Quality Indicators for the Detection and Management of Chronic Kidney Disease in Primary Care in Canada

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Abstract

Background
Detection and management of chronic kidney disease (CKD) lie within primary care; however, CKD performance measures applicable in the Canadian context are lacking.

Methods
We used a modified Delphi panel approach to develop a set of quality indicators for the detection and management of CKD in the primary care setting and then applied those indicators to primary care electronic medical records in the Electronic Medical Record Administrative data Linked Database (EMRALD) to assess the current state of primary care detection and management of CKD in Ontario.

Results
Delphi panelists agreed upon 17 primary care CKD quality indicators. After application in 140,147 adult patients in EMRALD we found that 4.9% of the adult population had stage 3+CKD with the average age being 76.1 years (SD 11.0) and 62.9% female. Family physicians were not prescribing non-steroidal anti-inflammatories, not prescribing angiotensin converting enzyme inhibitors and angiotensin receptor blockers concomitantly and appropriately monitoring the estimated glomerular filtration rates (eGFRs) and blood pressures in their CKD patients. However physicians may not be recognizing their CKD patients as 69.9% of patients with CKD did not have documentation of this in their active problem list or past medical history fields in their electronic medical records. Additionally we found that physicians were not performing repeat testing of abnormal eGFRs and not performing albumin to creatinine ratio testing when indicated.

Interpretation
We propose a measurement set for evaluating the quality of primary CKD care, and identified opportunities to improve current practices in Ontario using targeted interventions.

Introduction

Chronic kidney disease (CKD) is common. The median prevalence of CKD among adults aged 30 or older is estimated to be 7.2%, and between 23.4% to 35.8% for people over 64.[1] CKD has a prevalence similar to diabetes[2] and engenders at least the same amount of risk for cardiovascular events and mortality[3-6] yet does not get as much attention with respect to quality improvement. Studies in Canada,[7,8] the US,[9-11] UK[12,13] and Australia[14,15] have universally identified gaps in care and knowledge about CKD among patients and providers in both primary care and specialist settings.

Many countries have guidelines for the management of CKD[16-18] including Canada.[19] In 2014, the Kidney Disease Improving Global Outcomes (KDIGO) group published international CKD guidelines.[20] CKD-related measures are not currently included in the American Healthcare Effectiveness Data and Information Set (HEDIS) measures[21] and the Quality and Outcomes Framework (QOF) in the UK includes only one measure specific to CKD.[22] National primary care quality indicators in Canada[23] currently include no CKD-related measures.

Thus we set out to 1) develop a set of primary care quality indicators for CKD in the Canadian setting and 2) assess the current state of CKD detection and management in the primary care setting, using electronic medical record (EMR) data from a representative sample of Ontario physicians and patients.

Methods

Quality Indicator Selection

We used a modified Delphi approach to establish a CKD quality indicator measurement set for primary care. First we used a multi-faceted search strategy of the peer-reviewed and grey literature sources to identify CKD-related measures used by other organizations. Then we performed a focused search to identify high quality clinical practice guidelines, using AGREE

II[24] criteria, specific to the diagnosis and management of CKD, from which we extracted recommendations for consideration by the Delphi panel as evidentiary support for the identified measures. We did not use recommendations from clinical practice guidelines to develop new indicators. (see Appendix A for details on search strategy)

We identified 174 measures published by 26 sources (see Figure 1). Our project clinical leads in primary care (KT) and nephrology (GN) reviewed these measures for relevance to CKD in the primary care setting, and retained 89 (Appendix B) for prioritization by a Delphi panel.

We recruited 20 panel members from across Canada. Ten were family physicians, seven were nephrologists with clinical and methodological expertise, a patient, a primary care nurse and a pharmacist for participation in a modified Delphi process. Each panel member completed a Conflict of Interest and Consent Form. Panelists completed three rounds of ratings of candidate measures using a web-based tool and a criteria matrix based on an adaptation from previously established criteria[25,26] (Figure 2). Panelists participated in one webinar after the first round, to allow for discussion and consensus building. Panelists provided qualitative feedback during the review, and could propose new measures. Measures were excluded at each round according to the criteria in Figure 3. Panelists reviewed their own responses, the panel's aggregate responses and qualitative feedback at each round. The study team considered qualitative feedback and Canadian practice guidelines in modifying selected candidate measures to align with Canadian standards (e.g. blood pressure targets). Following three rounds of rating and the webinar, indicators that met the 'inclusion' criteria (see Figure 3) were reviewed by the panel and clinical leads for face validity and comprehensiveness to derive the final measurement set.

Measurement of Quality Indicators

Using our final measurement set, we performed a current state analysis of CKD detection and management practices in a convenience sample of Ontario residents and physicians. We used the Electronic Medical Record Administrative data Linked Database (EMRALD), which captures clinically relevant data contained in nearly 400 family physician EMRs distributed across Ontario. The representativeness of EMRALD patients and physicians along with the quality and comprehensiveness of EMRALD data has been previously found to be generally reflective of the Ontario population.[27,28]

In order to operationalize our measures using EMR data, we introduced a number of additional specifications. We included patients > 18 years at index date with and an EMR record that began at least one year prior to the extraction of the EMR data in the summer/fall of 2014. For indicators for patients with CKD, we identified patients with stage 3+ CKD as having a most recent eGFR <60 mL/min/1.73m^2 and a second abnormal reading at least three months prior. We excluded patients with CKD receiving dialysis as documented in the cumulative patient profile. For the first indicator, 'The primary care provider can identify patients' in their practice aged 18 or over with CKD', the proxy EMR measure was a recording of CKD or it's synonyms in the cumulative patient profile, a searchable EMR module which contains a 'history of past health' and active 'problem list'. For the two indicators that were written as '…initial eGFR <60 mL/min/1.73m^2...', we defined 'initial' as the first eGFR at least six months prior to the date the data was extracted to allow for at least six months to look for a repeat test or albumin/creatinine ratio (ACR) test. For the 'percentage of patients with CKD that had a serum potassium test 7-30 days after the initial angiotensin converting enzyme (ACE) inhibitor /angiotensin II receptor blocker (ARB) prescription', we only included patients with ACE inhibitor/ARB prescriptions after a full year of no ACE inhibitor/ARB prescription, thus ensuring new-user status among individuals in the denominator. For the indicator 'percentage of patients with CKD

simultaneously receiving both an ACE inhibitor and an ARB', the numerator only included patients that received a prescription for both types of medications on the same day.

We used validated methods for identifying patients with diabetes[29,30] and included patients with hypertension that had: 1) hypertension recorded in their cumulative patient profile, or 2) had an elevated blood pressure and a prescription for an antihypertensive on the same day and a prescription for an antihypertensive in the past 18 months, or 3) met Canadian Hypertension Education Program Criteria for hypertension at any time in their EMR record and an elevated blood pressure or antihypertensive prescription in the past 18 months. This algorithm had a sensitivity of 81.1%, specificity 97.7%, positive predictive value 93.2% and negative predictive value of 93.1% in a validation study of 969 randomly selected adults comparing EMRALD with chart-abstracted data.[31-33]

All analyses were done in SQL Server Management Studio 2012. The Sunnybrook Health Sciences Research Ethics Board approved both phases of the project.

Results

The response rate for all three of the rating rounds of the panel process was 100%. Seventeen indicators made up the final list with one under the category Prevalence, Incidence and Mortality, four under Screening, Diagnosis and Risk Factors, eleven under Management and one under Referral to a Specialist (Table1). There were two categories, System Level and Lifestyle for which no indicators met the inclusion criteria. The panel acknowledged through discussion that though important, System Level indicators are likely outside of the family physicians' control. Lifestyle-related indicators (e.g. smoking cessation, dietary, exercise counselling) did not get included as the panel rated them low in feasibility to measure in the EMR.

Overall, of the 140,147 eligible adult patients in EMRALD, 101,561 (72.5%) had at least one eGFR in their chart and although only 76935 (54.9%) of patients had at least two eGFRs recorded in their chart, 16585 of 17299 (95.9%) of the patients with an eGFR <60 mL/min/1.73m^2 had at least 1 additional eGFR test. There were 154 dialysis recipients and 6848/139993 (4.9%) had stage 3+ CKD. The average age of the EMRALD cohort was 50.0 years (SD 18.3) with 57.2% female; the average age of our stage 3+ CKD cohort in EMRALD was 76.1 years (SD 11.0) with 62.9% being female. The average duration of the EMR record was 5.8 years (SD 2.9). Among our patients with stage 3+ CKD, 32.9% had diabetes and 70.3% had hypertension compared to 10.6% with diabetes and 23.1% with hypertension in our general EMRALD population.

Family physician performance was highest in avoiding NSAIDS, avoiding simultaneous prescription of ACE inhibitors and ARBs, and measuring eGFR and blood pressure in patients with stage 3+ CKD, with over 80% adherence in these measures (See Table 2). As well, over 70% of patients with a clinical indication were on an ACE inhibitor or ARB and had an eGFR measured if at high risk for CKD. Less than 70% of applicable patients had a referral to a nephrologist, had an influenza vaccine, met blood pressure targets, were on a statin, or had a potassium test 7 to 30 days after initiation of an ACE inhibitor or ARB. Less than 50% of patients at risk for CKD had an ACR done, had their CKD documented in their cumulative patient profile, had a repeat of their initial eGFR < 60 mL/min/1.73m^2 within six months or had an ACR in patients at risk for CKD.

Interpretation

Through a modified Delphi process we, established a set of primary care indicators for CKD detection and management in a Canadian context. Additionally, we were able to demonstrate the feasibility of measuring these indicators to gain an understanding of the current

state of the detection and management of CKD in the primary care setting in Ontario. This has allowed us to identify gaps in care and ascertain areas that should be targeted for improvement.

Our measures span a broad range of identified measurement domains and concepts. A US-based panel identified 12 measures for the primary care management of CKD.[34] Most were conceptually similar to ours in terms of identifying important actions in the management of CKD, though differed slightly in their definitions of time frames for actions. Only an annual complete blood count for patients with stage 3b-5 CKD, and avoidance of bisphosphonates in patients with eGFR <30 were included in the US indicators but not in ours. Recently a Japanese team followed a modified Delphi method to identify a set of quality indicators for the care of CKD in the primary care setting.[35] They selected 11 indicators of which seven were conceptually similar to ours, with four measures not included in our set: prevention of contrast induced nephropathy, glycemic control of diabetes in CKD, avoidance of biguanides in diabetes, and quarterly urine testing. With respect to lipid management in CKD, our indicator measured statin prescribing, which is within the provider's control. The US-based panels' indicator required cholesterol testing and the Japanese indicator was based on achieving a cholesterol target, which is not necessarily within the provider's control.

We found the lack of documentation in problem lists or past medical history of CKD by family physicians consistent with other studies identifying the lack of recognition of CKD by primary care physicians.[13,36] Although our indicator methodology differed slightly from previous measures in the primary care setting in the US, we found similar rates of lipid lowering medication use (~60%) and avoidance of NSAID prescribing in CKD.[37]

Our prevalence rates for stage 3+ CKD (4.9%) were lower than identified elsewhere but other studies based their CKD diagnosis on a single eGFR measure and did not exclude patients that were on dialysis.[13,37] The higher prevalence of CKD in women that we found was similar to

that found in the United Kingdom and in the US and the rates of diabetes and hypertension were similar to the American rates but higher than that found in the United Kingdom.[13,37]

Our study has some limitations. It was necessary to modify some of the indicators for measurement as we only had laboratory data as far back as the date of creation of each EMR record. Therefore, we could not confirm disease onset and duration as we could not be certain that the first occurrence of eGFR <60 mL/min/1.73m^2 in the EMR was the first ever for a given patient. This limitation required us to redefine 'initial' in indicators measuring repeat testing after the initial eGFR < 60 mL/min/1.73m^2. It is possible that if we had the initial eGFR that our measured performance rate for repeat or ACR testing may have been higher. However, it is unlikely that it would have been significantly higher given the low rate of ACR testing in general. In Ontario the eGFR is typically provided when serum creatinine is ordered and calculated at the laboratory using the Modification of Diet in Renal Disease (MDRD) equation.[38] However the MDRD equation only takes into account white (Caucasian) and African American and does not consider the ethnic diversity of the Ontario population. Ethnicity is not typically provided when the laboratory test is ordered thus it is likely that even the correction factor for African Americans is not applied. The MDRD equation may underestimate eGFR and therefore may have led to an over diagnosis of CKD. More recently in 2015 Ontario laboratories have switched to using the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) equation [39] which is considered to be more accurate especially for females and the younger population but this change occurred after the conduct of this analysis. It is also possible that influenza vaccines were given to patients but not recorded in the EMR record as patients in Ontario may receive influenza vaccines outside of the family physician office, for instance in shopping malls, pharmacies or public health units and the completeness of this recording in EMR records is unknown. Additionally, we did not have access to medication duration and precise medication discontinuation dates and therefore we were required to make estimates on timing and duration

for medication indicators. We have been unable to identify similar CKD quality indicator measurement in other provinces in Canada, however it is hopeful with the release of these indicators, other provinces may be able to do comparable analysis in the future. Last we are limited by identifying patients with CKD through the lab tests in the EMR, and it is likely that laboratory tests ordered by specialists or in hospital are not accounted for in our analysis.

We have developed a set of quality indicators for the detection and management of CKD that are feasible to measure. Through our application of these indicators to real world primary care EMR data, we have identified areas that need improvement. Next steps for members of our team are to perform a cluster randomized-controlled trial with tools developed to target these identified care gaps.

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Figure 1: Modified Delphi Panel Process

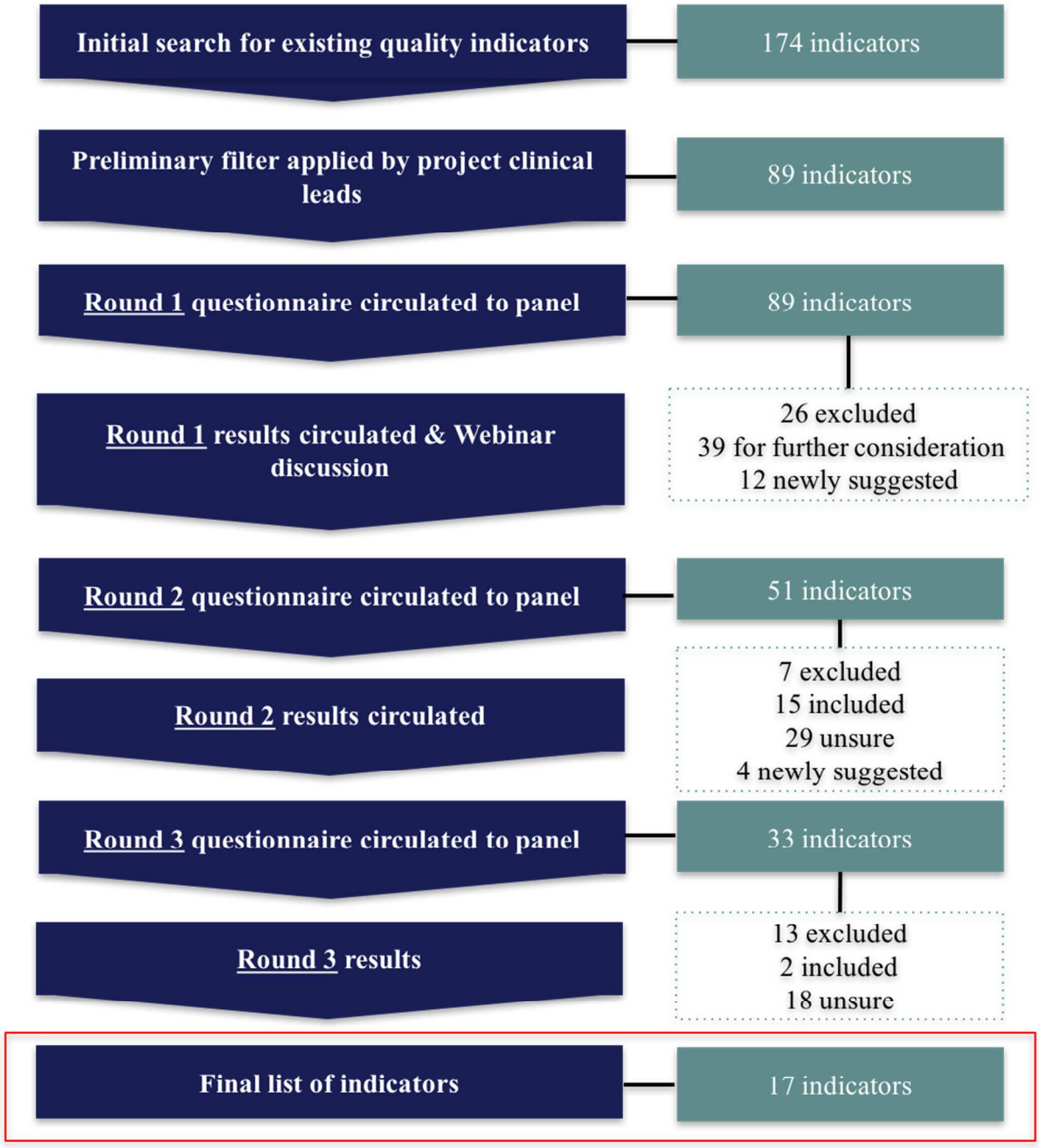

Figure 2. Indicator Rating Criteria Matrix

Indicator #: _____

Indicator: _____

Comments on Indicator:

Please rate this indicator in terms of the following statements, where 1 indicates that you *Definitely Disagree* with the statement and 9 indicates that you *Definitely Agree*. Please circle/select one number for each statement.

	Definitely Disagree				**Uncertain/ Equivocal**				**Definitely Agree**
1. Useful in Improving Patient Outcomes									
a. Evidence-based: evidence supports a link between this indicator and positive patient outcomes.	1	2	3	4	5	6	7	8	9
b. Interpretable: the results of the measure are interpretable by practitioners.	1	2	3	4	5	6	7	8	9
c. Actionable: the measure addresses an area that is under the practitioner's control.	1	2	3	4	5	6	7	8	9
d. Room for Improvement: this indicator can detect current gaps in primary CKD care.	1	2	3	4	5	6	7	8	9
2. Measure Design									
a. Validity: the measure appears to measure what it is intended to.	1	2	3	4	5	6	7	8	9
b. Reliability: the measure is likely to be reproducible across organizations and delivery settings.	1	2	3	4	5	6	7	8	9
3. Measure Implementation									
a. Feasibility: the data required for the indicator is likely to be obtained with reasonable effort at the primary care level.	1	2	3	4	5	6	7	8	9
4. Overall Assessment									
a. Overall: overall this indicator has strong utility for CKD quality of care in primary care.	1	2	3	4	5	6	7	8	9

Overall Comments:

Figure 3. Filter Criteria

Exclusion Criteria:
- 75% or more of panel member ratings to the "overall" criteria fell within the bottom 2 tertiles (between 1 and 6 on 9-point Likert scale)

OR

- 75% or more of panel members' composite ratings (sum of ratings for all 7 sub- criteria) fell within the bottom 2 tertiles (7-48)

Inclusion Criteria:
- 75% or more of panel member ratings to the "overall" criteria fell within the top tertile (between 7 and 9 on 9-point Likert scale)

OR

- 75% or more of panel members' composite ratings (sum of ratings for all 7 sub- criteria) fell within the top tertile (49-63)

AND

- Median "overall" score 7 or greater

Table 1. Quality Indicators Resulting from Delphi Panel Process

Prevalence, Incidence & Mortality
1. The primary care provider can identify patients in their practice aged 18 or over with CKD.
Screening, Diagnosis & Risk Factors
2. Percentage of patients with an initial eGFR<60 mL/min/1.73 m^2 that are followed by a repeat test within six months.
3. Percentage of patients with an initial eGFR<60 mL/min/1.73 m^2 with an ACR conducted within six months.
4. Percentage of patients with risk factors for CKD (diabetes and/or hypertension) with an eGFR in the past 18 months.
5. Percentage of patients with risk factors for CKD (diabetes and/or hypertension) with an ACR in the past 18 months.
Management
6. Percentage of patients with CKD with an eGFR in the past 18 months.
7. Percentage of patients with CKD with an ACR in the past 18 months.
8. Percentage of patients with CKD with a BP recorded in the past 18 months.
9. Percentage of patients with diabetes and albuminuria (moderately or severely increased ACR ≥3 mg/mmol) with a BP recorded in the past nine months.
10. Percentage of patients with CKD with a most recent BP<140/90 mmHg, or with CKD and diabetes with a most recent BP<130/80mmHg.
11. Percentage of patients with diabetes and albuminuria (moderately or severely increased ACR ≥3 mg/mmol) who were prescribed an ACE inhibitor or ARB unless a contraindication or side effects are recorded.
12. Percentage of patients with CKD that had a serum potassium test 7-30 days after initial ACE inhibitor/ARB prescription.
13. Percentage of patients with CKD simultaneously receiving both an ACE inhibitor and an ARB.
14. Percentage of patients with stage 3-5 CKD and a prescription for a NSAID longer than two weeks.
15. Percentage of patients ≥ 50 and ≤ 80 years of age with stage 3-5 CKD on a statin unless contraindicated.
16. Percentage of patients with CKD with an influenza vaccine in the past year unless contraindicated.
Referral to a Specialist
17. Percentage of patients age <80 years with a referral to a Nephrologist for eGFR<30 mL/min/1.73 m^2.

Acronyms

ACE	Angiotensin Converting Enzyme
ACR	Albumin to Creatinine Ratio
ARB	Angiotensin II Receptor Blocker
BP	Blood Pressure
CKD	Chronic Kidney Disease
eGFR	Estimated Glomerular Filtration Rate
NSAID	Non-Steroidal Anti-Inflammatory Drug

Table 2. Results as Applied in Electronic Medical Record Administrative data Linked Database

Quality Indicator	Numerator	Denominator	Percent
Prevalence, Incidence & Mortality			
1. **Patients with stage 3+CKD that have it documented in their cumulative patient profile.***	1856	6848	**27.1%**
Screening, Diagnosis & Risk Factors			
2. **Percentage of patients with an initial eGFR<60 mL/min/1.73 m2 with an eGFR in the +/- 6 months.***	4068	8573	**47.5%**
3. **Percentage of patients with an initial† eGFR<60 mL/min/1.73 m^2 with an ACR in the +/- 6 months.***	1400	8573	**16.3%**
4. **Percentage of patients with risk factors for CKD (diabetes and/or hypertension) with an eGFR in the past 18 months.**	23998	32637	**73.5%**
5. **Percentage of patients with risk factors for CKD (diabetes and/or hypertension) with an ACR in the past 18 months.**	9291	32637	**28.5%**
Management			
6. **Percentage of patients with CKD with an eGFR in the past 18 months.**	6190	6848	90.4%
7. **Percentage of patients with CKD with an ACR in the past 18 months.**	2341	6848	**34.2%**
8. **Percentage of patients with CKD with a BP recorded in the past nine months.**	5692	6848	**83.1%**
9. **Percentage of patients with diabetes and albuminuria (moderately or severely increased ACR ≥3 mg/mmol) with a BP recorded in the past nine months.**	5439	6320	**86.1%**
10. **Percentage of patients with CKD with a most recent BP<140/90 mmHg, or with CKD and diabetes with a most recent BP <130/80 mmHg.**	4465	6848	65.2%
11. **Percentage of patients with diabetes and albuminuria (moderately or severely increased ACR ≥3 mg/mmol) who were prescribed an ACE inhibitor or ARB unless a contraindication or side effects are recorded.**	3734	4997	**74.7%**
12. **Percentage of Patients with CKD that had a serum potassium test 7-30 days after initial ACE inhibitor/ARB prescription.***	2944	4965	59.3%
13. **Percentage of patients with CKD with an ACE inhibitor and an ARB prescription on the same day.***	48	6848	0.7%
14. **Percentage of patients with CKD and ≥ one prescription for a NSAID.***	99	6848	1.4%
15. **Percentage of patients ≥ 50 and ≤ 80 years of age with CKD on a statin unless contraindicated.**	2236	3701	60.4%
16. **Percentage of patents with CKD with an influenza vaccine in the past year unless contraindicated.**	4493	6848	65.6%
Referral to a Specialist			
17. **Percentage of patients age <80 years with a referral to a Nephrologist for eGFR<30 mL/min/1.73m^2.**	339	508	66.7%

*modified to be feasible to measure
†first eGFR< 60 mL/min/1.73 m^2 at least 6 months prior to the EMR load date

Acronyms

ACE	Angiotensin Converting Enzyme
ACR	Albumin to Creatinine Ratio
ARB	Angiotensin Receptor Blocker
BP	Blood Pressure
CKD	Chronic Kidney Disease
eGFR	Estimated Glomerular Filtration Rate
NSAID	Non-Steroidal Anti-Inflammatory Drug

Appendix A. Methodology for Identifying Preliminary Indicators and Supporting Evidence for Chronic Kidney Disease in Primary Care

1. Overview

The purpose of this search was to identify relevant quality indicators for chronic kidney disease in primary care, and to identify high quality clinical evidence to support these indicators. This involved a two-step approach designed to identify:

1. Existing quality indicators which have been established and measured by other organizations
2. Relevant recommendations from high quality clinical practice guidelines

This material was used to develop the preliminary list of indicators presented to the Delphi panel for their input and consideration.

2. Indicator Search Strategy

A multi-faceted approach was used to identify Canadian and international organizations that developed, recommended, or implemented performance indicators in primary care in both the grey literature and indexed, peer-reviewed literature.
This process included:

a. Developing a list of websites for relevant organizations that develop or report on indicators, and searching each website individually
b. Conducting a focused Internet search using Google to locate additional organizations relevant to each topic area, and examining their material to identify additional indicators
c. Conducting a focused search using Ovid MEDLINE to identify any relevant indicators in the indexed literature
d. Review of additional material provided by experts and clinical leads

2.1 Limits and Inclusion Criteria

- The search was limited to English language indicators published in the past 5 years (between November 2008 and December 2013).
- A number of large groups have published reports on indicators, but the data definitions and specific measures were pulled from other sources. Despite some duplication, these results were included at the first stage in order to provide an overview of the general adoption of specific indicators.
- Only published indicators from the most recent source available were included. For example, if information was collected in both 2009 and 2012, only the 2012 indicator was included.
- The search was focused on identifying indicators for chronic kidney disease in primary care. For this reason, indicators which focused only on patients with stage 4 or 5 CKD, end stage renal disease or who are receiving renal replacement therapy, self-reported measures/patient awareness indicators, and measures not specific to CKD (e.g. overall incidence of diabetes) were excluded.

- Indicators that groups reported that they considered, but ultimately discarded, were excluded. For example, if a paper reported a rigorous process to select what they considered to be key indicators, their rejected indicators were not included in our results.

2.2 Search of the Grey Literature for Indicators: List of Relevant Websites Examined

- Agency for Healthcare Research and Quality: http://www.ahrq.gov
- Agency for Healthcare Research and Quality – Quality Indicators: http://www.qualityindicators.ahrq.gov/default.aspx
- Alberta AIM: www.albertaaim.ca
- Alberta Health Services: http://www.albertahealthservices.ca
- Alberta Interactive Health Data Application: http://www.ahw.gov.ab.ca/IHDA_Retrieval/selectCategory.do
- American Medical Association 2013 Physician Quality Reporting System: http://www.ama-assn.org/apps/listserv/x-check/qmeasure.cgi?submit=PQRS%20group
- Australian Commission for Safety and Quality in Health Care: www.safetyandquality.gov.au/
- Australian Institute of Health and Welfare: http://www.aihw.gov.au/
- Australian National Health Performance Framework: http://meteor.aihw.gov.au/content/index.phtml/itemId/392569
- British Columbia Patient Safety and Quality Council: http://www.bcpsqc.ca/
- Canada Health Infoway: http://www.infoway-inforoute.ca/lang-en/
- Canadian Agency for Drugs and Technologies in Health: http://www.cadth.ca/index.php/en/home
- Canadian Foundation for Healthcare Improvement: http://www.cfhi-fcass.ca
- Canadian Institute for Health Information: www.cihi.ca
- Canadian Medical Association: http://www.cma.ca/
- Canadian Society of Nephrology: http://www.gain-ni.org/images/Uploads/Guidelines/Chronic%20Kidney%20Disease.pdf
- Centers for Disease Control and Prevention Chronic Kidney Disease Surveillance System: http://apps.nccd.cdc.gov/CKD/default.aspx
- Centers for Disease Control and Prevention: www.cdc.gov/DataStatistics/
- Centre for Health Services and Policy Research, The University of British Columbia: http://www.chspr.ubc.ca/
- Clinical Excellence Commission: http://www.cec.health.nsw.gov.au/
- The Commonwealth Fund: http://www.commonwealthfund.org/
- European Community Health Indicators: http://ec.europa.eu/health/indicators/echi/list/index_en.htm
- French National Authority for Health: www.has-sante.fr/portail/jcms/c_5443/english?pcid=c_5443
- Government of Saskatchewan, Ministry of Health: www.health.gov.sk.ca
- Heath Canada: http://www.hc-sc.gc.ca/index-eng.php
- Health Council of Canada: http://www.healthcouncilcanada.ca/

- Health Council of the Netherlands: www.gezondheidsraad.nl/en
- Health Indicators Warehouse: http://healthindicators.gov/
- Health Quality Council of Alberta: http://www.hqca.ca/index.php?id=%20229
- Health Quality Ontario: http://www.hqontario.ca/
- The Information System of the Federal Health Monitoring: http://www.gbe-bund.de/gbe10/pkg_isgbe5.prc_isgbe?p_uid=gastd&p_aid=53878946&p_sprache=E
- Institute for Clinical Evaluative Sciences: http://www.ices.on.ca/
- International Society for Quality in Health Care: http://www.isqua.org/
- Manitoba Centre for Health Policy: http://umanitoba.ca/medicine/units/mchp/
- Manitoba Health: http://www.gov.mb.ca/health/index.html
- Manitoba's Physician Integrated Network Quality Measurement: http://www.gov.mb.ca/health/primarycare/pin/qm.html
- Ministry of Health and Long Term Care: http://www.health.gov.on.ca/en/
- National Health Service Atlas of Variation in Healthcare for People with Kidney Disease: http://www.rightcare.nhs.uk/index.php/atlas/kidneycare
- National Health Service Outcomes Framework: http://www.hscic.gov.uk/nhsof
- National Health Service Quality Improvement Scotland: http://www.nhshealthquality.org/nhsqis/CCC_FirstPage.jsp
- National Centre for Health Outcomes Development: http://www.nchod.nhs.uk/
- National Committee for Quality Assurance: http://www.ncqa.org/
- National Institute for Health and Clinical Excellence: http://www.nice.org.uk/
- National Institute for Health Research: http://www.nihr.ac.uk/
- National Kidney Foundation Kidney Disease Outcomes Quality Initiative: http://www.kidney.org/professionals/KDOQI/
- National Quality Forum: http://www.qualityforum.org/Home.aspx
- National Quality Measures Clearinghouse: http://www.qualitymeasures.ahrq.gov/
- New Brunswick Health Council: http://www.nbhc.ca/
- New Zealand Ministry of Health: http://www.moh.govt.nz/moh.nsf
- Newfoundland and Labrador Department of Health and Community Services: http://www.health.gov.nl.ca/health/
- National Institute for Health and Clinical Excellence Chronic Kidney Disease Quality Standard: http://publications.nice.org.uk/chronic-kidney-disease-quality-standard-qs5/list-of-statements
- National Institute for Health and Clinical Excellence Clinical Commissioning Group Outcomes Indicator Set (formerly known as the 'Commissioning Outcomes Framework' or 'COF'): http://www.nice.org.uk/aboutnice/ccgois/CCGOIS.jsp
- National Institute for Health and Clinical Excellence Quality Standards: http://guidance.nice.org.uk/qualitystandards/qualitystandards.jsp
- Northwest Territories Department of Health and Social Services: http://www.hlthss.gov.nt.ca/
- Nova Scotia Department of Health: http://www.gov.ns.ca/health/

- Nuffield Trust for Research and Policy Studies in Health Services: http://www.nuffieldtrust.org.uk/
- Nunavut Health and Social Services: http://www.gov.nu.ca/health/
- Organization for Economic Co-operation and Development Health Care Quality Indicators Project: http://www.oecd.org/health/health-systems/healthcarequalityindicators.htm
- Ontario Renal Network: http://www.renalnetwork.on.ca/
- Organization for Economic Co-Operation and Development: http://www.oecd.org/home/0,3305,en_2649_201185_1_1_1_1_1,00.html
- Prince Edward Island Department of Health and Wellness: http://www.gov.pe.ca/health/index.php3
- Pan American Health Association: http://new.paho.org/
- Public Health Agency of Canada Canadian Best Practices Portal Health Indicators: http://cbpp-pcpe.phac-aspc.gc.ca/resources/health-indicators/
- Public Health England Health Profiles Indicator Guide: http://www.apho.org.uk/resource/item.aspx?RID=127372
- Québec Ministère de la Santé et des Services Sociaux: http://www.msss.gouv.qc.ca/en/index.php
- The RAND Corporation: http://www.rand.org/
- Royal College of Physicians and Surgeons of Canada: http://rcpsc.medical.org/
- Royal College of Physicians London: http://www.rcplondon.ac.uk/Pages/index.aspx
- Saskatchewan Health Quality Council: www.hqc.sk.ca
- Statistics Canada: http://www.statcan.gc.ca/
- United States Department of Health and Human Services Measure Inventory: http://www.qualitymeasures.ahrq.gov/hhs/inventory.aspx#browseType=current
- United States Renal Data System Annual Data Report: http://www.usrds.org/adr.aspx
- United Kingdom Quality and Outcomes Framework: http://www.nice.org.uk/aboutnice/qof/qof.jsp
- United States Renal Data System: http://www.usrds.org/
- World Health Organization: http://www.who.int/en/
- World Health Organization Statistical Information System: www.who.int/whosis/indicators/en/
- Yukon Health and Social Services: http://www.hss.gov.yk.ca

2.3 Search of the Grey Literature for Indicators: Supplemental Internet Search

General Google search: (indicator* OR measure* OR quality measure) and (chronic kidney disease or CKD). The first three pages of results were examined for each search except for searches combining the term “chronic kidney disease” which returned more relevant results, so the review was expanded to include the first five pages of results.

2.4 Search of Indexed Literature for Indicators: Ovid MEDLINE Search

<1996 to November Week 3 2013>

1 Quality of Health Care/ or Quality Assurance, Health Care/ or Total Quality Management/ or Health Status Indicators/ or Quality Indicators, Health Care/ or "Outcome and Process

Assessment (Health Care)"/ or "Outcome Assessment (Health Care)"/ or "Process Assessment (Health Care)"/ (150619)
2 (indicator$ or (quality adj assess$) or (quality adj care) or (logic adj model$) or (health adj improve$) or (quality adj metric$) or (quality adj measur$) or (quality adj improvem$) or (quality adj report$) or (assessment adj criteria) or (care adj evaluat$) or framework or (performance adj measure$) or (system$ adj performance)).ab,ti. (218826)
3 renal insufficiency, chronic/ or kidney failure, chronic/ or ("kidney disease$" or "renal disease$" or CKD).mp. (98743)
4 1 and 2 and 3 (304)
5 limit 4 to (english language and yr="2008 -Current") (129)
Notes regarding search terminology:

- Capitalized terms followed by a / indicate MeSH terms
- .m_titl indicates that the terms are being searched in the title field
- .mp indicates that the terms are being searched in multiple fields, including the title, abstract or MeSH field
- $ is a "wildcard" that allows for truncation (eg. improve$ will return results for improvement, improves, etc.)
- adj indicates that two terms need to be adjacent to each another, in either direction. (eg. quality adj assess$ will return results for 'quality assessment' and 'assessing quality', etc.)

3. Selecting and Compiling Preliminary Indicator List

174 existing quality indicators were identified using the search strategy outlined above. These indicators were reviewed by two clinical leads (GN, KT) who identified where indicators were similar enough that they could be combined. Original phrasing was maintained where possible, and if multiple quality indicators were similar enough to be combined into one, the indicator with the most specific details was the one which was preserved. When indicators were combined, all references supporting the measure were maintained to show that multiple organizations considered it an important measure of quality. For example, the indicators "Proportion of CKD patients with a formal assessment of cardiovascular risk factors documented in their records during the past year" and "Proportion of people with CKD who are assessed for cardiovascular risk" were combined into one indicator, maintaining the wording of the first, while providing the references for both.

If there was agreement between both clinical leads that an indicator was out of scope, then it was removed from the list. If only one clinical lead suggested an indicator be removed, it was still maintained at this stage. None of the indicators were modified at this stage to make them more feasible to measure in an EMR, as it was agreed by the project team that this would happen at a later step in the process if necessary.

This first review by the clinical leads to combine duplicate measures, and to exclude indicators which both agreed were out of scope, resulted in the list being focused to 102 quality indicators.

4. Clinical Evidence Search Strategy

A focused search strategy was designed that concentrated on quickly identifying high quality clinical practice guidelines by searching the following resources:

4.1 Guideline Repositories:

- National Guideline Clearinghouse: www.guideline.gov/

- Canadian Medical Association Clinical Practice Guideline Infobase: http://mdm.ca/cpgsnew/cpgs/index.asp

4.2 Renowned Developers with Proven Methodologies:[1]

- United States Preventive Services Task Force: www.uspreventiveservicestaskforce.org/
- Scottish Intercollegiate Guidelines Network: www.sign.ac.uk/guidelines/index.html
- New Zealand Guidelines Group: www.nzgg.org.nz
- Institute for Clinical Systems Improvement: www.icsi.org/

4.3 Supplemental Internet Search:

- Relevant Canadian and international organizations in the area:
    - Canadian Society of Nephrology: www.csnscn.ca/
    - International Society of Nephrology: www.csnscn.ca/
    - The Renal Association: www.renal.org
    - The Kidney Foundation of Canada www.kidney.ca
    - National Kidney Foundation www.kidney.org
    - Kidney Disease Improving Global Outcomes www.kdigo.org
    - British Renal Society www.britishrenal.org
    - Renal Society of Australasia www.renalsociety.org
    - European Renal Association www.era-edta.org
    - American Society of Nephrology www.asn-online.org
    - Ontario Renal Network www.renalnetwork.on.ca
    - British Columbia Renal Agency www.bcrenalagency.org
- Search for additional guidelines using Google: ("kidney" or "renal") and "guideline(s)", the first five pages of results were examined.

All results were limited to English language resources published in the past five years (between November 2008 and December 2013).
Results identified in this manner were evaluated using criteria from the Rigour of Development domain of the AGREE II Instrument,[24] a validated instrument for assessing the quality of clinical practice guidelines. This ensures that relevant evidence was considered during guideline development, and that the recommendations in the guideline are linked directly to levels of evidence. Guidelines which were identified that satisfied these criteria were then reviewed using the AGREE II Instrument, and the most methodologically sound guidelines which addressed the full scope of CKD care in primary care were selected to form the evidence base supporting the indicators.

[1]Note: Guidelines published by these key developers are also indexed in the National Guideline Clearinghouse, but there is a delay between publishing and indexing. This search strategy is designed to ensure that guidelines from these reputable developers are considered.

Appendix B. Original List of Indicators for Chronic Kidney Disease Identified in the Literature Search

#	Indicator
1.0 Prevalence & Incidence	
1	The contractor can identify patients aged 18 or over with CKD [10, 11].
2	Diagnosis of stages 1–5 CKD [2, 3, 8, 19] (e.g. age, gender).
3	Diagnosis of CKD by comorbidity [2, 8] (e.g. subgroups can be listed in the notes: diabetes, hypertension, CV disease) [8].
4	Incidence of stages 1–5 CKD by eGFR (kidney function) and by demographics and risk factor categories (diabetes, hypertension, cardiovascular disease,obesity, age, and gender) [2, 19].
5	Prevalence of overall CKD, and prevalence by demographics and risk factor categories (diabetes, hypertension, cardiovascular disease, obesity (BMI >=30)), and by CKD stage (eGFR<60 and ACR>=30) [8, 19].
6	CKD patients (all CKD, CKD patients eGFR<60, and CKD patients ACR >=30) with glycohemoglobin<7% [8].
7	Proportion of CKD patients moving stage over time [2].
8	Proportion of CKD patients moving to ESRD over time [2].
9	Progression of CKD by demographic characteristics [2].
10	Progression of decreased renal function by level of proteinuria [2].
1.1 Mortality	
11	All-cause mortality rates [2].
12	All-cause mortality by eGFR and albuminuria [19].
13	All cause mortality rates by eGFR category/stage [19].
2.0 Screening, Diagnosis & Risk Factors	
14	Proportion of patients (without CKD diagnosis) with eGFR<60 where there is evidence of a repeat creatinine test and a proteinuria test within 3 months (or 6 months) [21].
15	Proportion of initial abnormal estimated GFR results that are followed by a repeat test within 2 weeks and a further test at 90 days (where appropriate) [14].
16	Proportion of patients screened for CKD who have had (a) an assessment of estimated GFR, (b) urinalysis, (c) both an assessment of estimated GFR and urinalysis [14].
17	Proportion of patients with CKD stage 3 or worse in whom the diagnosis has been confirmed by two estimated GFR readings, at least 90 days apart [14].
18	Proportion of patients with a diagnosis of microalbuminuria in whom the diagnosis has been confirmed with at least 2 abnormal results [14].
19	Prevalence of NSAID use among persons with and without CKD in the general population [19].
20	Proportion of CKD patients with a formal assessment of cardiovascular risk factors documented in their records during the past year [7, 14].
21	Percentage of physicians reporting the perceived risk factors that increased CKD risk [19].
3.0 Management	
22	Proportion of patients with a confirmed diagnosis of CKD in whom the rate of change in GFR has been evaluated with at least 3 assessments of GFR over not less than 90 days [14].

23	Proportion of patients with CKD with regular monitoring of the estimated GFR at the frequency recommended by NICE or local guidelines [14].
24	Measurement of eGFR every 6 months in patients with Stage 3 CKD [20].
25	Proportion of CKD patients with eGFR< 30ml/min with an annual Hb level [14].
26	Complete blood count measured annually for all patients with Stage 3b-5 CKD (eGFR<45) [20].
27	Percent of persons 65 years of age and over with CKD who receive medical evaluation with serum creatinine, lipids, and microalbuminuria [4].
28	Proportion of CKD patients who have serum creatinine and urine protein tests at least annually [21].
29	Proportion of CKD patients who had a serum creatinine test prior to and 7-10 days after initial ACEI/ARB prescription. [21].
30	Proportion of CKD patients who had a serum potassium test 7-14 days after initial ACEI or ARB prescription [21].
31	Proportion of CKD patients who were prescribed an ACEI or ARB [21].
32	Percentage patients 18 and older with CKD who have had a urine albumin:creatinine ratio (or protein:creatinine ratio) test in the preceding 12 months [11].
33	Percentage patients 18 and older with CKD who have a record of an albumin: creatinine ratio (or protein: creatinine ratio) value in the previous 15 months [11].
34	Probability of urine albumin, creatinine testing or both in patients at risk for CKD, by risk factor (diabetes, and hypertension) [2, 7, 14, 18].
35	Proportion of patients with CKD who have had a measurement of proteinuria within the previous 12 months [14, 15].
36	Proportion of patients with proteinuria equivalent to <0.5 g/day in whom the result has been confirmed with a repeat test performed on an early morning urine specimen [14].
37	Proportion of CKD patients and proteinuria who achieve a decrease in proteinuria to <0.5 g/day [14].
38	Percentage of physicians reporting that clinical guidelines influence their treatment of CKD [19].
39	Percentage of patients with assessment of cognitive function among adults with CKD by kidney function [19].
40	Avoidance of non-steroidal anti-inflammatory drugs or COX-2 inhibitors in patients with Stage 3-5 CKD [20].
41	Proportion of people with CKD who have a current agreed care plan appropriate to the stage and rate of progression of CKD [7].
42	Evidence of local arrangements to ensure that people with CKD who become acutely unwell have their medication reviewed, and receive an assessment of volume status and renal function [7].
3.1 Hypertension & Chronic Kidney Disease	
43	Blood pressure recorded in six months for patients with CKD [20].

44	Percentage of patients 18 and older with CKD who have a record of blood pressure measurement in the previous 15 months [11].
45	Percentage of patients 18 and older with CKD in whom the last blood pressure reading, measured in the previous X months, is 140/85 or less [10, 11, 13].
46	CKD patients (all CKD, CKD patients eGFR<60, and CKD patients ACR >=30) at target blood pressure [2, 8, 19].
47	Proportion of patients with CKD and follow-up for at least 6 months, whose last recorded BP was within the target range specified unless specifically contraindicated. (SBP should be lowered to <140 mmHg (target range 120-139mmHg) and the DBP to <90mmHg for the majority. For those with diabetes mellitus or proteinuria of 1g/24 hours or greater, the SBP should be lowered to <130 mmHg (target range 120-129mmHg) and the DBP to <80mmHg unless the risks are considered to outweigh the potential benefits) [14].
48	Proportion of patients with CKD and hypertension, followed up for at least 6 months, with a systolic blood pressure <120mmHg in the absence of cardiac failure [14].
49	Proportion of people with higher levels of proteinuria with a recording of blood pressure in the previous 9 months [7].
50	Proportion of people with higher levels of proteinuria with a recording of blood pressure in the previous 9 months, whose latest systolic blood pressure reading is in the range 120–129 mmHg and diastolic blood pressure below 80 mmHg [7].
51	Most recent BP <140/90 mmHg for patients with CKD without proteinuria, Most recent BP <130/80 mmHg for patients with CKD with proteinuria (Proteinuria defined as albumin to creatinine ratio >300 mg/g or >300 mg of albumin in the urine per 24 hrs or protein to creatinine ratio >0.3 mg/g) [20].
52	Proportion of proteinuric CKD patients without contraindications who have an ACEI or ARB on their last recorded list of chronic medications [14].
53	Prescription of ACE-Inhibitor or Angiotensin Receptor Blocker recorded in past year for patients with CKD and hypertension with proteinuria [20].
54	Percentage of patients with CKD, age 18 and older, with hypertension and proteinuria who are treated with an angiotensin converting enzyme inhibitor (ACE-I) or angiotensin receptor blocker (ARB) (unless a contraindication or side effects are recorded) [10, 11, 13, 14].
55	Utilization of medications for hypertension [2].
3.2 Diabetes & Chronic Kidney Disease	
56	eGFR measured in past year for patients with diabetes and/or hypertension [20].
57	People with diabetes who have received nine care processes at their annual health check: weight and BMI measurements, blood pressure, smoking status, blood test (HbA1c or blood glucose levels), urinary albumin test (or protein test to measure kidney function), serum creatinine test (indicator for renal function), cholesterol levels , eye check (retinopathy screening) , foot check [5].

58	In patients with type 2 diabetes: laboratory values at the most recent clinic visit (serum creatinine, hemoglobin, hemoglobin A1c, ferritin, albumin, phosphate, calcium, alkaline phosphates, low-density lipoprotein) [12].
59	Percent of persons 65 years of age and over with type 1 or type 2 diabetes and chronic kidney disease who receive medical evaluation with serum creatinine, microalbuminuria, HbA1c, lipids, and eye examinations [4].
60	In patients with type 2 diabetes: blood pressure at the most recent clinic visit [12].
61	Proportion of people with diabetes and microalbuminuria with a recording of blood pressure in the previous 9 months. [7].
62	Proportion of people with diabetes and microalbuminuria with a recording of blood pressure in the previous 9 months, whose latest systolic blood pressure reading is in the range 120–129 mmHg and diastolic blood pressure below 80 mmHg [7].
63	Proportion of patients with diabetes mellitus and microalbuminuria (without specific contraindications) who had an ACEI or ARB on their last recorded list of chronic medications [4, 13, 14].
64	Proportion of patients receiving an ACEI or ARB for diabetes and microalbuminuria who received the maximum licensed antihypertensive dose (or maximum dose tolerated without hypotension) on their most recent prescription. [14].
65	Percentage of patient population, age 18 and older, with diabetes mellitus who received testing for nephropathy screening (for example, albumin/creatinine ratio, microalbuminuria) within the past 12 months [1].
66	Proportion of patients with diabetic nephropathy and follow-up for at least 6 months, whose last recorded HBA1C was below their agreed target [14].
67	Average HBA1C of all patients with diabetes mellitus and CKD [14].
68	Record of glycated haemoglobin concentrations in IFCC (mmol/mol) and HBA1C% [14].
3.3 Lipids	
69	Percentage of patients aged 18 years and older with a diagnosis of CKD (stage 3, 4 or 5, not receiving renal replacement therapy) who had a fasting lipid profile performed at least once within a 12-month period [9, 17, 20].
70	Cholesterol concentrations in patients prescribed HMG CoA reductase inhibitors [14].
71	Record of prescribed statins allied to indications and comorbidities of patients [14].
3.4 Cardiovascular Disease & Chronic Kidney Disease	
72	Cardiovascular disease & pharmacological interventions , by CKD status (all CKD, stage 1-2, stage 3, stage 4-5): ACEI/ARB, Beta blocker [8].
73	Percentage of patients with a diagnosis of stable coronary artery disease and chronic kidney disease who are prescribed an ACE inhibitor or ARB [6].
74	Cardiovascular disease (CHF, AMI, Stroke, CHF and AMI, CHF and Stroke, AMI and Stroke, CHF and AMI and Stroke) in patients with CKD [8].
75	Heart failure in patients with or without CKD (systolic, diastolic, systolic and diastolic, unspecified) [8].

3.5 Lifestyle	
76	The percentage of patients with CKD whose notes record smoking status in the preceding 12 months [10, 14].
77	The percentage of patients with CKD who are recorded as current smokers who have a record of an offer of support and treatment within the preceding 12 months [10, 14].
78	Proportion of smoking CKD patients who ceased smoking during the past year [14].
79	Proportion of patients with CKD and obesity who have received dietary advice to assist weight loss [14].
80	Proportion of patients with CKD who have received dietary advice to assist dietary sodium restriction [14].
81	Proportion of patients with CKD stages 1–3 and hyperkalaemia or hyperphosphataemia who have received dietary advice to assist dietary restriction of potassium and phosphate [14].
82	Proportion of patients with CKD who have received advice to undertake regular exercise [14].
83	Proportion of patients with CKD who report performing regular moderate exercise [14].
4.0 Referral to a Specialist	
84	Referral to a nephrologist by primary care physicians prior to ESRD [2].
85	Referral to a nephrologist for eGFR<30 [20].
86	Proportion of CKD patients who were not referred to a nephrologist when they should have been (based on the three criteria: Nephrologists should participate in the care of CKD patients when a) eGFR<30 mL/min/1.73 m2; b) there is a significant change in eGFR or; c) there is evidence of high proteinuria (PCR >100 mg/mmol, ACR >60 mg/mmol or protein present in 2/3 of samples)) [21].
87	Proportion of patients with CKD with an indication for referral who have been referred to a Nephrology Department [14, 19].
88	Cumulative probability of a physician visit by month 12 after CKD diagnosis, and after stage 3 CKD diagnosis by physician specialty (primary care, cardiology, nephrology) and demographics [8].
89	Proportion of patients with persistent nonvisible/microscopic haematuria in the absence of significant proteinuria or a reduced GFR that were referred to a Urology Department [14].

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