Scope of point-of-care ultrasound practice in rural New Zealand

Garry Nixon MNZM, MBChB, FRNZCGP(dist.), FDRHMNZ, PGDipRPHP;[1] Kati Blattner MBChB, FRNZCGP, FDRHMNZ, PGDipRPHP(dist);[1] Jillian Muirhead DMU, AFASA;[1] Wendy Finnie NZCS, ASCT;[1] Ross Lawrenson MBBS, MD, DRCOG, Dip. Comm. Health (Otago), FPCert, DHMSA, FAFPHM, FFPH, FRCGP;[2] Ngaire Kerse MBChB, PhD, FRNZCGP[3]

[1] Dunedin School of Medicine, University of Otago, Dunedin, New Zealand

[2] Medical Research Centre, University of Waikato and Waikato District Health Board, New Zealand

[3] School of Population Health, University of Auckland, Tamaki, Auckland, New Zealand

ABSTRACT

INTRODUCTION: Point-of-care ultrasound (POCUS) is an increasingly common adjunct to the clinical assessment of patients in rural New Zealand.

AIM: To describe the scope of POCUS being practiced by rural generalist hospital doctors and gain insights, from their perspective, into its effect.

METHODS: This was a mixed-methods descriptive study. Main outcome measures were type and frequency of POCUS being undertaken. A questionnaire was given to POCUS-active rural hospital doctors to survey the effect of POCUS on clinical practice and assess issues of quality assurance.

RESULTS: The most commonly performed scans were: cardiac (18%) and volume scans (inferior vena cava and jugular venous pressure) (14%), followed by gallbladder (13%), kidney (11%), Focused Assessment with Sonography in Trauma (FAST) (7%), bladder (6%), leg veins (6%) and lungs (5%). There was large variation in frequency of scan types between the study hospitals that could not be accounted for by differences in training. The participating doctors considered that POCUS had a positive and significant effect on their practice, largely by adding to diagnostic certainty. Challenges identified included maintenance of POCUS skills, lack of systems for POCUS set-up and the absence of quality assurance for POCUS in rural hospitals.

DISCUSSION: Rural generalists consider the broad scope of POCUS they practise to be an important but challenging skill set. Clinical governance, including an agreed scope and standards, may increase the benefits and improve the safety of rural POCUS.

KEYWORDS: Rural hospital; rural medical education; diagnostic imaging; rural health services

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CORRESPONDENCE TO:
Garry Nixon
Dunedin School of Medicine, University of Otago, Dunedin, New Zealand
garry.nixon@otago.ac.nz

Introduction

Ultrasound was traditionally the domain of sonographers, specialist radiologists and cardiologists. This has changed with the emergence of point-of-care ultrasound (POCUS), which is now used in a range of specialties for both diagnosis and to guide procedures.[1] The potential diagnostic value of POCUS may be greatest in rural settings where access to formal ultrasound, and imaging modalities generally, is limited.

POCUS has been advocated both in rural settings and in the hands of generalist hospital doctors dealing with inpatients.[2,3] However, apart from one study of 43 patients in a rural emergency department in the USA, surveys of rural physicians in Ontario and Quebec, and others in the very remote or wilderness settings, there are no published papers that describe the scope of POCUS being practiced by rural generalists or its effect on patient management in the rural context.[1,4–8]

Rural doctors are learning POCUS skills. This is evidenced by more than 250 graduates of the University of Otago Postgraduate Certificate in Clinician-Performed Ultrasound (PGCertCPU) since its inception in 2006.[9] The Australian College of Rural and Remote Medicine and other providers run similar courses in Australia.[10]

Rural generalist medicine encompasses primary, inpatient and emergency care and requires some advanced skills.[11] A consequence of broad scopes of practice is lower volumes of any particular presentation or procedure. This raises important issues around maintaining competence and patient safety. We are unaware of efforts by any professional college or credentialing body to recognise a scope of practice or set standards for rural POCUS, although policies have been developed by the Australasian College of Emergency Medicine for their members.[12]

The aim of this research was to provide an overview of diagnostic POCUS in a sample of New Zealand rural hospitals. The study measures the volume and range of POCUS examinations being undertaken and, using a questionnaire, provides perspectives of the effect of POCUS from the point of view of participating doctors. This analysis is part of a larger study that evaluates the ability of generalist rural doctors to obtain and correctly interpret POCUS images and to assess the effect of POCUS on patient care. The intention is to collect information that will inform appropriate training, policy and resourcing for rural POCUS.

Methods

The quantitative and qualitative data in this mixed-methods study are analysed concurrently but separately, and integrated during interpretation, described as an 'integrative process'.[13]

The study was conducted in six rural hospitals. These hospitals represent the geographic and sociodemographic diversity of rural New Zealand, collectively accounting for 25% of all the country's rural hospitals.[14] These hospitals are staffed by general practitioners and hospital generalists. None of the hospitals have surgical capabilities or on-site surgeons. Two hospitals are integrated with general practice. The catchment populations and distance to the nearest base hospital are presented in Table 1. All the generalist rural doctors practising POCUS in these hospitals during the study period were eligible for inclusion and invited to participate in the study.

WHAT GAP THIS FILLS

What is already known: Point-of-care ultrasound (POCUS) is being used increasingly across the medical specialties in urban hospitals globally and in Australasian emergency departments. POCUS is a user-dependent technology and requires appropriate training and quality assurance.

What this study adds: Rural generalist doctors have a broad scope of POCUS practice that is different from their emergency medicine colleagues. Rural doctors consider that POCUS has a positive effect on their practice, but are concerned about the absence of agreed standards and quality assurance systems.

Quantitative data collection and analysis

Each time they undertook POCUS as part of their routine clinical duties, the participating doctors completed a form (Appendix 1) that, in addition to the patient's age, ethnicity and gender (via the National Health Index Number), captured details about the type of POCUS examinations, POCUS findings and whether the doctor asked for the images to be reviewed. Scans undertaken principally for training or to guide procedures were not included in this study. Participating doctors were encouraged to record all scans performed over a 9-month period in 2012.

Descriptive statistics were used to summarise the number and type of POCUS examinations undertaken, as well as the characteristics of patients. Differences in scan frequency between the hospitals and doctors working in multiple hospitals were corrected for, using a generalised linear mixed model with a Poisson distribution, and the interaction between doctor and POCUS scan type as random term. The Poisson distribution with the log link was chosen, as this regression can be used for multinomial distributions.[15] The Function 'glmer' in the R package lme4 was used for the analysis.[16]

Qualitative data collection and analysis

Three months after the completion of the quantitative data collection, participants were asked to complete a questionnaire that included questions about the effect of POCUS on patient management, quality assurance and credentialing, and the implementation of POCUS in their rural hospital (Appendix 2). The written responses were entered into an Excel spreadsheet (Microsoft Corporation, Redmond, WA, USA) according to the categories used in the questionnaire. After review by the research team, responses were collated into categories that related to the original questions, capturing the main issues. Participant responses were reported as summaries and quotes. To maintain participant anonymity, all respondents were designated a number (1–17) and were referred to throughout the study by this coding (e.g. Respondent 5 or R5).

Ethics approval for the study was obtained from the Multi Region Ethics Committee MEC/10/09/091 and consent was obtained from the participating doctors.

Results

Quantitative results

Twenty-eight doctors enrolled in the study; one eligible doctor declined to participate. POCUS scans were conducted and forms completed for 1044 patients. Of these, 30 were excluded because there was incorrect or inadequate patient information on the form. Scans from 1014 patients were included in the study. Many scans involved

Table 1. Characteristics of the study hospitals and patients

	North Island hospitals			South Island hospitals			
	1	2	3	4	5	6	All
Hospital characteristics:							
Bed numbers†	10	15	12	30	10	24	
Distance to base hospital (km)‡	126	55	57	112	187	200	
Approximate resident catchment population§	6,500	36,500	13,500	21,000	17,500	26,000	
% Māori in catchment**	70	41	31	4.5	5.4	6	
Number POCUS active staff††	3	3	5	1	8	8	28
X-ray available 24 h/7 days	N	Y	Y	Y	Y	Y	
Visiting sonography	N	Y	N	Y	Y	Y	
In-house sonography	N	N	N	Y	N	N	
In-house computed tomography	N	N	N	Y	N	N	
Characteristics of patients scanned:							
Median age in years	66	57	61	50	38	68	63
Percent Māori	64	44	21	5.3	4	2	20
Percent inpatients‡‡	67	83	35	23	40	87	66
Total number (*n*) of patients scanned§§	180	104	127	76	113	414	1014
Total number (*n*) of POCUS examinations	212	121	144	87	134	550	1248
Total number (*n*) of POCUS findings	238	142	159	98	156	616	1409

N (no); Y (yes); POCUS (point-of-care ultrasound).
* Number of general medical inpatient beds.
† Distance to the nearest base hospital by road in km. The bases hospitals covering Hospitals 1, 2, 3 and 5 do not have tertiary services such as interventional cardiology or vascular surgery. The tertiary hospitals providing these services is a further 160–200 km distant.
‡ Rural hospitals in New Zealand do not have clearly defined catchment boundaries. These figures were obtained from local hospital administrators.
§ Māori as a percentage of catchment population, % = percent.
¶ Number of medical staff practising ultrasound at the time and therefore eligible for enrolment in the study.
** Percentage of patients scanned who were inpatients at the time. The remainder were emergency department or general practice clinic patients.
†† Total number of patients scanned and included in the study.

more than one type of examination (e.g. gallbladder and kidney). The 1014 patients underwent 1247 examinations.

Age data were missing for 16 patients. The youngest patient scanned was aged 1 year, the oldest was aged 102 years and the median age was 63 years. Ethnicity data were missing for eight patients. Overall, 78% of patients scanned were European, 20% Māori and 2% were of other ethnicities.

The frequency of each POCUS examination is shown in Table 2. The most commonly performed examinations were cardiac scans and scans assessing intravascular volume (inferior vena cava diameter and jugular venous pressure).

Even after correcting for variation between the participating doctors, there remained a significant variation between the hospitals in the frequency of scan types that were performed ($P < 0.001$). This is shown in Figure 1.

In only 3% of cases, participants reviewed the images with a colleague in person or by sharing them electronically. If this occurred, it was most likely to have been with a sonographer, an echocardiographer or a cardiologist.

Qualitative results

Twenty-three of the participating doctors were still working in the study hospitals when the questionnaire was undertaken; five had moved to work elsewhere. Seventeen completed and returned the questionnaire (17/23, 74% response).

The key findings are summarised in three main categories. Examples in the form of quotes are presented in Table 3 for each category.

Clinical Practice: POCUS made a valuable impact on patient management largely by adding to diagnostic certainty. Respondents enjoyed using their new and practical POCUS skill and regarded scanning as an extension of their clinical examination.

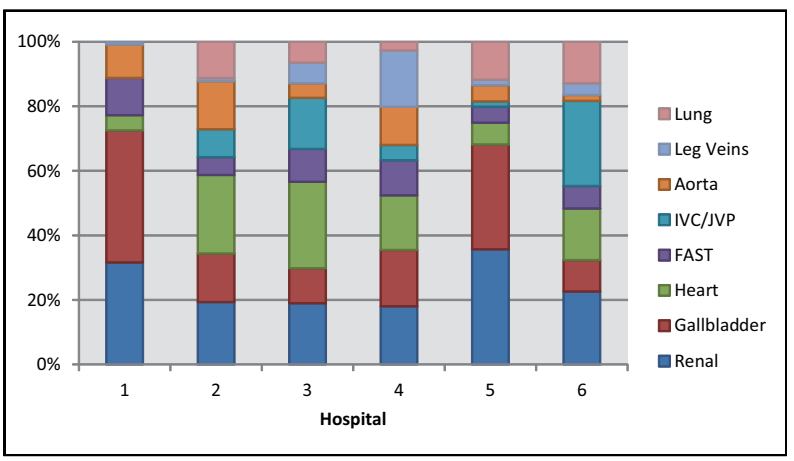
Training and quality assurance: Fifteen out of the 17 respondents were graduates of the University

Table 2. Frequency of POCUS Examinations

POCUS Examination:	Commonly sought findings	Number	Percentage
Cardiac	Pericardial effusion, Left ventricular function, Chamber size	226	18
IVC/JVP*	Hypvolemia and volume overload	172	14
Gallbladder	Gallstones	163	13
Kidney	Hydronephrosis	139	11
FAST†	Free intraperitoneal fluid	86	7
Bladder	Urinary retention	80	6
Leg veins‡	Deep vein thrombosis	70	6
Subcutaneous§	Abscess, Foreign bodys	68	6
Aorta	Abdominal aortic aneurysm	65	5
Lung¶	Pleural fluid, consolidation, pulmonary oedema	63	5
Pelvic**	Intrauterine pregnancy	55	4
Abdomen††	Ascites	28	2
Musculoskeletal‡‡	Fractures, tendon rupture	23	2
Uncommon§§	Testicular torsion, Retinal detachment	9	1
	Total	**1247**	

* IVC/JVP = Jugular venous pulse and inferior vena cava for volume assessment.
† FAST = Focused Assessment with Sonography for Trauma looking for free intraperitoneal or pericardial fluid.
‡ Deep venous system above the knee looking for thrombosis.
§ Collections and foreign bodies.
¶ Pleural fluid, pneumothorax, pulmonary oedema or consolidation.
** Intrauterine pregnancy, free fluid, ovarian cyst.
†† Ascites.
‡‡ Fractures, tendons.
§§ Testes, eyes.

Fig. 1. Scan types as a percentage of all scans performed in each hospital.



of Otago's PGCertCPU, a year-long programme that includes three workshops and an online learning platform.[9] One had attended a week-long course in Australia and the other had learned ultrasound in his undergraduate medical education in Germany.

Respondents were conscious of POCUS scope limitations and their need for ongoing training. Respondents mentioned the pressure of ongoing maintenance of their competency in POCUS in the context of the already challenging scopes of practice in rural hospitals. No respondents were aware of any formal POCUS Quality Assurance or credentialing systems in New Zealand. Respondents commented on the need for their hospitals to incorporate systems for set up and maintenance of POCUS equipment (including download, storage and transmission of images) into routine operations (Table 4).

Colleague perception: While some respondents experienced negative responses from urban specialist colleagues, others indicated a growing acceptance by these same specialists of POCUS and its value in the rural context. Particular support was noted from specialists who regularly visited the rural centres.

While the POCUS-trained rural clinicians had a good understanding of their POCUS scope and its limitations, rural colleague perception of POCUS scope varied. Several respondents found referrals from onsite colleagues who were not POCUS trained difficult to manage because of the expectation that they should perform stand-alone ultrasound examinations rather than incorporating it as part of clinical assessments.

Respondents valued being involved in the research and more than half of the respondents specified that the rural provenance of the study was key in prompting their participation and interest in the research.

Discussion

The notable quantitative findings in this study are a scope of rural POCUS that is broad, relatively complex and varies considerably between hospitals. Cardiac scans, arguably the technically most difficult, were the most commonly performed, while Focused Assessment with Sonography in Trauma (FAST) and aorta scans, which are more straightforward POCUS examinations and the most commonly performed scans in emergency departments, were only the fifth and ninth most

Table 3. Main categories with supportive examples taken from participant questionnaire responses

Category	Example 1	Example 2	Example 3
1. Clinical practice	'…it has become a normal part of what we [clinicians] do here. [Now I]… use it [POCUS] more than my stethoscope.' [R10]	'…, acutely unwell patients with multiple medical problems … volume status is often hard to assess clinically and IVC [inferior vena cava] is very helpful especially serial scans, in determining management… [it] allows more confidence in managing cases here.' [R1]	'[POCUS]…adds a level of skill and experience that allows doctors to broaden their arsenal of diagnostic tests, especially in a small hospital where access to imaging is limited.' [R3]
2. Quality assurance and training	'…discussion and looking at each other's images is good but lack of formal [QA] process is an issue.' [R2]	'…operational support for technical aspects …not well understood (*by rural hospital service*) so doctors end up doing that too.' [R6]	'…was it [the PGCertCPU course] adequate: yes, but my practice since hasn't been…I find it is something you have to do every day even when you are busy otherwise you don't have the skills when you need them.' [R5]
3. Colleague perception	'… [with] other doctors asking me to do a scan - the limitations have to be clear and the question asked has to be clear for it [POCUS] to work.' [R14]	'AB… [a radiologist who teaches on the PGCertCPU course] is [supportive], the others not so particularly but [they're] not obstructive.' [R10]	'…good support from echo technician and cardiologist who visit us (rural hospital) regularly.' [R1]

POCUS (point-of-care ultrasound); QA (quality assurance); PGCertCPU (Postgraduate Certificate in Clinician-Performed Ultrasound).

frequently undertaken in this study.[6,17,18] This broad scope of rural POCUS reflects the scope of rural generalist medicine, a context that is typified by poor access to complex diagnostic imaging.[11,19]

This same breadth and complexity of POCUS may underlie the concerns the participants expressed about the limitations of their personal POCUS skills, the lack of formal quality assurance processes and very limited opportunities for ongoing training.

The absence of a recognised scope and clinical governance for rural POCUS may also be reasons for other study findings: the absence of systems to maintain machines and download and store images; the limited understanding of rural POCUS by health-care managers and urban colleagues; low rates of image review with colleagues or specialists; and the large variation in frequency of POCUS examinations between the study hospitals. This last finding was unexpected and cannot be explained by differences in training, as most of the participants graduated from the same university-based POCUS course. Equally, while there are differences in the demographics of the hospital catchment populations, these are insufficient to explain the variation we observed. Each hospital is in a sense 'doing their own thing'.

This study recorded only a very small number of obstetric scans. This finding was expected and reflects how few generalist doctors in New Zealand now practice obstetrics.[20] This may represent a missed opportunity for rural doctors and midwives. Australian rural doctors consider obstetric scanning to be an important part of their POCUS practice.[21]

Patients of Māori ethnicity comprised 20% of the patients scanned, but 27% of the hospital catchments' population base. Potential explanations include the younger age profile of the Māori population, but older age of patients being scanned. In one of the northern communities, 88% of patients aged <25 years are Māori, but only 61% of patients are aged >45years, and the median age of scanned patients was 66 years. The hospital catchment populations are estimates obtained from local hospital managers. This further complicates these calculations and makes it difficult to generate age-standardised rates. Two of the southern hospitals are in tourist centres and it is unknown how many of the patients scanned were non-residents. The institutions and their clinicians must, however, consider the possibility that these results reflect systemic bias, and future audits and studies designed to test this will be needed.

In this study, the North Island rural hospitals were smaller, further away from tertiary services and had less access to imaging than their South Island counterparts (see Table 1 for a summary). These same hospitals serve large Māori populations. Māori are disadvantaged in health outcomes and access to health services, and rural Māori may face even greater disadvantages than their urban counterparts.[22] This underscores the need for, and importance of, equitable and safe POCUS services for to all rural communities.

The rural 'ownership' of this study was important for the participants, and supports previous findings that research developed in consultation with rural communities and health-care providers, and embedded in rural areas, is more likely to align with the health-care aspirations of rural communities.[23]

This is the first research to describe the use of POCUS in rural hospitals and one of the largest studies to describe its use in day-to-day clinical practice in any context. The qualitative component of the study is limited by the methodology; collated responses from a written questionnaire

*Table 4. Recommendations for establishing a rural point-of-care ultrasound (POCUS) service, developed from questionnaire responses feedback**

1. Consult with existing rural POCUS services for advice.
2. Obtain quality equipment fit for purpose.
3. Ensure rural-focused POCUS training for rural doctors, incorporating likely scope of practice.
4. Establish responsibility for supplier contact, software and data storage and maintenance schedule for equipment.
5. Define clear guidelines for POCUS use and referral of patients to the POCUS clinician. Ensure these are clearly communicated to relevant staff.
6. Incorporate and start using POCUS as soon as is practicable.

* Developed in conjunction with respondent feedback from this study.

lack the depth that could be gained from other qualitative research methods. The real-world nature of the study and geographic and demographic spread of the hospitals are strengths of the study. While doctors were strongly encouraged to include all the scans they undertook during the study period, we were unable to ascertain how many examinations were not reported. POCUS is an evolving field and it is likely the skills of rural practitioners will have developed further since this study was undertaken in 2012. However, the scope of POCUS taught to PGCertCPU students in 2018 is, apart from the addition of some lung ultrasound, unchanged from 2012.[9] Importantly, quality assurance and credentialing processes for POCUS in most rural hospitals have not progressed.

In light of these study findings, the authors recommend that clinical governance be implemented for rural POCUS in New Zealand, so that safe scopes of practice, credentialing and quality assurance can be maintained. Given the size of New Zealand's hospitals, it may be appropriate for this governance to be provided by the hospitals collectively or through the Royal New Zealand College of General Practitioners. This process should be informed by further rurally based research into the outcomes of POCUS.

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COMPETING INTERESTS
None.

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Appendix 1. Data collection form

DIAGNOSIS/VOLUME

DATE:……..

TIME:……..

Stick patient label here or

Patient Name:……

NHI……

Clinicians initials:

Inpatient / Outpatient

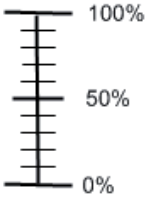
Ultrasound quality:

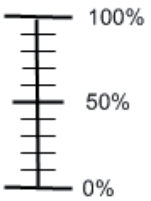
Good ☐ **Adequate** ☐ **Not diagnostic** ☐

Potential Diagnosis:

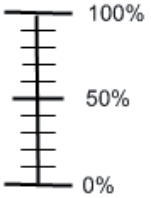
Potential Diagnosis:

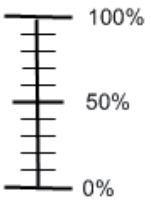
Pre-test Likelihood





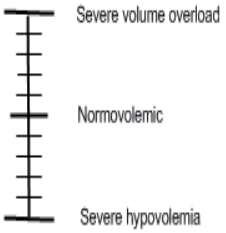
Post-test likelihood

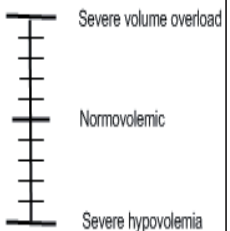




Ultrasound Findings:

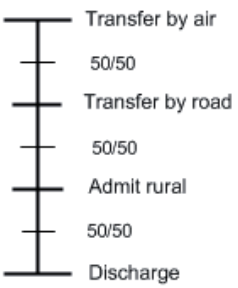
Volume Assessment. What is the patients problem e.g. trauma, heart failure?:



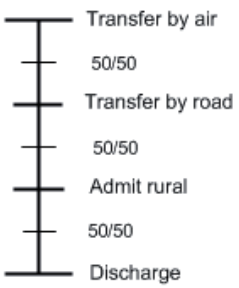


What do you plan to do with the patient?

Pretest



Post test



In what other ways has the test altered patient management? (Include treatment, follow-up, referrals for other imaging; mention calling in out of hours radiology or lab or other referrals):

Did you get the images reviewed? ☐ If yes provide details.

Appendix 2. Participant questionnaire

POINT-OF-CARE CLINICIAN PERFORMED ULTRASOUND IN RURAL PRACTICE

Questionnaire for Participating Doctors

1. **Clinical experiences**

(a) What CPU examinations do you use most often?

.....

.....

(b) What CPU examinations do you find the **most** helpful clinically and why?.....
.....
.....

(c) What CPU examinations do you find the **least** helpful and why?
.....
.....
.....

(d) What CPU examinations are you the most comfortable performing ?
.....
.....
.....

(e) What CPU examinations do you have the most difficulty performing?
.....
.....
.....

2. **Training**

(a) What formal training have you received in CPU?

..... Was this adequate? .....

b) Would you like to receive further or ongoing training in CPU?
……..

c) What type of training is the most useful
……

Rank the following (if possible) on a scale of 1 to 4 with 1 being **least** useful and 5 being **most** useful:

- Self teaching (reading could be part of this) ……..
- One-on one training with a tutor ……
- Workshop ……
- Working together with/discussions with colleagues ……...

d) Were you involved in getting CPU up and going in your hospital?

…….
If so, were there any issues in implementing CPU?
……
……
……
……

e) What advice would you have to others doing the same?

……
……
……
……...

3. **Quality assurance and credentialing**

a) What are the QA and Credentialing systems in place for you?.(if any).....
.....
.....

b) Are these systems useful? Please give examples
……
……
……
……..

4. **Equipment and technology issues**

a) Are there issues around the availability of equipment, maintenance, and quality, budgetary constraints, downloading and storing images?

……

……..

b) How supportive is hospital management for CPU?

……
……
……

c) Do you have the facility to electronically transmit images to base hospital colleagues?
…… Is this happening?
……..Please give examples
……
……..
……

5. **Relationships with specialists including radiologists and ultrasound technicians**

a) Are they supportive?

……
…….

b) Do they look at images for you? Please give examples

……..……
……
……

6. **Practice**

a) Does doing the CPU impose restrictions on or improve your time management? Please give examples

……
……
……
……

b) What do you think would be potentially useful extensions of the scope of practice?

……

……

……

c) How does the ability to do CPU affect job satisfaction? Please give examples.

……

……

……

d) What other issues around CPU do you think are worth discussing?

……

……

……

7. **Research**

How have you found being part of this research project?

……

……

……

8 **Administration**

a) How did you and your staff find administrative aspects of the project?

……

……

……

c) How was communication with the university staff ?

……

……

Thanks for taking the time to fill this out.

Garry Nixon
Dunstan Hospital
Ph: 03 4404337
0211782662

Kati Blattner
Rawene Hospital
Ph: 09 4057709
021457736