An Algorithm to Identify Delivery of Palliative Radiation Therapy Using Health Care Claims Data: A Proof of Concept Application of Data Visualization Tools in the Prostate Cancer Setting

E Onukwugha¹, J Gardner¹, J Jayasekera¹, S Malik², CD Mullins¹, A Valderama³, A Hussain⁴

1 University of Maryland School of Pharmacy
2 University of Maryland College Park, HCIL
3 Bayer Healthcare Pharmaceuticals
4 University of Maryland School of Medicine
Acknowledgements

• Bayer Healthcare Pharmaceuticals, Inc.
• Center for Health-related Informatics and Bioimaging
• UMB:
  – Owen White, MD, UM School of Medicine
  – Candice Yong, PhD candidate, UMSOP
  – Christine Franey, Pharmaceutical Research Computing, UMSOP
• UMCP, Human-Computer Interaction Lab (HCIL), UMIACS & Dept of Computer Science:
  – Amitabh Varshney, PhD, UMCP
  – Ben Shneiderman, PhD, UMCP
  – Catherine Plaisant, PhD, UMCP
Prior work using EventFlow
EventFlow implementation case no.1:
Warfarin usage before and after traumatic brain injury

- Data: Medicare Claims data, NIH R21: Long-term anticoagulation therapy after traumatic brain injury in older adults (5R21AG042768-02)

- Aim: to examine warfarin usage patterns among elderly atrial fibrillation patients who suffered traumatic brain injury

- Methods: patients grouped and sorted by distinct event sequence before and after injury (warfarin usage: yes, no, or missing)
  - Events are color coded bars
  - Height of the bar represents number of patients
  - The horizontal gap between bars represents the average time between two adjacent events

- Findings: the prevalence of warfarin use in elderly AF patients decreased after TBI
Warfarin Usage in Elderly Atrial Fibrillation Patients Who Experienced Traumatic Brain Injury

Xinggang Liu, Mona Baumgarten, Gordon Smith, Stephen Gottlieb, Christine Franey, Bilal Khokhar, Gail Rattinger, Megan Monroe, Ilene Zuckerman
University of Maryland, Baltimore, School of Pharmacy

Background
Warfarin is highly effective for the prevention of ischemic stroke among elderly patients with atrial fibrillation (AF). Traumatic brain injury (TBI) is prevalent among older adults and has been associated with an increased risk of bleeding and thromboembolic events.

Patients may briefly stop using warfarin or undergo anticoagulation reversal at the time of injury to counteract the abruptly increased bleeding risk. It is crucial to re-institute warfarin as soon as the risk of thrombotic events starts to outweigh the risk of bleeding.

There is a paucity of research examining the long term management of warfarin after TBI.

Objective
- To examine warfarin usage patterns among elderly atrial fibrillation patients who suffered traumatic brain injury

Methods: study sample
Using the 5% Chronic Condition Warehouse administrative claims data, we included fee-for-service Medicare beneficiaries who had a single TBI hospitalization between 1/1/2006 and 12/31/2006, complete Medicare Parts A, B (no O) and D coverage 6 months before TBI, were 65 or older, and were diagnosed with AF at least 1 year before TBI.

Definition of warfarin usage
- Patients follow up time divided into 30-day periods (months) before injury hospitalization admission and after hospital discharge
- Warfarin usage during Part D covered months determined by the number of days with warfarin coverage based on prescription refills

Covariates
- Age, sex, and race
- Chronic disease conditions which may increase the risk of thrombotic or bleeding events
  - Vascular heart disease/valve replacement
  - Atrial fibrillation
  - Stroke or transient ischemic attack (TIA)
  - Chronic liver disease/alcohol abuse
  - Congenital coagulation defect
  - Chronic kidney disease

Methods: statistical model
- Tabulated the proportion of patients with warfarin usage in each month, and then modeled the probability of receiving warfarin in part D covered months in a generalized linear model with generalized estimating equations to account for within patient correlation.

Results
1634 patients who met the Medicare coverage requirement and were diagnosed with AF at least 1 year before TBI

Warfarin usage patterns:
- 46% of the 1634 AF patients were using warfarin before TBI (Figure 1, 2)
- Dramatic decrease in warfarin use after injury, with 17%, 24%, and 27% of patients using warfarin in the 1st, 2nd, and 3rd month post-TBI
- By 12 months after TBI, warfarin usage increased to 30% but remained significantly lower than the pre-injury level

Patient characteristics associated with lower warfarin usage:
- Older age
- Non-white
- No history of vascular heart disease/valve replacement, atrial fibrillation, stroke, or TIA
- History of chronic liver disease, chronic kidney disease, coagulation defect, alcohol abuse (Figure 3.1-3.3)

After covariates adjustment, OR of having warfarin usage post-injury vs. pre-injury=0.43 (95% CI: 0.39 to 0.48), p<0.001

Figures: by diagnosis groups

Figures: warfarin usage pattern

Conclusions
- The prevalence of warfarin use in elderly AF patients decreased after TBI
- The decline in warfarin usage was sustained for months following injury.
- The excessive risk of bleeding, perceived or real, may prevent initiation or resumption of warfarin in elderly AF patients after TBI.
- Policy makers and practitioners should be alerted to the low prevalence of warfarin usage in this high-risk population and its potential impact on patient outcomes.

Acknowledgements
- This research is supported by NIH R21: Long-term anticoagulation therapy after traumatic brain injury in older adults. Project number: 1R21AG042786-02
- We are grateful to Ron Sheldon, and the team at University of Maryland College Park for access to the EventFlow software. Link: http://www.ca.umd.edu/tool/eventflow
EventFlow implementation case no.2:
Variation in the Length of Radiation Therapy among Men Diagnosed with Incident Metastatic Prostate Cancer

**Background:**
- Radiation therapy to the bone (RttB) is a common skeletal-related event (SRE) experienced by prostate cancer patients with bone metastasis.
- Codes available in claims data cannot distinguish RttB from radiation to the prostate gland (RttP), and may therefore overestimate RttB.

**Objective:**
- Recognizing that the course of therapy for RttB is typically shorter than the course for RttP, we examined the variation in length of radiation treatment episodes among patients diagnosed with metastatic (M1) prostate cancer (PCa), compared to patients with stage 4 non-metastatic (M0) PCa.

**Results:**
- The majority of radiation episodes among M1 patients were of short duration (<4 weeks). In the majority of M0 patients, the initial radiation episodes following diagnosis of PCa were of longer duration (>6 weeks).
- SREs occurred sooner after PCa diagnosis among M1 patients compared to M0 patients. Among M1 patients, radiation episodes following an SRE were more likely to be of shorter duration than longer duration.
Variation in the Length of Radiation Therapy among Men Diagnosed with Incident Metastatic Prostate Cancer

E Onukwugha1, Y Kwok2, C Yong1, CD Mullins1, B Seal3, A Hussain2,4

1 University of Maryland School of Pharmacy, Baltimore, MD; 2 University of Maryland School of Medicine, Baltimore, MD; 3 Bayer HealthCare Pharmaceuticals, Inc., Wayne, NJ; 4 Veterans Affairs Medical Center, Baltimore, MD.

ABSTRACT

Objective: To examine the length of radiation treatment episodes among patients diagnosed with metastatic prostate cancer (PCa) and metastatic bone metastasis (MBM).

Methods: Data were collected from the University of Maryland College Park, Human-Computer Interaction Lab, and the University of Maryland School of Pharmacy, Baltimore, MD. The data was analyzed using statistical software. The analysis was conducted using descriptive statistics and inferential statistics. Results: The average length of the radiation treatment episodes was 4.5 weeks. The length of the radiation treatment episodes varied significantly between patients with MBM and patients without MBM. Conclusions: The length of the radiation treatment episodes among patients with MBM was significantly longer than those without MBM. This indicates that patients with MBM may require additional follow-up and monitoring.

RESULTS

Fig. 1a: Overview of events among M1 patients (M1, M2, M3) and M0 patients (M0, M1).

Fig. 2a: Pattern of events among M1 patients with MBM (M1b, M2b, M3b) and M1 patients with MBM (M1a, M2a, M3a).

Fig. 2b: Pattern of events among M1 patients with MBM (M1b, M2b, M3b) and M1 patients with MBM (M1a, M2a, M3a).

Fig. 3: Algorithm for identifying radiation to the bone from EBT claim data.

LIMITATIONS OF ALGORITHM

- The algorithm is based on billing codes available in claims data and has not been validated against chart review.
- The algorithm does not consider the timing of the EBT episode relative to the diagnosis of bone metastasis and can be further refined to incorporate this information.
- The algorithm does not include other treatments for delivering palliative radiation to the bone. The algorithm can be expanded to include other treatments for delivering palliative radiation to the bone, e.g., radiopharmaceutical therapies.

CONCLUSIONS

- The length of the EBT episode varied among stage 4 and M1 patients: among M1 patients, 8 out of 10 EBT episodes were longer than 4 weeks; whereas among M0 patients, 4 out of 10 EBT episodes were <4 weeks.
- The length and timing of shorter duration EBT episodes in M1 and M0 patients was consistent with real-word expectations regarding radiation to the bone, with a similar result concerning longer duration EBT episodes and radiation to the prostate gland.
- Claims-based algorithm should consider the duration of the EBT episode as well as the timing of the EBT episode relative to pathological fracture, spinal cord compression, and bone surgery.

ACKNOWLEDGEMENTS

- Funding for the study was provided by the National Institute of Health (NIH), the University of Maryland College Park, and the University of Maryland School of Medicine.

CONTACT INFORMATION

Eberchukwu Onukwugha, PhD
onukwugha@umd.edu
Case Study
An Algorithm to Identify Delivery of Palliative Radiation Therapy Using Health Care Claims Data: A Proof of Concept Application of Data Visualization Tools in the Prostate Cancer Setting
Background
Background

• Bone is a common site of metastasis among individuals with solid tumors.  
  – For example, breast, prostate, and lung cancers.

• Patients with bone metastasis (BM) are at risk of skeletal-related events (SRE).

• SREs have a negative impact on health.
Skeletal related events

• Skeletal complications are associated with
  – morbidity
  – poor health-related quality of life
  – reduced survival

• Nearly two thirds of the men diagnosed with PCa in the United States are aged 65 years or older and are at increased risk of skeletal related events (SREs).
Rationale

- Skeletal-related events (SRE) include:
  - Pathological fracture (PF)
  - Spinal cord compression (SCC)
  - Bone surgery (BS)
  - Radiation to the bone (RttB)

- Issue:
  - Codes available in claims data cannot distinguish RttB from radiation to the prostate gland (RttP), and may therefore overestimate RttB.
Measurement

• Reliable measures for identifying the components of SREs are critical.
• Studies using healthcare claims employ various algorithms to identify RttB.
  – Condition on prior claims with a bone metastasis code
  – Concerns regarding sensitivity and specificity of diagnosis codes
A look at radiation codes...
<table>
<thead>
<tr>
<th>HCPCS Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>77402</td>
<td>Radiation treatment delivery, single treatment area, single port or parallel opposed ports, simple blocks or no blocks; up to 5 MeV</td>
</tr>
<tr>
<td>77403</td>
<td>Radiation treatment delivery, single treatment area, single port or parallel opposed ports, simple blocks or no blocks; 6-10 MeV</td>
</tr>
<tr>
<td>77404</td>
<td>Radiation treatment delivery, single treatment area, single port or parallel opposed ports, simple blocks or no blocks; 11-19 MeV</td>
</tr>
<tr>
<td>77406</td>
<td>Radiation treatment delivery, single treatment area, single port or parallel opposed ports, simple blocks or no blocks; 20 MeV or greater</td>
</tr>
<tr>
<td>77407</td>
<td>Radiation treatment delivery, two separate treatment areas, three or more ports on a single treatment area, use of multiple blocks; up to 5 MeV</td>
</tr>
<tr>
<td>77408</td>
<td>Radiation treatment delivery, two separate treatment areas, three or more ports on a single treatment area, use of multiple blocks; 6-10 MeV</td>
</tr>
<tr>
<td>77409</td>
<td>Radiation treatment delivery, two separate treatment areas, three or more ports on a single treatment area, use of multiple blocks; 11-19 MeV</td>
</tr>
<tr>
<td>77411</td>
<td>Radiation treatment delivery, two separate treatment areas, three or more ports on a single treatment area, use of multiple blocks; 20 MeV or greater</td>
</tr>
<tr>
<td>77418</td>
<td>Intensity modulated treatment delivery, single or multiple fields/arcs, via narrow spatially and temporally modulated beams</td>
</tr>
</tbody>
</table>
Objective
Objective

• To examine the variation in the length of radiation treatment episodes among patients diagnosed with metastatic (M1) PCa, comparing to patients with stage 4 non-metastatic (M0) PCa.

• To determine the components of a claims-based algorithm for identifying palliative radiation therapy.
**Dataset**: Linked Surveillance, Epidemiology and End Results (SEER)-Medicare database.
Overview of SEER-Medicare

SEER
- Cancer registry data
- Cause of death
- Area characteristics
- Cases from 1973-2009

Medicare
- Health Care claims
- Treatment dates
- Cost data
- Claims from 1991 to 2010

SEER-Medicare
Methods – Data source

• Data source and study cohort:
  • Linked Surveillance, Epidemiology and End Results (SEER) and Medicare data
  • Patients aged 66+ with an initial diagnosis of stage 4 PCa during 2000 - 2007
  • Medicare claims data from 1999 to 2009
Methods – Measures

• Outcome
  • External beam radiation therapy (EBT) episode lengths were grouped by duration:
    • Less than 4 weeks
    • 4-6 weeks
    • 6-8 weeks
    • Greater than 8 weeks

• Other events of interest
  • Prostate cancer diagnosis date
  • Treatment initiation: Androgen deprivation therapy, radiation, chemotherapy, radiopharmaceutical, or intravenous bisphosphonate
  • Other skeletal-related events (SRE)
    • Pathological fracture
    • Spinal cord compression
    • Bone surgery
Methods – Newer cut of data

• Data source and study cohort:
  • Linked Surveillance, Epidemiology and End Results (SEER) and Medicare data
  • Patients aged 66+ with an initial diagnosis of stage 4 PCa during 2005 - 2009
  • Medicare claims data from 1999 to 2010
Measures (contd.)

- Patient groups were defined as follows:
  - C1: diagnosed with incident bone metastases;
  - C2: diagnosed with incident AJCC stage IV M0 PCa.
- RttB was defined as the receipt of external beam radiation therapy, radiopharmaceutical therapy, intensity modulated radiotherapy or stereotactic radiosurgery.
- Eventflow visualization software was used to:
  - compare C1 and C2 in terms of the time from diagnosis to probable RttB, SCC, BS, and PF;
  - select potential criteria for identifying probable RttB using claims data
Thank you!