

Variables associated with successful access cannulation in haemodialysis patient and the development of a vascular access cannulation complexity instrument

Dr. Linda Coventry, RN, BSc, MS, PhD

Post-Doctoral Research Fellow Edith Cowan University and Centre for Nursing Research, Sir Charles Gairdner Hospital



The Team

Investigators

- Dr Linda Coventry
Research Fellow, SCGH & ECU
- Jon Hosking
Nurse Manager, Diaverum Toto Ora Clinic
- Evelyn Coral
Staff Development Nurse, SCGH Haemodialysis
- Dr Doris Chan
Nephrologist, SCGH
- Dr Amanda Towell
Post-Doctoral Research Fellow, SCGH & ECU
- Dr Wai Lim
Nephrologist, SCGH and Joondalup Health Campus
- Chrianna Bharat
Statistician, UWA
- Professor Di Twigg
Research Consultant, SCGH & ECU
- Professor Claire Rickard
Professor of Nursing, Griffith University



Background

End stage renal disease (ESRD)

- RRT (PD, HD, or kidney transplantation)

Significant economic burden on the Australian healthcare system

- Estimated cost of A\$12.3 billion dollars over an 11 year period (2009-2020)¹

At the end of 2015¹

- 23,012 patients were receiving treatment for ESRD,
- 12,461 patients were receiving HD

By 2020²

- It is projected between 27,013 to 30,293 will be receiving treatment for ESRD
- 16,627 to 16,403 patients receiving dialysis



1. Australia and New Zealand Dialysis and Transplant Registry (ANZDATA). Available from: http://www.anzdata.org.au/anzdata/AnzdataReport/39thReport/c02_prevalence_v2.1_20170418.pdf
2. Kidney Health Australia. Fast facts on CKD in Australia. Available from: http://kidney.org.au/cms_uploads/docs/kha-economic-impact-of-eskd-in-australia-projections-2020.pdf

- **WA HD Leaders working group**
 - **7 HD nurse experts**
 - 22 WA HD centres
 - Developed the WAHVAC (from the SCGH Access Grading Tool)
 - Aims to grade the complexity of the cannulation
 - Simple
 - Challenging
 - Complex
 - Match the complexity grade of the access, with a suitably skilled, competency-assessed nurse to perform the cannulation
 - Goal is to minimise risk of missed cannulation, trauma, delayed or poor quality dialysis

Western Australian Haemodialysis Units
**Vascular Access
Classification Tool**

URN:	
Surname:	
Forename:	
Gender:	
DOB:	

HD patient vascular access classified & reported quarterly - Q1: Feb, Q2: May, Q3: Aug, Q4: Nov

An AV Fistula less than three months is automatically classified Complex

Classification
colour-coded

Simple
Scores: < 12 **S**

Challenging
Scores: 13 - 20 **Cg**

Complex
Scores: > 21 **Cx**

Date		Score	Score	Score	Score	Score	Score
Access History							
Surgically created < 3 months		20					
First cannulation < 3 months		20					
Surgical revision < 3 months		10					
Stent in situ in useable section of AVF		10					
Access Assessment							
Single vessel - relatively straight		0					
Vessel not straight - zig zag		3					
Bifurcation	single	3					
	multiple	4					
Areas of aneurysm		4					
Bruit (high pitch) indicates area(s) of stenosis		3					
History of / current stenosis		3					
AVF very 'soft' with tendency to 'blow' easily		3					
Buttonhole tracks formed < 3 months		6					
Anatomy							
Length of viable vessel: (cm)	< 10.0	4					
	10.0 – 15.0	2					
	> 15.0	0					
Depth: (cm)	Superficial	0					
	Palpable	3					
	Non Palpable	6					
AVF Site							
Forearm	Radio-Cephalic	0					
Upper Arm	Brachio-Cephalic	3					
	Brachio-Basilic	6					
Thigh		8					
AVG Site							
Forearm		10					
Upper Arm		10					
Thigh		15					
Necklace		25					
Patient Co-morbidities							
Diabetic		1					
Peripheral Vascular Disease		1					
Heart disease		1					
Hypertension		1					
Hypotension		1					
Taking steroids / Immunosuppressant		1					
Nicotine use		1					
Extreme needle phobia		12					
No further surgical access options		13					
Total Score:							
Classification:							



Access history
-surgically created < 3 months
-First cannulation < 3 months
-Surgical revision > 3 months

Access assessment
-Straight vs. zig-zag
-Bifurcation
-Aneurysm
-Bruit
-Stenosis

Anatomy
-Length of viable vessel
-Depth

Site

Comorbidities

Extreme needle phobia



Literature Review

Current literature suggests cannulation-related complications are under-estimated

Previous studies have the following variables may be associated with cannulation-related complications:

- **Age**
- Maturation time of the fistula / graft
- Site of access (upper vs. lower arm)
- Length of the cannulation route
- **Cannulation technique**
 - Including: **use of tourniquet, local anaesthetic, needle gauge, needle length, cannulation technique (rope ladder, area), needle bevel position, rotation of needle after insertion**
- Comorbidity
- Type of access (AVF vs. AVG)
- Vessel depth
- **Bruising & oedema**



Aims

- Phase I
 - Identify variables associated with successful VA cannulation and modify the existing WAHVAC instrument
- Phase II
 - Evaluate the revised WAHVAC instrument for content validity, and reliability y



Methodology

- Phase I
- Study design, participants & setting
 - Prospective cohort study
 - Participants
 - Haemodialysis nurses who consent (n=63)
 - Haemodialysis patients who do not opt-out (n=175)
 - Setting
 - SCGH haemodialysis unit
 - Stirling Diaverum haemodialysis unit
 - Joondalup hospital haemodialysis unit



Data collection

- Nurse demographic data
- Patient demographic data
- Case report form data



Outcome measures

Primary outcome measure

- Cannulation success
- Variables associated with cannulation success

Secondary outcome measures

- The number of cannulations
- 2nd nurse required to cannulate
- Extravasation
- Use of an existing CVC
- Use of single needle for dialysis
- Required a temporary CVC
- Online clearance at end of treatment (Kt/V)



Data analysis

- Frequencies (n) and percentages (%) are provided for categorical variables
- Summary statistics are provided for continuous variables (mean, SD)
- Univariate and multivariate generalised estimating equation models were used to determine factors associated with first-time cannulation success
 - Models were conducted Nurse only, Patient only, CRF only, and All measures combined, all with repeated measures for Patient ID and Nurse ID
 - Stepwise backward selection removing the highest p-value to provide the final multivariate model



Results

Nurse Characteristics	n	%
Employment status		
Full time	31	49.2
Part time / Casual	32	50.8
Sex Female	53	84.1
Highest Level of Education		
Bachelor / Registered Nurse	48	76.2
Graduate degree or higher	15	23.8
Job Title		
RN	50	79.4
CN / SDN	13	20.6
Post graduate in renal nursing		
No	43	68.2
Yes	20	31.8

Nurse Characteristics	Mean (SD)	Min - Max
Age	41.4 (9.4)	20 – 62
Years as RN	16.2 (9.8)	1 - 40
Years in Haemodialysis	9.8 (6.7)	½ - 30

Patient Characteristics (n=175)	n	%
Gender		
Female	62	35.4
Male	113	64.6
Medications (Yes)		
Steroids	8	4.6
Immunosuppressant	5	2.9
Anticoagulant	15	8.6
PAI	19	10.3
Comorbidity (Yes)		
Diabetes	93	53.1
PVD	37	21.1
Heart disease	82	46.9
Hypertension	130	74.3
Hypotension	11	6.3
Smoker	6	3.4

Patient Characteristics	Mean (SD)	Min - Max
Patient Age (Years)	50.8 (31.2)	31 – 94
Age of graft / fistula (years)	3.7 (3.8)	3/12 – 29
BMI	27.2 (6.5)	14 – 65



Patient Characteristics	n	%
AV Type		
Fistula	157	89.7
Graft	16	9.1
Depth AVF / AVG		
Non-palpable	1	0.6
Palpable	87	49.7
Superficial	61	34.9
Surgical revision < 3 months	17	9.7
Vessel		
Straight	109	62.3
Zig-zag	44	25.1
Bifurcation		
Nil	94	53.7
Single	54	30.9
Multiple	13	7.4
Areas of Aneurysm		
Yes	54	30.9
No	110	62.9



Case Report Form (n=1946)	n	%
Graft / Fistula characteristics (Yes)		
Stenosis	175	9.0
Bruit	189	9.7
Stent in situ	69	3.6
Oedema	59	3.0
Bruising	251	12.9
Haematoma	64	3.3
AVF very 'soft' with tendency to 'blow'	312	16.0
Hospital		
SCGH	609	31.3
Joondalup	457	23.5
Stirling	880	45.2

	n	Mean (SD)
Vessel length (cm)	n=1895	12.2 (4.3)
Confidence (Scale 0-10)	n=1895	8.6 (2.2)



Cannulation Technique (n=1946)	n	%
Tourniquet	1225	62.9
Ultrasound	80	4.1
Standard needle length	1875	96.4
Arterial needle antegrade	1523	78.3
Arterial needle bevel up	1587	81.6
Arterial needle rotated	824	42.3
Venous needle bevel up	1610	82.7
Venous needle rotated	685	35.2
Local anaesthetic		
Nil	546	28.1
Topical	1085	55.8
Subcutaneous	287	14.7
Both	28	1.4
Cannulation technique		
Area	481	24.7
Rope-ladder	1436	73.8



- Primary Outcome – cannulation success
- Whole cohort
 - Success: 1862 / 1946 = 95.7%
 - Fail: 84 / 1946 = 4.3%
- Included in the multivariate analysis (75.8%)
 - Success: 1534 / 1597 = 96.1%
 - Fail: 63 / 1597 = 3.9%



Multivariate Variables associated with First-time success

Variable	OR	95% CI	p-value
Use of ultrasound – if yes	10.1	4.62, 22.3	<0.001
Stent in useable section of fistula -if no	3.09	1.30, 7.37	0.01
AV Type (fistula vs graft)	2.40	1.32, 4.36	0.004
Age of access	1.31	1.07, 1.60	0.008
Gender of nurse (if male)	58.9	8.88, 390	<0.001
Nurse confidence of success (0-10)	0.91	0.80, 1.03	0.15
Gender*Nurse confidence interaction (if female)	1.34	1.15, 1.56	<0.001



Secondary Outcome Measures

Variables	n	%
No. of cannulation attempts		
3	69	3.5
4	16	0.8
6	1	0.1
Allocated nurse cannulate (no)	127	6.5
Extravasation (yes)	17	0.9
Used an existing CVC	6	0.3
Mid-treatment Arterial pressures > 150mmHg	941	48.4
Mid-treatment venous pressures < 100mmHg	156	8.0
Mid-treatment venous pressure > 150mmHG	880	45.2

	Mean (SD)
Kt/V (n=1084)	1.38 (0.21)



Limitations

- Missing data
- Under powered



Phase II

- Revise the current WAHVAC instrument based on Phase I results.
- Content Validity Index
- Reliability and Validity



Vascular Access Classification Tool

URN:	
Surname:	
Forename:	
Gender:	
DOB:	



HD patient vascular access classified & reported quarterly - Q1: Feb, Q2: May, Q3: Aug, Q4: Nov

Classification
colour-coded

Simple
Scores: < 12 **S**

Challenging
Scores: 13 - 20 **Cg**

Complex
Scores: > 21 **Cx**

An AV Fistula less than three months is automatically classified Complex

Date							
	Score	Score	Score	Score	Score	Score	Score
Access History							
Surgically created < 3 months	20						
First cannulation < 3 months	20						
Surgical revision < 3 months	10						
Stent in situ in useable section of AVF	10						
Access Assessment							
Single vessel - relatively straight	0						
Vessel not straight - zig zag	3						
Bifurcation	single	3					
	multiple	4					
Areas of aneurysm	4						
Bruit (high pitch) indicates area(s) of stenosis	3						
History of / current stenosis	3						
AVF very 'soft' with tendency to 'blow' easily	3						
Buttonhole tracks formed < 3 months	6						
Anatomy							
Length of viable vessel: (cm)	< 10.0	4					
	10.0 - 15.0	2					
	> 15.0	0					
Depth: (cm)	Superficial	0					
	Palpable	3					
	Non Palpable	6					
AVF Site							
Forearm	Radio-Cephalic	0					
Upper Arm	Brachio-Cephalic	3					
	Brachio-Basilic	6					
Thigh		8					
AVG Site							
Forearm		10					
Upper Arm		10					
Thigh		15					
Necklace		25					
Patient Co-morbidities							
Diabetic		1					
Peripheral Vascular Disease		1					
Heart disease		1					
Hypertension		1					
Hypotension		1					
Taking steroids / Immunosuppressant		1					
Nicotine use		1					
Extreme needle phobia		12					
No further surgical access options		13					
Total Score:							
Classification:							



Conclusion

- Primary Outcome – cannulation success
 - Success: $1862 / 1946 = 95.7\%$
 - Fail: $84 / 1946 = 4.3\%$
- Variables associated with successful cannulation
 - Use of ultrasound
 - Stent in re-usable section fistula
 - Fistula compared with graft
 - Age of Access
 - Nurse gender
 - Nurse gender * confidence interaction



Any Questions??



Thank you



Thank you

