An innovative nephrology elective enhances learning in internal medicine residents

Debajyoti Roy[1], Shui Boon Soh[2], Alvin Ng[2]

**Abstract**

**Background:** Despite an increase in the number of chronic kidney disease patients, there is declining interest in careers in nephrology worldwide, including in Singapore. Singhealth is the largest sponsoring institution for residency in Singapore. A renal rotation is not a core internal medicine requirement of Singhealth, and it will be imperative for internists to help fill this gap. We report on an innovative nephrology elective which enhances learning in internal medicine trainees.

**Methods:** The typical trainee was a 4th- or 5th-year internal medicine resident. The Kern six-step model was used to create and evaluate the course curriculum. The elective was of 4 weeks' duration and had both an inpatient and an outpatient component. An anonymized questionnaire was sent to the trainees to assess the learning value by comparing knowledge before and after the rotation. The trainees reported improvement in their ability to manage patients with kidney disease, fluid electrolyte disorders, and acid-base disorders (p<0.05). They were also more confident in their ability to teach these matters to junior doctors.

**Conclusions:** The 4-week nephrology elective was found to greatly enhance learning in internal medicine residents. This format was also perceived favourably by IM residents, and might lead to more residents choosing careers in nephrology.

**Keywords:** nephrology; curriculum; internal medicine; Kern six-step model; medical residency; Singapore

**Introduction**

Current estimates suggest that 8–16% of the world population has chronic kidney disease (CKD) (Hamer and El Nahas 2006, Sitprija 2003, Katz et al. 2011, Jha 2013, Tonelli et al. 2006). Despite the increasing burden of CKD, there is a declining interest in nephrology fellowships (Sharif et al. 2016, Field 2008, Jhaveri et al. 2013). The various reasons given include poor learning experiences with nephrology in medical school, nephrology not being a core rotation, the perception that work hours are very long, and exposure to very sick patients such as dialysis or
transplant patients in a hospital setting (Jhaveri et al. 2013, Akbar et al. 2015, Shah et al. 2015). As patients with acute kidney injury (AKI), CKD and fluid electrolyte imbalance are routinely admitted to medical wards, not only specialist nephrologists but also internal medicine (IM) physicians will need to be conversant in their management. Healthcare models will have to rely on internists to fill this gap.

In Singapore since 2010, there has been a transition from UK-style specialist training to a US-style residency accredited by the ACGME(I). Singhealth is the largest sponsoring institution for residency in Singapore, with 34 programs under its purview. Since nephrology is not a core rotation, many trainees complete their training without sufficient exposure to renal patients in a structured learning environment. To be accredited as an IM physician, candidates are required by the Specialist Accreditation Board (SAB) to complete a further 2-year training programme known as the Advanced Internal Medicine (AIM) programme followed by an exit exam after a 3-year internal medicine residency (total 5 years).

AIM residents have often voiced that they are unsure about how to manage of patients with kidney disease, fluid electrolyte disorders, and acid-base disorders. A recent nationwide survey of renal electives offered to internal medicine residents in USA describes about 30% being of 2 weeks duration, 99% offered inpatient nephrology general consultative services with some exposure to inpatient and outpatient dialysis services. Exposure to critical care nephrology was almost absent (Shah et al. 2015).

We offered an innovative 4-week elective course to a group of AIM trainees to evaluate if the curriculum enhanced nephrology learning. The areas addressed in this elective included: critical care nephrology with its associated AKI, fluid electrolyte disorders, and acid-base disorders, and it involved inpatient general nephrology consults, inpatient ESRF/dialysis, general consultative nephrology as well as out-patient clinics. This rotation is representative of the work of a renal specialist.

Methods

We conducted this study at the Changi General Hospital, Singapore. A renal curriculum was specially designed for the implemented elective based on the areas of concern previously raised by IM trainees earlier, which included lack of confidence evaluating patients with acute or chronic kidney disease and managing fluid electrolyte and acid-base disorders. The elective included both inpatient and outpatient experience. The Kern six-step model was used to create the curriculum (Kern et al. 2010, Kaufman 2003).

Problem identification and general needs assessment

This 4-week elective was designed to address the AIM residents’ knowledge and skill gaps in the nephrology field. As the majority of patients with AKI, CKD, or electrolyte imbalance are in medical wards, they would be expected to be managed by non-renal specialists, unless dialysis is indicated.

Targeted needs assessment

The programme provides curricular content to foster competency in managing patients with renal diseases. The learners were AIM senior residents (SRs), typically year 4 or 5 residents from Singhealth. They were offered a 4-week elective in renal medicine with some off-site service commitments.

Goals & objectives

The aim of the renal elective is to help AIM SRs develop effective knowledge and skills in managing patients with
renal diseases. After the 4-week renal elective, the learner is expected to be able to do the following:

- Evaluate a patient with AKI and formulate a management plan.
- Evaluate a patient with CKD and take appropriate steps to retard rate of progression.
- Discuss the complications of CKD.
- Manage anaemia in CKD.
- Evaluate a patient with diabetic kidney disease.
- Identify patients who have diabetes mellitus but have non-diabetic renal disease.
- Be conversant with the various modalities of renal replacement therapy.
- Discuss the work-up and management of patients with electrolyte imbalance and acid-base disorders.

**Educational strategies**

These strategies were designed to address the knowledge gaps identified earlier. The AIM SR joins a renal consultant on daily ward rounds, and is rostered to see inpatient referrals. Complex cases, especially in the intensive care units, are discussed with a faculty member the same day, either one-on-one or in small group sessions. There is exposure to patients with ESRF on maintenance haemodialysis and peritoneal dialysis. The SR also attends didactic renal teaching twice a week, much of it using a problem-based approach, and has access to an online platform with renal lectures covering multiple topics. In addition, the SR presents and participates weekly in mortality and morbidity (M&M) meetings and multidisciplinary meetings with medical social workers (MSW), and, finally, presents a critique of a related paper during his/her posting.

The typical weekly training schedule is found in Appendix 1.

**Implementation**

The programme was discussed with the institution's associate programme director for advanced internal medicine and renal medicine, the renal department head, and core faculty. The teaching sessions were arranged such that they did not overlap with clinical commitments of the faculty. This elective has been in place since 2015, and 14 AIM residents have rotated through.

**Evaluation and feedback**

An anonymized questionnaire was sent at the end of the rotation to assess learning after as against before the rotation, and hence the course’s impact (five-point Likert scale). (Appendix 2). This study was deemed ethics clearance exempt by the institutional review board of Singhealth.

Methods of evaluation utilized in this rotation were:

**I. Ongoing feedback**

a. Patient records are reviewed by the attending consultant, who provides specific feedback to the resident on data-gathering and documentation skills.

b. At the end of the 4-week rotation a mini-cex was performed to evaluate if learning goals were achieved.

**II. Resident performance.** Upon completion of the rotation, faculty complete computerized resident evaluation forms. The evaluation is competency based. It is shared with the resident, who receives a copy, and is internally reviewed by the residency office. The evaluation is part of the resident's file and is
incorporated into the semi-annual performance review for directed resident feedback.

III. Faculty Performance. Assessed at the 12-monthly programme evaluation committee meeting.

Results

All 14 AIM residents who took up the renal elective answered the questionnaire. The results of the questionnaire assessing the impact of the programme before and after the rotation are presented in Table 1. From clinical and education perspectives, there was a significant improvement in senior residents’ ability to evaluate and manage patients with acute kidney injury, diabetic kidney disease, and chronic kidney disease with its complications. They also learnt how to evaluate and manage patients with electrolyte imbalance and acid-base disorders (p < 0.05). However, there was no significant improvement in the aspect of research and evidence-based medicine (p = 0.083). This may perhaps be because the rotation had only one slot available during the 4 weeks for critical appraisal of journal articles.

Table 1. Goals achieved post elective

<table>
<thead>
<tr>
<th></th>
<th>Before</th>
<th>After</th>
<th>p-value</th>
</tr>
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<tbody>
<tr>
<td><strong>CLINICAL</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diagnosing and managing patients with diabetic nephropathy</td>
<td>3.0 (2.0–4.0)</td>
<td>4.0 (4.0–4.0)</td>
<td>0.010</td>
</tr>
<tr>
<td>Managing patients with acute kidney injury, and knowing when to refer to nephropathy</td>
<td>3.0 (2.0–4.0)</td>
<td>4.0 (4.0–5.0)</td>
<td>0.004</td>
</tr>
<tr>
<td>Managing patients with chronic kidney disease, and knowing when to refer to nephropathy</td>
<td>3.0 (2.0–3.0)</td>
<td>4.0 (4.0–4.0)</td>
<td>0.004</td>
</tr>
<tr>
<td>Dealing with acid-base disorders</td>
<td>3.0 (2.0–3.0)</td>
<td>4.0 (3.0–4.0)</td>
<td>0.008</td>
</tr>
<tr>
<td>Dealing with fluid and electrolyte disorders</td>
<td>3.0 (3.0–4.0)</td>
<td>4.0 (3.0–4.0)</td>
<td>0.011</td>
</tr>
<tr>
<td>Setting temporary vascular dialysis catheter for patients requiring hemodialysis</td>
<td>4.0 (3.0–4.0)</td>
<td>4.0 (4.0–4.0)</td>
<td>0.046</td>
</tr>
<tr>
<td><strong>RESEARCH &amp; EBM</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medical journal critiques</td>
<td>2.0 (1.8–3.0)</td>
<td>3.0 (2.0–3.0)</td>
<td>0.083</td>
</tr>
<tr>
<td><strong>EDUCATION</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Giving didactic teaching sessions on renal-related topics to junior medical colleagues</td>
<td>2.0 (2.0–3.0)</td>
<td>3.0 (3.0–3.0)</td>
<td>0.008</td>
</tr>
<tr>
<td>Giving bed-side teaching in renal-related topics to junior medical colleagues</td>
<td>3.0 (2.0–3.0)</td>
<td>3.0 (3.0–4.0)</td>
<td>0.014</td>
</tr>
</tbody>
</table>

All data presented as median (interquartile range)
Discussion

There is a worldwide increase in patients with CKD especially among the elderly (Hamer and El Nahas 2006, Sitprija 2003, Katz et al. 2011, Jha 2013, Tonelli et al. 2006). In contrast, however, the number of new nephrology workers is declining (Sharif et al. 2016, Field 2008), in Singapore and elsewhere. The British Renal Society established a National Renal Workforce Planning Group to recommend staffing levels across professional groups involved in renal care. They suggest a staffing ratio of 1 nephrologist per 75 renal replacement therapy (RRT) patients or 1.0 work hour equivalent in nephrology per 100 dialysis/transplant patients (Renal Team, 2002). Even in European countries, which have generally higher funding and physician-per-population levels, the number of nephrologists per 100 end-stage renal failure (ESRF) patients ranges only from 9.4 in Italy to 1 in the UK (Sharif et al. 2016). It is well accepted that patients with CKD if referred to nephrologists early can delay initiation of dialysis as well as mortality risk (Stack 2003).

Healthcare systems with reduced supply of nephrologists and an increasing number of CKD patients will need internists to share this clinical load, as well as allied health practitioners like clinical nurse practitioners, renal pharmacists, and dieticians (Sharif et al. 2016, Field 2008).

An elective in a subspecialty helps internal medicine trainees improve their understanding in areas which may translate to their clinical practice (Akbar et al. 2015, Shah et al. 2015). Goldenberg et al. (1983) were able to demonstrate this educational impact in a group of residents undergoing a rheumatology elective. An Australian study demonstrated early exposure to nephrology had influenced subsequent career choices in a survey of prospective nephrology trainees (Lane et al. 2008).

One of the challenges in designing learning experiences for medical residents is the fact that most medical educators are not formally trained in the practice areas. Often, trainees feel that what is taught is not relevant to practice. The Kern six-step model is a simple practical approach to curriculum planning used here to develop a renal curriculum designed to address targeted needs, create goals and objectives, implement educational strategies and have evaluation of and feedback from both trainees and faculty to close the loop. We assessed trainee knowledge in areas such as evaluation of a patient with AKI and formulation of a management plan, evaluation of a patient with CKD, taking appropriate steps to slow rate of progression, discussing work-up and management of patients with electrolyte imbalance and acid-base disorders. Table 1 clearly demonstrates the effectiveness of this curriculum in improving trainee abilities in the clinical and education domains. The lack of perceived improvement in ability to critique a scientific paper and in evidence-based medicine is probably because the rotation was only of 4 weeks’ duration.

Conclusions

In conclusion, our 4-week elective in renal medicine was able to make a significant difference in the renal-related abilities of the internal medicine trainees, who appreciated the learning. A slightly longer rotation of 6–8 weeks with greater outpatient content and exposure to other areas like kidney transplant and interventional nephrology might have been even more effective and better perceived.

Take Home Messages

1. In the current climate of shortage of nephrologists worldwide, an internal medicine specialist who has done a nephrology elective may be one way to bridge this gap.
2. A 4-week elective with both in- and outpatient components significantly improved the ability of internal medicine residents to evaluate and manage patients with AKI, diabetic kidney disease, and CKD and associated complications. They also learnt to evaluate and manage patients with acid-base disorders and electrolyte imbalance.

3. Problem-based or case-based learning seems to be more effective than formal didactic teaching for these advanced learners.

Notes On Contributors

Dr Debajyoti Roy, MD, FRCP, is a Senior Consultant in the Department of Renal Medicine at Changi General Hospital. He is also the Associate Program Director for the Singhealth Renal residency programme. He has a keen interest medical education and has won several awards for the same.

Dr Shui Boon Soh, MRCP, is a Consultant in the Department of Endocrinology at Changi General Hospital, and the Associate Program Director for the Singhealth Advanced Internal Medicine (AIM) programme. She is dedicated to the cause of improving training.

Dr Alvin Ng, FRACP, is a Consultant in Renal Medicine at Changi Hospital. He is core faculty for the internal medicine residency as well as the renal residency.

Acknowledgements

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Appendices

Appendix 1: Weekly training schedule

<table>
<thead>
<tr>
<th>Time</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
</tr>
</thead>
<tbody>
<tr>
<td>0800–1100 h</td>
<td>Ward round</td>
<td>Ward round</td>
<td>Ward round</td>
<td>Ward round</td>
<td>Medicine grand round</td>
</tr>
<tr>
<td>1100–1230 h</td>
<td>Inpatient referrals</td>
<td>MDM</td>
<td>Inpatient referrals</td>
<td>Inpatient referrals</td>
<td>Inpatient referrals</td>
</tr>
<tr>
<td>1300–1400 h</td>
<td>Didactic teaching</td>
<td>Inpatient referrals</td>
<td>Mortality &amp; morbidity meeting</td>
<td>Didactic teaching</td>
<td></td>
</tr>
</tbody>
</table>
Appendix 2: Questionnaire

Dear AIM SRs, we are interested to find out the usefulness/effectiveness of your 4 week elective rotation to Renal Medicine during AIM training, in preparing you to be a competent General Medicine specialist. We will appreciate if you can help us with this short questionnaire. Please complete it (highlight your responses in bold) and email/courier back to me. Your responses will be kept confidential.

1) Did you have rotation to Renal Medicine during your junior residency training?

| Yes | No |
--- | --- |

In the following questions below, please rate your confidence / comfort level, on a scale of 0 to 5.

(0 = not confident; 5 = very confident)

2) CLINICAL
   a) Are you confident in diagnosing and managing patients with diabetic nephropathy?

   Before your Renal rotation in senior residency

   | 0 | 1 | 2 | 3 | 4 | 5 |

   After your Renal rotation in senior residency

   | 0 | 1 | 2 | 3 | 4 | 5 |

   b) Are you confident in managing patients with acute kidney injury, and knowing when to refer to a nephrologist?

   Before your Renal rotation in senior residency

   | 0 | 1 | 2 | 3 | 4 | 5 |

   After your Renal rotation in senior residency

   | 0 | 1 | 2 | 3 | 4 | 5 |

   c) Are you confident in managing patients with chronic kidney disease, and knowing when to refer to a nephrologist?

   Before your Renal rotation in senior residency

   | 0 | 1 | 2 | 3 | 4 | 5 |
d) Are you confident in dealing with acid-base disorders?
Before your Renal rotation in senior residency

After your Renal rotation in senior residency

e) Are you confident in dealing with fluid and electrolyte disorders?
Before your Renal rotation in senior residency

After your Renal rotation in senior residency

f) Are you confident in setting a temporary vascular dialysis catheter for patients requiring hemodialysis?
Before your Renal rotation in senior residency

After your Renal rotation in senior residency

3) RESEARCH & EBM
Are you confident in medical journal critiques?
Before your Renal rotation in senior residency

After your Renal rotation in senior residency

4) EDUCATION
a) Are you confident in giving didactic teaching sessions on renal-related topics to your junior
medical colleagues?
Before your Renal rotation in senior residency

0 1 2 3 4 5

After your renal rotation in senior residency

0 1 2 3 4 5

b) Are you confident in giving bed-side teaching in renal-related topics to your junior medical colleagues?
Before your renal rotation in senior residency

0 1 2 3 4 5

After your renal rotation in senior residency

0 1 2 3 4 5

**Declarations**

*The author has declared that there are no conflicts of interest.*

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**Ethics Statement**

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