Patient Focused Technology Enabled Programs improve Outcomes in Primary Total Hip and Knee Replacement

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L Rong

Kingsfund Digital Health and Care Congress 2016
Disclosures

P Jayakumar
Consulting Clinician
• Johnson and Johnson MD Value Creation Team
• Research and Development
• Data analysis
• Collaborative partnerships
Overview

1.0 Enhanced Recovery in Orthopaedic Surgery: The Context of Value
   - What is Enhanced Recovery?
   - How can it improve Outcomes and Value in surgical health care?

2.0 The Care4Today® Program
   - What is it Care4Today®?
   - Evidence Generation from Guys & St Thomas’ & Nottingham University Hospital

3.0 Next Steps
   - Technology enabled solutions in ERAS
1.0 Goals of Enhancing Recovery after Surgery (ERAS)

Integrate evidence-based clinical best practices within enhanced pathway of care
Comprehensive in scope: ”The whole patient journey”

ERAS Society, 2015
1.0 Improving Outcomes and Value in Surgical Health Care

Learning
Minimizing Variation
CE & Value Based Payment
Improving Performance

Value

Volume = Cost

1.0 Care4Today Orthopaedic Solutions

A program integrating health and multi-media features with clinical ERAS protocols and technology

Aim: To improve patient experience and flow management

Health-service Components

- Modified Joint School
- Accelerated Physical Therapy
- Outreach Service

Multi-media Components

- Patient Website
- AHCP Website
- Patient Education Pack
- DVD

Information Technology (IT) Platform

- Electronic Health Record (EHR) System
- Patient Information Management System (PiMS)
1.0 Novel Outreach Service developed by cross-training personnel from Allied Healthcare Disciplines

- GSTT
- NUH
2.0 Study Design & Methodology

Retrospective Cohort (pre-program implementation)

Prospective Cohort (post-program implementation)

Extended Baseline

Real-time Baseline

n = x

n = y

Contract Signed including Data Sharing Agreement

Program Implementation

Follow up Contacts 6m Limit

Data Analysis
2.1 Objectives & Outcome Measures
Understand the impact of the program on clinical outcomes, patient-focused outcomes and cost

**CLINICAL**
- Length of Stay
- 30d Readmission Rates
- 6m Readmission Rates
- Complication
- Re-operation
- Re-attendance rates

**PATIENT-FOCUSED**
- PROM
  - OHS / OKS
  - Numerical Rating Scale
- Experience Ratings
  - Education
  - Satisfaction
  - Confidence
  - Expectation management

**COST**
2.1 GSTT C4T OS Overview

2088 consecutive adult Primary Joint Replacement patients January 2012 to December 2014; Program start June 2013

- OS = Outreach Support
- NOS = No Outreach Support

Eligibility Criteria
1. Satisfactory medical status
2. Satisfactory social support
3. One floor living initial period
4. Geographical catchment

CLINICAL
<table>
<thead>
<tr>
<th></th>
<th>Pre-Program</th>
<th>Post-Program</th>
<th>Post-Program OS</th>
<th>Post-Program NOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age at Ax (mean ± SD)</td>
<td>66.3 ± 10.23</td>
<td>64.7 ± 12.15</td>
<td>65.6 ± 10.33</td>
<td>64.1 ± 13.30</td>
</tr>
<tr>
<td>Gender (% female)</td>
<td>59.4%</td>
<td>61.0%</td>
<td>62.4%</td>
<td>60.0%</td>
</tr>
<tr>
<td>Charlson index (mean ± SD)</td>
<td>4.1 ± 1.96</td>
<td>4.0 ± 2.07</td>
<td>4.0 ± 1.99</td>
<td>3.9 ± 2.12</td>
</tr>
<tr>
<td>% ASA Grade 3+</td>
<td>28.2%</td>
<td>34.3%</td>
<td>33.6%</td>
<td>34.9%</td>
</tr>
</tbody>
</table>

Comparable patient demographics
Medical complexity is high based on ASA and Charlson Index
...considering 16% ASA 3+ (UK National Avg 2013/14)
...considering Charlson Index of 2+ high
LoS reduced by 9-41%

- p-value calculated using 2-sample t-test based on log-transformed data
- p < 0.001 to p=0.003
30d Readmissions not increased & rates below national levels

**THR**

<table>
<thead>
<tr>
<th></th>
<th>Pre-Program</th>
<th>Post-Program</th>
<th>Post + OS</th>
<th>Post + NOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>NJR</td>
<td>4.6%</td>
<td>3.5%</td>
<td>4.2%</td>
<td>3.1%</td>
</tr>
<tr>
<td>Reduction</td>
<td>24%</td>
<td>8%</td>
<td>33%</td>
<td></td>
</tr>
</tbody>
</table>

**TKR**

<table>
<thead>
<tr>
<th></th>
<th>Pre-Program</th>
<th>Post-Program</th>
<th>Post + OS</th>
<th>Post + NOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>NJR</td>
<td>5.9%</td>
<td>5.7%</td>
<td>5.7%</td>
<td>5.7%</td>
</tr>
<tr>
<td>Reduction</td>
<td>4%</td>
<td>4%</td>
<td>3%</td>
<td></td>
</tr>
</tbody>
</table>

* p-value calculated using method by Miettinen and Nurminen (1990)

**National Re-admission Rate NJR 2012-2013**

- THR: 7.3%
- TKR: 9.6%

- p-value calculated using 2-sample t-test based on log-transformed data
- p<0.0001
<table>
<thead>
<tr>
<th></th>
<th>Pre-Program</th>
<th>Program Combined</th>
<th>% Reduction</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>THR</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30d Readmission</td>
<td>5%</td>
<td>3.7%</td>
<td>26%</td>
<td>0.102</td>
</tr>
<tr>
<td>6m Readmission</td>
<td>4.6%</td>
<td>2.7%</td>
<td>41%</td>
<td>0.063</td>
</tr>
<tr>
<td>General Complications</td>
<td>9.3%</td>
<td>7.0%</td>
<td>25%</td>
<td>0.282</td>
</tr>
<tr>
<td>Specific Complications</td>
<td>6.4%</td>
<td>4.1%</td>
<td>36%</td>
<td>0.107</td>
</tr>
<tr>
<td>A&amp;E Reattendance</td>
<td>17.6%</td>
<td>14.5%</td>
<td>18%</td>
<td>0.677</td>
</tr>
<tr>
<td><strong>TKR</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30d Readmission</td>
<td>6.3%</td>
<td>5.5%</td>
<td>13%</td>
<td>0.681</td>
</tr>
<tr>
<td>6m Readmission</td>
<td>8.1%</td>
<td>6.1%</td>
<td>25%</td>
<td>0.247</td>
</tr>
<tr>
<td>General Complications</td>
<td>11.3%</td>
<td>8.4%</td>
<td>26%</td>
<td>0.211</td>
</tr>
<tr>
<td>Specific Complications</td>
<td>7.5%</td>
<td>5.9%</td>
<td>21%</td>
<td>0.738</td>
</tr>
<tr>
<td>A&amp;E Reattendance</td>
<td>19.4%</td>
<td>15.4%</td>
<td>21%</td>
<td>0.109</td>
</tr>
</tbody>
</table>

Complication and Re-attendance rates not increased
Outcomes improved in patients with a range of medical complexity

Model-based reduction of LOS, complication and readmission from pre-program to program versus subgroups of Charlson Comorbidity Index (CCI)
Patient Experience improved in 5 Domains comparing three time-points

**THR**

**TKR**
# Cost savings overall

<table>
<thead>
<tr>
<th></th>
<th>THR</th>
<th>TKR</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fixed Costs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Program implementation</td>
<td>£11.41</td>
<td>£11.41</td>
</tr>
<tr>
<td>Joint school</td>
<td>£13.21</td>
<td>£13.21</td>
</tr>
<tr>
<td>Staff training</td>
<td>£6.86</td>
<td>£6.86</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>£31.48</td>
<td>£31.48</td>
</tr>
<tr>
<td><strong>Variable Costs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-assessment clinic</td>
<td>£42.00</td>
<td>£42.00</td>
</tr>
<tr>
<td>Post-operative A/HCP activity</td>
<td>£42.00</td>
<td>£42.00</td>
</tr>
<tr>
<td>Home visits</td>
<td>£1.97</td>
<td>£7.28</td>
</tr>
<tr>
<td>Travel costs</td>
<td>£0.64</td>
<td>£2.33</td>
</tr>
<tr>
<td>Post-discharge A/HCP activity</td>
<td>£8.27</td>
<td>£8.24</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>£94.88</td>
<td>£101.85</td>
</tr>
<tr>
<td><strong>Total Cost per patient</strong></td>
<td><strong>£126.36</strong></td>
<td><strong>£133.33</strong></td>
</tr>
</tbody>
</table>

- **Cost difference based on Cost per bed stay and mean change in LOS per patient**
  - **Total Variable cost** - £528
  - **Total Change in cost per patient** - £401.64

- **Overall Program Costs**
  - **Fixed** + £16,403
  - **Variable** + £49,428
  - **Total** + £65,831

- **Cost difference based on Cost per bed stay and mean change in LOS in total**
  - **Total variable costs** - £275,123
  - **Total Change in Costs in total** - £209,292

- **Overall Total**
  - **- £209,292**
  - **- £250,331**
2.2 NUH C4T OS Overview

2389 consecutive adult Primary Joint Replacement patients
April 2014 to October 2015; Program start April 2015

n=2389

Pre-Program
n=1483

Post-Program
n=906

CLINICAL

n=140

n=136

PATIENT-FOCUSED
2.2 Objectives & Outcome Measures
Understand the impact of the program on clinical outcomes, patient experience

<table>
<thead>
<tr>
<th>Endpoints of interest</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of stay (LOS)</td>
<td>Days from admission to discharge</td>
</tr>
<tr>
<td>Delay discharge rate (DDR)</td>
<td>% of patients who stayed in hospital &gt; 3 days</td>
</tr>
<tr>
<td>Delay discharge day (DDD)</td>
<td>For patients who had delay discharge, additional days they stayed in hospital</td>
</tr>
<tr>
<td>30d Readmission Rate (RR)</td>
<td>Readmission rate within 30 days post discharge</td>
</tr>
<tr>
<td>60d Complication Rate (CR)</td>
<td>Complication rate within 60 days post discharge</td>
</tr>
<tr>
<td>60d Reoperation Rate (ReR)</td>
<td>Reoperation rate within 60 days post discharge</td>
</tr>
<tr>
<td>Patients satisfaction score (PSS)</td>
<td>Measurement of patients’ satisfaction</td>
</tr>
</tbody>
</table>
### 2.2 NUH C4T: Patient Demographics

<table>
<thead>
<tr>
<th></th>
<th>Hip</th>
<th>Knee</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-C4T</td>
<td>Post-C4T</td>
</tr>
<tr>
<td><strong>Total # of Subjects</strong></td>
<td>698</td>
<td>432</td>
</tr>
<tr>
<td><strong>Age at Admission</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n (missing)</td>
<td>697 (1)</td>
<td>432 (0)</td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>67.5 (12.3)</td>
<td>67.3 (11.9)</td>
</tr>
<tr>
<td>Range (Min, Max)</td>
<td>(19, 95)</td>
<td>(20, 91)</td>
</tr>
<tr>
<td># (%) of patients with Age &gt; 65</td>
<td>450 (65.5%)</td>
<td>267 (61.8%)</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n (missing)</td>
<td>697 (1)</td>
<td>432 (0)</td>
</tr>
<tr>
<td># (%) of females</td>
<td>412 (59.1%)</td>
<td>251 (58.1%)</td>
</tr>
<tr>
<td><strong>ASA</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n (missing)</td>
<td>698 (0)</td>
<td>432 (0)</td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>2.1 (0.6)</td>
<td>2.1 (0.5)</td>
</tr>
<tr>
<td># (%) of patients with ASA &gt;2</td>
<td>157 (22.5%)</td>
<td>84 (19.4%)</td>
</tr>
</tbody>
</table>

Comparable patient demographics
Medical complexity is high based on ASA and Charlson Index
...considering 16% ASA 3+ (UK National Avg 2013/14)
Majority of patients staying 4-6d pre-program are now staying 1-3d post-program

P-values were calculated based on multivariate regression with predictors Age, Gender and ASA.

<table>
<thead>
<tr>
<th>LOS</th>
<th>P-value (hip)</th>
<th>P-value (knee)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3 days</td>
<td>0.0071</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>4-6 days</td>
<td>0.0053</td>
<td>0.0074</td>
</tr>
<tr>
<td>7-10 days</td>
<td>0.1727</td>
<td>0.0297</td>
</tr>
<tr>
<td>&gt;10 days</td>
<td>0.1946</td>
<td>0.0577</td>
</tr>
</tbody>
</table>
Note: P-values were calculated based on multivariate regression with predictors Age, Gender and ASA.
30d readmissions, complication and re-operation rates improved overall

P-values were calculated based on multivariate regression with predictors Age, Gender and ASA.
Patient Experience improved in 6 domains comparing pre-program with post-program cohorts

Patient Satisfaction Score for Hip Surgery

Patient Satisfaction Score for Knee Surgery

<table>
<thead>
<tr>
<th></th>
<th>P-value (hip)</th>
<th>P-value (knee)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-C4T vs. Post-C4T pre-op</td>
<td>0.2549</td>
<td>0.0001</td>
</tr>
<tr>
<td>Pre-C4T vs. Post-C4T post-op</td>
<td>0.0002</td>
<td>0.0001</td>
</tr>
<tr>
<td>Post-C4T pre-op vs. Post-C4T post-op*</td>
<td>0.0001</td>
<td>0.0101</td>
</tr>
</tbody>
</table>

PSS = Patient Satisfaction Survey
Limitations

- **Multiple components within program**
  - “What are the most influential factors?”

- **Confounding variables**
  - “How do components interact with each other?”

- **Enhanced Recovery**
  - “What is the impact of clinical protocols (i.e. pain, anaesthetic and surgical?”

- **Clinical outcomes**
  - “What happens to patients being followed or seeking medical attention elsewhere?”

- **Costing study assumptions**
  - “What are the IT related costs for a new hospital taking on this program?”
Real World Evidence
Large scale collaborative projects – ‘First of a kind’ in terms of technology enabled ERAS

Unique
Few, if any, programs integrate patient engagement & pathway management features with ERAS practices and technology

Clinical Effectiveness
Programs drives clinical effective delivery of care reducing LoS without negatively impacting clinical outcomes

Truly Patient-Focused
• Patient-reported outcomes & experience improved and even the more medically complex patients with greater needs benefit
Program Development & Evidence Generation should be fully integrated in order to measure relevant outcomes of the program and demonstrate value over the whole cycle of care.

**Program Development**
- Define program packages
- Extend to other specialties
- New ways of engaging patients
- Outcomes dashboard

**Evidence Generation**
- Extend to full RCTs
- Newer PROMs, PREMs, PAMs
- Build costing models
- Evaluate outcomes across full care cycle
Appendix
### 2.0 C4T OS Evidence Generation Process Map

<table>
<thead>
<tr>
<th>Study Protocol</th>
<th>Study Approval</th>
<th>Data Sourcing</th>
<th>Data Extraction</th>
<th>Raw Data Synthesis</th>
<th>Data Transfer</th>
<th>Quality Control</th>
<th>Validation Phase I</th>
<th>Final Data Synthesis</th>
<th>Validation Phase II</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSTT THA Project 1.0</td>
<td></td>
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<tr>
<td>GSTT TKA Project 1.0</td>
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<td>NUH THA Project 1.0</td>
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<tr>
<td>NUH TKA Project 1.0</td>
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<tr>
<td>NUH TKA Project 2.0</td>
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</tr>
</tbody>
</table>

- 27/6/2016
- 1/7/2016
- 8/7/2016
- 13/7/2016
- 20/7/2016
- TBC
- TBC

### Outputs

- **Regional**
  - **Guy's and St Thomas' NHS Foundation Trust**
  - **Nottingham University Hospital NHS Trust**

- **International**
  - **British Hip Society**
  - **International ERAS Society, Health Economic, Digital Health Conference**
  - **The King's Fund**
  - **International General Orthopaedic Conference**
  - **Journal of Arthroplasty**

- **Paper Publication**
  - **British Journal of Joint Disorders**
  - **The Journal of Arthroplasty**
  - **The King's Fund**

- **Completed**
- **In Progress**

### Dates
- ISTKA, Poland 10/2015
- BHS, Milan 11/2015
- ERAS, Lisbon 4/2016
- EFORT, Geneva 6/2016
- SICOT, Rome 9/2016
- GSTT Trust Audit 10/2014
- NUH Malkin Meet 6/2016