuria in the testing register.

The regular meetings with the chronic care teams were recorded and used as qualitative data with regard to the feasibility of introducing the screening test. The researcher also directly observed the screening process and noted any key positive or negative aspects of performing the test. A focus group interview was held with each chronic care team at the end of the study period to explore its experience of using the new test. The interview was recorded and transcribed verbatim.

### Data analysis

Microsoft® Excel® was used to capture the quantitative data and Statistica® version 8 to analyse the data with the help of the Centre for Statistical Consultation. Only simple descriptive statistics were required. Recording of the team meetings were analysed qualitatively using the framework approach and key themes relating to the feasibility and organisation of care reported.

## Results

### Study sample

The random sample for evaluation of the screening process included 171 patients from the disease register in each facility, giving a total study population of 342. The mean age of the study sample was 57.5 years, 107 (31.3%) were men and 235 (68.7%) women. Table I presents a profile of key diabetes indicators in this diabetic population.

### Screening process

Overall, 50 patients (14.6%) were noted to have macroalbuminuria and an additional 40 patients (11.7%) were diagnosed with microalbuminuria. Key indicators that describe the screening process are shown in Table II.

As 50 patients of the total study population of 342 already had macroalbuminuria, only 292 patients were eligible for

microalbuminuria testing. Of these, 260/292 (89%) had a first test. This implies that 32 patients were not screened at this stage. Of those who received a positive first test result, 51/98 (52%) underwent the necessary second test. This implies that 47 patients were not fully screened at this stage. Fourteen patients were found to have an abnormal first test result and a normal second test result, 5/14 (35.7%) of whom then had the required third test. This implies that nine patients were not fully screened at this stage. Therefore, out of the 292 eligible for screening, 88 (30.1%) did not complete the screening process. If all patients had been fully screened, these results imply that 92 (26.9%) would then have been diagnosed with microalbuminuria.

### Assessment of intervention in patients with microalbuminuria

These results are based on 140 patients diagnosed with microalbuminuria in the test register, and not on the random sample used above to evaluate the screening process. The intervention received by this group as a direct result of the diagnosis is described in Table III. The opportunity to initiate ACE inhibitors was missed in 20% of patients, while the benefits of ACE inhibitors were increased in 49.2% of patients.

### Cost analysis

The cost of additional ACE inhibitor medication shown in Table IV was based on the cost as purchased by the Metro District Health Service in August 2011. The prescriptions as listed in Table III. The cost of intensifying other treatments and education is not included as such efforts to improve diabetes control should be part of standard care.

Table V summarises the additional costs of the screening process based on the 342 patients who were sampled and the actual performance achieved in these CHCs. Costs of screening with full fidelity of the screening process are also estimated. It was assumed that the analyser would last for a period of five years and that costs relative to screening 342 patients over a 12-month period were allocated. The cost of staff time was based on the salary scale of a full-

**Table I:** Profile of key diabetes indicators in the diabetic population in this study

| Indicators                                    | CHC1 n = 171   | CHC2 n = 171   | All n = 342    |
|---|----------------|----------------|----------------|
|   | n (%)          | n (%)          | n (%)          |
| Patients tested for HbA <sub>1c</sub>         | 99 (57.9)      | 55 (32.2)      | 154 (45)       |
| Patients with raised HbA <sub>1c</sub> (> 7%) | 81/99 (81.8)   | 35/55 (63.6)   | 116/154 (75.3) |
| Patients tested for creatinine                | 113 (66.1)     | 58 (33.9)      | 171 (50)       |
| Patients with raised creatinine               | 21/113 (18.6)  | 4/58 (6.9)     | 25/171 (14.6)  |
| Patients tested for cholesterol               | 110 (64.3)     | 59 (34.5)      | 169 (49.4)     |
| Patients with raised cholesterol              | 63/110 (57.3)  | 29/59 (49.1)   | 92/169 (54.4)  |
| Mean systolic BP (mmHg)                       | 146            | 149.6          | 147.8          |
| Patients with raised systolic BP              | 135/165 (81.8) | 146/170 (85.9) | 281/335 (83.9) |
| Mean diastolic BP                             | 86             | 87.5           | 86.8           |
| Patient with raised diastolic BP              | 131/165 (79.4) | 141/170 (82.9) | 272/335 (81.2) |

BP: blood pressure, CHC: community health centre, HbA<sub>1c</sub>: haemoglobin HbA<sub>1c</sub>

**Table II:** Indicators of the screening process

| Indicators   | CHC1 n = 171 | CHC2 n = 171 | All n = 342 |
|--|--------------|--------------|-------------|
|  | n (%)        | n (%)        | n (%)       |
| Patients tested for macroalbuminuria   | 171 (100)    | 163 (95.3)   | 334 (97.7)  |
| Patients with macroalbuminuria   | 20 (11.7)    | 30 (17.5)    | 50 (14.6)   |
| Patients tested for microalbuminuria   | 151 (88.3)   | 109 (63.7)   | 260 (76)    |
| Patients with positive first test  | 57 (33.3)    | 41 (23.9)    | 98 (28.7)   |
| Patients with positive first test receiving a second test                      | 35 (20.5)    | 16 (9.3)     | 51 (14.9)   |
| Patients with positive second test   | 25 (14.6)    | 12 (7)       | 37 (10.8)   |
| Patients with two tests (one negative and one positive) receiving a final test | 3 (1.8)      | 2 (1.1)      | 5 (1.5)     |
| Patients with positive third test  | 1 (0.6)      | 2 (1.1)      | 3 (0.9)     |
| Total number of tests  | 189          | 127          | 316         |
| Diagnosis of microalbuminuria  | 26 (15.2)    | 14 (8.2)     | 40 (11.7)   |
| Patients with final results clearly recorded in the folder                     | 171 (100)    | 109 (63.7)   | 280 (81.9)  |

CHC: community health centre

**Table III:** Frequency of interventions in those with microalbuminuria (n = 140)

| Intervention  | CHC1 n = 72 | CHC2 n = 68 | All n = 140 |
|---|-------------|-------------|-------------|
|   | n (%)       | n (%)       | n (%)       |
| Patients not started on ACE inhibitors  | 7 (9.7)     | 21 (30.8)   | 28 (20)     |
| Patients started on ACE inhibitors  | 36 (50)     | 2 (2.9)     | 38 (27.1)   |
| Patients maintained on ACE inhibitors   | 29 (40.3)   | 42 (61.8)   | 71 (50.7)   |
| Patients with a dose increase in ACE inhibitors                                   | 28 (38.9)   | 3 (4.4)     | 31 (22.1)   |
| Patients receiving other additional treatment (a dose increase or new medication) | 23 (31.9)   | 26 (38.2)   | 49 (35)     |
| Patients receiving additional health education or lifestyle advice                | 40 (55.6)   | 56 (82.3)   | 96 (68.6)   |

CHC: community health centre, ACE: angiotensin-converting enzyme

**Table IV:** Additional costs in Rands for angiotensin-converting enzyme inhibitor treatment (n = 140)

| Medication                                       | Dose started or added | Cost per month | Additional cost per month | Number of prescriptions | Total cost |
|--|-----------------------|----------------|---------------------------|-------------------------|------------|
| Enalapril  | 5 mg BD               | 4.96           | 4.96                      | 40                      | 198.4      |
|  | 10 mg BD              | 5.36           | 0.40                      | 29                      | 11.6       |
| Total cost to treat 69 patients for one month    |                       |                |                           |                         | 210        |
| Average cost to treat 100 patients for one month |                       |                |                           |                         | 304.35     |
| Average cost to treat one patient for one month  |                       |                |                           |                         | 3.04       |
| Average cost to treat one patient for one year   |                       |                |                           |                         | 36.48      |

BD: twice daily

time staff nurse grade one, notch one (new occupational-specific dispensation salary notches/total cost-to-employer packages on 1 July 2010), with a time of two minutes allocated per test.

### Observations and feedback from staff

Fidelity of implementation of the new screening process was worse in the first few weeks as staff made mistakes in performing the test, and training had to be adapted to the constant rotation of new nurses in the preparation area. Eventually, a critical mass of nurses was competent at the test and could train or supervise their colleagues. Support from the researcher and the family physician was important

in building motivation and ensuring competence. By the end of the study, it was difficult to stop the nurses from carrying out the screening as it had become part of their routine care. The CNPs involved with the interventions used their cell phones to obtain advice when they needed clarification on management issues. The only technical problems were ensuring a supply of paper for the analysers and its correct insertion in the machine. The following themes were derived from the focus group interview.

### Ease and feasibility of carrying out the test

Respondents reported that the test was easy to carry out and it could be introduced into primary care practice. They

**Table V:** Cost of screening process in Rands (n = 342)

| Item   | Cost with observed fidelity of screening | Cost with full fidelity of screening |
|--|--|--------------------------------------|
| Portion of capital cost of analyser                      | 1 802                                    | 1 802                                |
| Test strips used   | 1 580                                    | 2 160                                |
| Rolls of printing paper for analyser                     | 9  | 9                                    |
| Cost of staff nurse time                                 | 113.76                                   | 155.52                               |
| Total cost to screen study patients                      | 3 504.76                                 | 4 126.52                             |
| Total cost to screen 100 patients                        | 1 024.78                                 | 1 206.58                             |
| Total cost to identify one patient with microalbuminuria | 87.62                                    | 44.85                                |

appreciated the benefits that patients would derive from the introduction of this test:

“I think it is feasible, to prevent renal failure in the long term... to pick up if there is any protein in the urine or not, so the doctor can start with treatment on the patient immediately.”

“It’s actually very easy because the patients know themselves that if they are diabetic their heart and their kidneys are at stake, so it’s much easier to explain to them that this treatment is something that will prevent them from going into renal failure in the future. Most of them do understand it. It’s only a few patients, a little number, who are negative towards it”.

#### Time required for carrying out the test

Participants in the preparation room spent significantly more time on patients who were eligible for the test. This was quantified as five minutes, which is inclusive of time spent in documenting the result in a test register for the purpose of the study:

“It takes about five minutes, maybe less, but let’s keep it at five minutes”.

#### Time required for interpreting and acting on the test results

CNPs believed that the time spent acting on the positive results was short and did not significantly increase their workload or constitute a burden:

“I am coping and it’s only a few extra minutes with each patient. You only react on the abnormal, and only on seeing the abnormality do you intervene with the medication. Not every patient is like that. Maybe there are a few hypertensives and then another diabetic, so it’s not a huge burden”.

However, all of the respondents in the preparation room believed that additional staff would be required if the test was introduced as it added to their already busy schedule. One nurse in the preparation room was already overworked:

“It is possible if there are more staff because we are sitting with ±600 diabetic patients in total, and for one nurse in the preparation room to do it for all those patients is not possible”.

Practitioners did not think that they needed additional staff:

“With us, we are fine because it doesn’t take much time to talk to the patient and put the patient on the new treatment,

but it could be more time-consuming in the preparation room, but not for us. It’s okay with us. We don’t need any additional staff”.

## Discussion

This study represents the first reported attempt to assess the feasibility of introducing microalbuminuria screening in patients with diabetes in the primary healthcare public sector in South Africa. Microalbuminuria screening was successfully introduced into the care of patients with diabetes at two CHCs. With the fidelity of screening that was observed in the study, it was determined that if 100 patients were screened, then 15 would be identified with macroalbuminuria and 12 with microalbuminuria. Therefore, by combining the cost analysis for screening and treatment, it will cost the health system an additional R1 463 to screen and treat these (100) patients for a year. With full fidelity of screening, it is estimated that 27 patients would be diagnosed, and that costs would increase to R 2 192.

Staff found the testing and intervention easy, and feasible to integrate into their daily routine. However, although it only took an extra two minutes to perform the test, staff in the preparation room felt that additional staff capacity would be needed if this test became part of the normal protocol. Alternatively, other unnecessary tasks could be discontinued to increase the capacity of existing staff. Approximately 69.9% of eligible patients completed the screening process, which compares favourably with the fidelity of screening for haemoglobin A<sub>1c</sub> (45%), cholesterol (49%) and creatinine (50%).

Overall, half of the diagnosed patients received the benefit of increased ACE inhibitor therapy. Stricter glycaemic and blood pressure control, lipid-lowering therapy, and dietary and weight control education were other interventions that were instituted as a direct response to a positive result. Screening for microalbuminuria, followed by optimised intervention, has been found to lead to a 44% reduction in the cumulative incidence of end-stage renal disease, the benefits of which are noted from two years after commencing screening and intervention.<sup>7</sup> Therefore, it is anticipated that if this intervention was maintained, it would lead to better clinical outcomes, such as a reduced incidence of end-stage renal disease and cardiovascular complications, improved life expectancy and quality-adjusted life years.<sup>7,17</sup>

Diabetes is one of the most common causes of kidney failure. It accounts for 44% of new cases, and 40% of patients with diabetes are likely to develop nephropathy.<sup>18,19</sup> Within the current health budget for the Western Cape, it is not possible to dialyse or transplant all patients with end-stage renal failure. Therefore, investment in early screening and treatment may be the only viable strategy to prevent these premature deaths. The average annual cost of dialysis per patient is R120 000, and approximately R78 000 is spent annually on each transplanted patient (Davids R, Nephrology Unit, Department of Medicine, Tygerberg Hospital, 2012, personal communication, May 25). It is difficult to quantify the cost of recurrent cardiovascular complications and repeated hospitalisation prior to dialysis and transplantation. The cost to the government of disability grants that are paid to patients with end-stage renal disease must also be taken into account. Nevertheless, it is evident that the cost of treating one patient with dialysis for one year is at least equivalent to that of screening 8 202 patients with diabetes, and treating the 984 patients at risk of renal disease for a year.

In this context, early identification and immediate treatment has the potential for huge economic savings, coupled with improved quality and length of life. A recent review also concluded that there is strong evidence that screening for microalbuminuria is cost-effective and that policy-makers should give it higher priority.<sup>20</sup>

The results are clearly influenced by the motivation and performance levels of the staff and degree of organisation within the chosen CHCs. The results represent the likely effect of screening under these normal working conditions. Performance might be worse in CHCs with a more chaotic organisational framework or demotivated staff. Therefore, it is difficult to generalise about performance in the district or province as a whole.

In this study, the possibility of a false positive result because of initial staff mistakes could not be ruled out, despite the necessary precaution that was taken to prevent it. This could lead to unnecessary intervention and attendant costs, as well as worrying by patients. The qualitative data were collected by the researcher, who might have been perceived by the health workers as having a vested interest in a more positive viewpoint. The researcher was also responsible for analysing and interpreting the data.

## Conclusion

This study demonstrated that it is feasible to introduce microalbuminuria testing into the routine chronic care of patients with diabetes in a public sector primary healthcare facility. The immediate additional cost of R2 192 to fully screen 100 patients and treat those identified with microalbuminuria is overshadowed by the anticipated short-term reduction in cardiovascular events and the avoidance of long-term, end-stage renal disease. Benefits to patients in terms of quality of life, and to the government in terms of future savings in health care, make this a worthwhile cost-effective intervention.

## Acknowledgements

We thank the chronic care teams and family physicians, Dr Muideen Bello and Dr Arina Schlemmer, who supported the study. We also thank Siemens Medical Solutions Diagnostics who provided the equipment and material for the work. Funding was obtained from the Chronic Diseases Initiative for Africa.

## References

- Bradshaw D, Norman R, Schneider M. A clarion call for action based on refined DALY estimates for South Africa. *S Afr Med J*. 2007;97(6):438-440.
- International Diabetes Foundation. *Diabetes atlas*. 3<sup>rd</sup> ed. Brussels: International Diabetes Foundation; 2008.
- Mollentze W, Levitt N. Diabetes mellitus and impaired glucose tolerance in South Africa. In: Steyn K, Fourie J, Temple N, editors. *Chronic diseases of lifestyle in South Africa: 1995-2005*. Cape Town: South African Medical Research Council, 2006; p. 109-121.
- Matsha TE, Hassan MS, Kidd M, Erasmus RT. The 30-year cardiovascular risk profile of South Africans with diagnosed diabetes, undiagnosed diabetes, pre-diabetes or normoglycaemia: Bellville, South Africa pilot study. *Cardiovasc J Afr*. 2012;23(1):5-11.
- Diabetes. World Health Organization [homepage on the Internet]. 2008. c2008. Available from: <http://www.who.int/mediacentre/factsheets/fs312/en/>
- Mathew T, Corso O. Early detection of chronic kidney disease in Australia: which way to go? *Nephrology (Carlton)*. 2009;14(4):367-373.
- Chronic Kidney Disease Prognosis Consortium, Matsushita K, van der Velde M, et al. Association of estimated glomerular filtration rate and albuminuria with all-cause and cardiovascular mortality in general population cohorts: a collaborative meta-analysis. *Lancet*. 2010;375(9731):2073-2081.
- Gerstain HC, Mann JF, Yi Q, et al. Albuminuria and risk of cardiovascular events, death and heart failure in diabetic and non-diabetic individuals. *JAMA*. 2001;286(4):421-26.
- Palmer AJ, Valentine WJ, Chan R, et al. A health economic analysis of screening and optimal treatment of nephropathy in patients with type 2 diabetes and hypertension in the USA. *Nephrol Dial Transplant*. 2008;23(4):1216-1223.
- Glasscock RJ. Should microalbuminuria ever be considered as a renal endpoint in any clinical trial? *Am J Nephrol*. 2010;31(5):462-465.
- Weir MR, Bakris GL. Should microalbuminuria ever be considered as a renal endpoint in any clinical trial? *Am J Nephrol*. 2010;31(5):469-470.
- National guidelines: new revised guidelines for the management of type 2 diabetes mellitus (non-insulin dependant diabetes mellitus) at primary healthcare level in South Africa. SEMDSA [homepage on the Internet]. c2008. Available from: <http://www.semDSA.org.za/dessa/information.htm>
- IDF African Region Task Force. *Type 2 diabetes clinical practice guidelines for Sub-Saharan Africa*. Dar es Salaam: International Diabetes Federation Africa Region; 2006.
- National Collaborating Centre for Chronic Conditions. *Type 2 diabetes: national clinical guideline for management in primary and secondary care (update)*. London: Royal College of Physicians; 2008.
- Martell R, Van Vuuren U. *Metro District Health Services Diabetic Audit 2005-2007*. Cape Town: Provincial Government of the Western Cape; 2007.
- Mash B, Levitt N, Van Vuuren U, Martell R. Improving the diabetic annual review in primary care: an appreciative inquiry in the Cape Town District Health Services. *S Afr Fam Pract*. 2008;50(5):50-50d.
- Rippin JD, Barnett AH, Bain SC. Cost-effective strategies in the prevention of diabetic nephropathy. *Pharmacoeconomics*. 2004;22(1):9-28.
- National Institutes of Health, US Department of Health and Human Services. *United States Renal Data System (USRDS). 2007 Annual Data Report*. Bethesda: National Institutes of Health; 2007.
- Scheid DC, McCarthy LH, Lawler FH, et al. Screening for microalbuminuria to prevent nephropathy in patients with diabetes: a systematic review of the evidence. *J Fam Pract*. 2001;50(8):661-668.
- Li R, Zhang P, Barker LE, et al. Cost-effectiveness of interventions to prevent and control diabetes mellitus: a systematic review. *Diabetes Care*. 2010;33(8):1872-1894.