THE DETERMINANTS OF TRAINING AND TECHNIQUE FAILURE IN HOME HEMODIALYSIS

CHRISTOPHER T CHAN MD FRCPC
DIRECTOR – DIV OF NEPHROLOGY – UNIVERSITY HEALTH NETWORK
R FRASER ELLIOTT CHAIR IN HOME DIALYSIS
PROFESSOR OF MEDICINE – UNIVERSITY OF TORONTO
OBJECTIVES

• TO DISCUSS STRATEGIES AND INNOVATION IN MAINTAINING HOME HEMODIALYSIS TECHNIQUE SURVIVAL
  • VASCULAR ACCESS MANAGEMENT
  • TECHNIQUE SURVIVAL
• TO ILLUSTRATE NEW OPPORTUNITIES AND OUTCOME RESEARCH IN HOME HEMODIALYSIS
# Determinants of training and technique failure in home hemodialysis

Michael E. SCHACHTER,* Karthik K. TENNANKORE,* Christopher T. CHAN  
Division of Nephrology, Department of Medicine, University Health Network, Toronto, Ontario, Canada

## Table 2  Social and dialysis-associated factors among incident home hemodialysis patients

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Failure (n = 32)</th>
<th>Success (n = 145)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Social factors</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>College/university education, n (%)</td>
<td>21 (68)</td>
<td>88 (61)</td>
<td>0.55</td>
</tr>
<tr>
<td>Renting current residence, n (%)</td>
<td>13 (41)</td>
<td>31 (21)</td>
<td>0.04</td>
</tr>
<tr>
<td>Living alone or with dependents, n (%)</td>
<td>9 (28)</td>
<td>26 (18)</td>
<td>0.22</td>
</tr>
<tr>
<td>Distance from HHD training unit, (median km, IQR)</td>
<td>19 (9–37)</td>
<td>22 (11–45)</td>
<td>0.18</td>
</tr>
<tr>
<td><strong>Dialysis factors</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nephrology follow-up before start of HHD, n (%)</td>
<td>27 (84)</td>
<td>140 (97)</td>
<td>0.02</td>
</tr>
<tr>
<td>Central venous catheter dialysis access, n (%)</td>
<td>22 (69)</td>
<td>71 (49)</td>
<td>0.05</td>
</tr>
<tr>
<td>RRT vintage, (median years, IQR)</td>
<td>0.8, 0–8.0</td>
<td>1.5, 0–12.0</td>
<td>0.71</td>
</tr>
<tr>
<td>Capacity to perform HHD independently, n (%)</td>
<td>26 (81)</td>
<td>101 (70)</td>
<td>0.28</td>
</tr>
</tbody>
</table>

HHD = home hemodialysis; IQR = interquartile range; RRT = renal replacement therapy.
SUBOPTIMAL INITIATION OF HOME HEMODIALYSIS:

DETERMINANTS AND CLINICAL OUTCOMES
BACKGROUND

• TRANSITION FROM CKD TO DIALYSIS IS A CRITICAL PERIOD
  • HIGH MORTALITY
  • HIGH RATE OF HOSPITALIZATIONS

• PATIENTS’ PREPAREDNESS TO INITIATE DIALYSIS REMAIN HIGHLY VARIABLE
  • IMPROVED BY PRE-DIALYSIS CLINICS
  • NOT ALWAYS REFERRED
  • NOT ALWAYS COMPLIANT
Adjusted for age, gender, diabetes
METHODOLOGY

• RETROSPECTIVE COHORT STUDY
• SINGLE CENTER (TGH)
• INCIDENT HHD PATIENTS WITH COMPLETED TRAINING
  • JANUARY 1996 – DECEMBER 2011
  • PATIENTS FOLLOWED UNTIL JULY 2012

• INCLUSION:
  • HHD = FIRST RRT OR FIRST AFTER KIDNEY TRANSPLANT
  • PATIENTS WITH TRANSITION THROUGH CHD < 30 DAYS

• EXCLUSION:
  • PATIENTS TRANSFERRED FROM CHD ≥ 30 DAYS
  • PATIENTS TRANSFERRED FROM PD
DEFINITION UNAVOIDABLE SUBOPTIMAL

- ACUTE DECLINE IN KIDNEY FUNCTION (9)
- DOCUMENTED NON-COMPLIANCE TO FOLLOW-UP (6)
- ABSENCE OF NEPHROLOGY FOLLOW-UP (5)
- CONTRAINDICATION (OR FAILURE) TO VASCULAR ACCESS CREATION (3)
- NEPHRECTOMY (BILATERAL OR GRAFT) (3)
207 HHD incident patients

112 excluded: Transfer from PD 8 / CHD 104

44 optimal starts
51 suboptimal starts

25 avoidable
26 unavoidable

CVC: 47 (92%)
Inpatient: 32 (63%)
### BASELINE CHARACTERISTICS

<table>
<thead>
<tr>
<th>Characteristics, n (%)</th>
<th>Optimal start (n= 44)</th>
<th>Suboptimal start (n=51)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean ± SD</td>
<td>48.4 ± 14.0</td>
<td>44.0 ± 13.8</td>
<td>0.12</td>
</tr>
<tr>
<td>Caucasian</td>
<td>30 (68)</td>
<td>25 (49)</td>
<td>0.07</td>
</tr>
<tr>
<td>Male</td>
<td>33 (75)</td>
<td>33 (65)</td>
<td>0.37</td>
</tr>
<tr>
<td><strong>ESRD etiology</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diabetic nephropathy</td>
<td>7 (16)</td>
<td>10 (20)</td>
<td>0.79</td>
</tr>
<tr>
<td>Glomerulonephritis</td>
<td>13 (30)</td>
<td>19 (37)</td>
<td>0.52</td>
</tr>
<tr>
<td><strong>Comorbidities</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diabetes</td>
<td>9 (20)</td>
<td>16 (31)</td>
<td>0.25</td>
</tr>
<tr>
<td>Coronary arterial disease</td>
<td>3 (7)</td>
<td>6 (12)</td>
<td>0.50</td>
</tr>
<tr>
<td>Charlson comorbidity index, median (IQR)</td>
<td>2 (2-4)</td>
<td>3 (2-5)</td>
<td>0.03</td>
</tr>
<tr>
<td><strong>Nephrology follow-up</strong></td>
<td></td>
<td></td>
<td>0.01</td>
</tr>
<tr>
<td>General nephrology clinic</td>
<td>20 (46)</td>
<td>13 (25)</td>
<td></td>
</tr>
<tr>
<td>Transplantation clinic</td>
<td>8 (18)</td>
<td>20 (39)</td>
<td></td>
</tr>
<tr>
<td>Pre-dialysis clinic</td>
<td>16 (36)</td>
<td>13 (26)</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>0</td>
<td>5 (10)</td>
<td></td>
</tr>
</tbody>
</table>
PRIMARY OUTCOME EVENTS

- HOSPITALIZATION 52
- TECHNIQUE FAILURE 3
- DEATH 1

<table>
<thead>
<tr>
<th>Hospitalizations</th>
<th>Optimal (18)</th>
<th>Suboptimal (34)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access-related bacteremia</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>Access</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Dialysis-related</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Other</td>
<td>14</td>
<td>24</td>
</tr>
</tbody>
</table>
KAPLAN-MEIER SURVIVAL CURVES FOR TIME TO COMPOSITE OUTCOME (HOSPITALIZATION, TECHNIQUE FAILURE OR DEATH)

Log Rank $p < 0.001$
Factors in model include age, Caucasian race, gender, diabetic end-stage renal disease and the CCI.
## DETERMINANTS OF SUBOPTIMAL START - UNIVARIABLE LOGISTIC REGRESSION

<table>
<thead>
<tr>
<th>Factor</th>
<th>Odds Ratio</th>
<th>[95% Confidence Interval]</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male gender</td>
<td>0.61</td>
<td>[0.25-1.49]</td>
<td>0.28</td>
</tr>
<tr>
<td>Caucasian race</td>
<td>0.45</td>
<td>[0.19-1.04]</td>
<td>0.06</td>
</tr>
<tr>
<td>Age (per year increase)</td>
<td>0.98</td>
<td>[0.95-1.01]</td>
<td>0.12</td>
</tr>
<tr>
<td>CCI (per point increase)</td>
<td>1.29</td>
<td>[1.01-1.63]</td>
<td>0.04</td>
</tr>
<tr>
<td>Transplantation clinic follow-up</td>
<td>2.90</td>
<td>[1.12-7.51]</td>
<td>0.03</td>
</tr>
</tbody>
</table>
AVOIDABLE SUBOPTIMAL STARTS & EGFR SLOPES

• UNAVOIDABLE IF:
  • ACUTE DECLINE IN KIDNEY FUNCTION (9)
  • DOCUMENTED NON-COMPLIANCE TO FOLLOW-UP (6)
  • ABSENCE OF NEPHROLOGY FOLLOW-UP (5)
  • CONTRAINDICATION (OR FAILURE) TO VASCULAR ACCESS CREATION (3)
  • NEPHRECTOMY (BILATERAL OR GRAFT) (3)

• 51 SUBOPTIMAL STARTS:
  • 26 UNAVOIDABLES SUBOPTIMAL START
  • 25 AVOIDABLES SUBOPTIMAL START
EGFR 6 MONTHS BEFORE DIALYSIS INITIATION

Optimal start

Avoidable suboptimal start

Unavoidable suboptimal start

eGFR at start (ml/min/1.73 m²):

A 11 (8-13)
B 8 (6-10)
C 10 (7-15)

Slope: -0.44 (-1.1; -0.17)
Slope: -1.27 (-1.86; -0.88)
Slope: -2.25 (-4.83; -1.38)
DISCUSSION

• CONCERNS THAT MORE THAN 50% HHD PATIENTS INITIATE DIALYSIS SUBOPTIMALLY
  • “HEALTHIER”
  • YOUNGER
  • MORE INDEPENDENT

• IN THIS SELECTED COHORT, SUBOPTIMAL START IS ALSO ASSOCIATED WITH ADVERSE OUTCOMES
  • MOSTLY HOSPITALIZATIONS
BUTTONHOLE

• AKA “CONSTANT-SITE CANNULATION”
• DESCRIBED IN 1977 (HOSPITAL FOR MINERS, POLAND)

• CANNULATION:
  • SAME SPOT
  • SAME ANGLE
  • SAME DEPTH
  • EVERY TIME

Scar tissue tunnel tract develops
Risk of Vascular Access Complications with Frequent Hemodialysis

Rita S. Suri,* Brett Larive,† Susan Sherer,‡ Paul Eggers,‡ Jennifer Gassman,† Sam H. James,§ Robert M. Lindsay,* Robert S. Lockridge,¶ Daniel B. Ornt,¶ Michael V. Rocco,** George O. Ting,†† Alan S. Kliger,‡‡ and the Frequent Hemodialysis Network Trial Group

A

\[
\text{HR (95\% CI) = 1.76 (1.11 - 2.79), } P = 0.017
\]

B

\[
\text{HR (95\% CI) = 1.81 (0.94 - 3.46), } P = 0.076
\]

<table>
<thead>
<tr>
<th>Variable</th>
<th>Daily Trial</th>
<th></th>
<th>Nocturnal Trial</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Conventional</td>
<td>Daily</td>
<td>Conventional</td>
<td>Nocturnal</td>
</tr>
<tr>
<td>AVF/AVG*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patients (n)</td>
<td>106 (79/28)</td>
<td>114 (90/28)</td>
<td>28 (23/6)</td>
<td>32 (29/3)</td>
</tr>
<tr>
<td>Total follow-up (yr)</td>
<td>87.9 (67.1/20.8)</td>
<td>95.8 (76.9/18.9)</td>
<td>24.2 (18.8/5.4)</td>
<td>24.3 (22.0/2.3)</td>
</tr>
<tr>
<td>Repairs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Angioplasty</td>
<td>21 (11/10)</td>
<td>28 (14/14)</td>
<td>5 (3/2)</td>
<td>14 (13/1)</td>
</tr>
<tr>
<td>Stent placement</td>
<td>2 (2/0)</td>
<td>2 (1/1)</td>
<td>0 (0/0)</td>
<td>0 (0/0)</td>
</tr>
<tr>
<td>Thrombectomy</td>
<td>10 (3/7)</td>
<td>22 (5/17)</td>
<td>1 (0/1)</td>
<td>2 (1/1)</td>
</tr>
<tr>
<td>Surgical revision</td>
<td>5 (3/2)</td>
<td>14 (7/7)</td>
<td>1 (1/0)</td>
<td>0 (0/0)</td>
</tr>
<tr>
<td>Overall rate (per 100 patient-yr)</td>
<td>43</td>
<td>69</td>
<td>29</td>
<td>66</td>
</tr>
</tbody>
</table>

P=0.011

P=0.069

INTEGRATED HOME DIALYSIS

Figure 1 – The integrated care concept [based on Refs. (1), (3), and (4)].

Figure 2 – A broader concept of integrated care.

MENDELSOHN and PIERRATOS, PDI 2002
CUMULATIVE PATIENT AND TECHNIQUE SURVIVAL:
INTEGRATED HOME DIALYSIS SYSTEM

Log rank P=0.893

HR 1.15 (0.51-2.59), P=0.601

Number at risk
No PD exposure 172 144 109 84 67 52
PD exposure 35 31 25 21 15 12
# Procedure-Related Serious Adverse Events Among Home Hemodialysis Patients: A Quality Assurance Perspective

Ben Wong, MD, Deborah Zimmerman, MD, Frances Reintjes, BScN, Mark Courtney, MD, Scott Klarenbach, MD, Graeme Dowling, MD, and Robert P. Pauly, MD, MSc, FRCP C

## Table 2. Causes of Adverse Events

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Human Error(s) or Machine/Disposable Defects</th>
<th>Immediate Cause of Adverse Event</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Human error</td>
<td>Blood loss</td>
<td>Ignored machine alarms; improper threading of connections; placement of wetness detectors in incorrect position</td>
</tr>
<tr>
<td>2</td>
<td>Human error</td>
<td>Air embolism</td>
<td>Neglected to clamp CVC</td>
</tr>
<tr>
<td>3</td>
<td>Possible human error, possible disposable defect</td>
<td>Blood loss</td>
<td>Possible failed integrity of cap; possibly did not correctly thread connections</td>
</tr>
<tr>
<td>4</td>
<td>Possible human error, possible disposable defect</td>
<td>Blood loss</td>
<td>Improper placement of clamp; failed integrity of cap</td>
</tr>
<tr>
<td>5</td>
<td>Human error</td>
<td>Blood loss</td>
<td>Improper machine setup; neglected to use wetness detectors</td>
</tr>
<tr>
<td>6</td>
<td>Human error</td>
<td>Blood loss</td>
<td>Improper threading of connections; placement of wetness detector in incorrect position</td>
</tr>
<tr>
<td>7</td>
<td>Human error</td>
<td>Blood loss</td>
<td>Did not follow machine setup protocol specific to local home HD program</td>
</tr>
</tbody>
</table>

Abbreviations: CVC, central venous catheter; HD, hemodialysis.
The Feasibility of Caregiver-Assisted Home Nocturnal Hemodialysis

Karthik K. Tennankore  S. Joseph Kim  Christopher T. Chan

University Health Network/Toronto General Hospital, University of Toronto, Toronto, Ont., Canada

Fig. 2. Baseline comorbidities stratified by dependency status.

- Hypertension
- Diabetes
- Coronary artery disease
- Malignancy
- Congestive heart failure
- Peripheral vascular disease
- Cerebrovascular disease

<table>
<thead>
<tr>
<th>Condition</th>
<th>Dependent</th>
<th>Independent</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension</td>
<td>83</td>
<td>44</td>
<td></td>
</tr>
<tr>
<td>Diabetes</td>
<td>19</td>
<td>43</td>
<td>**</td>
</tr>
<tr>
<td>Coronary artery disease</td>
<td>6</td>
<td>30</td>
<td>**</td>
</tr>
<tr>
<td>Malignancy</td>
<td>21</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>6</td>
<td>19</td>
<td>*</td>
</tr>
<tr>
<td>Peripheral vascular disease</td>
<td>4</td>
<td>15</td>
<td>*</td>
</tr>
<tr>
<td>Cerebrovascular disease</td>
<td>6</td>
<td>13</td>
<td></td>
</tr>
</tbody>
</table>

Cumulative survival

Number at risk

- Independent: 105, 73, 45, 32, 21, 11, 5
- Dependent: 47, 29, 13, 7, 3, 2, 1

*p < 0.05
**p < 0.01
CANADIAN HOME DIALYSIS VIRTUAL WARD TEAM

• MULTISITE STUDY (FUNDED THROUGH BAXTER CEC GRANT PROGRAM)
• PROTOCOLISED TELEPHONE F/U
• HIGH RISK PATIENTS DURING TRANSITION FROM CARE
  • GRADUATING FROM TRAINING
  • USE OF ANTIBIOTICS
  • AV ACCESS INSTRUMENTATION
  • HOSPITALIZATION
SUMMARY

• THERE IS A RESURGENCE OF INTEREST IN HOME DIALYSIS

• DATA SUGGEST THAT SUBOPTIMAL START IS ASSOCIATED WITH ADVERSE TECHNIQUE SURVIVAL

• ADVERSE SIGNAL
  • DIALYSIS ACCESS

• INTEGRATED HOME DIALYSIS SYSTEM
  • EDUCATION
  • TELEHEALTH STRATEGIES
ACKNOWLEDGMENTS

- **HUMAN CARDIOVASCULAR PHYSIOLOGY GROUP**
  - JS FLORAS

- **SLEEP MEDICINE**
  - D BRADLEY

- **STEM CELL GROUP**
  - S VERMA
  - H MESSNER

- **CARDIOVASCULAR GENOMICS**
  - PETER LIU

- **MYOCARDIAL MECHANICS**
  - HARRY RAKOWSKI

- **E-HEALTH GROUP**
  - J CAFAZZO

**GRANTING AGENCIES**

- CIHR, HSFO, BUL – MEDICINE, PSI, BAXTER EXTRAMURAL GRANT PROGRAM, BAXTER CEC PROGRAM NIDDK

- FHN CONSORTIUM

- ACTIVE CONSORTIUM