Making It Personal

Using Population Health Data and Incentives to Drive Behavior Change

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Understanding Behavior

1. Early work
2. Data-driven personalized medicine
3. Reinforcing behavioral change
Understanding Behavior

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2. Data-driven personalized medicine
3. Reinforcing behavioral change
Disclosures

1. Financial (consulting to public companies)
2. Corporate (ForMyOdds Inc, trUStr LLC)
3. Reputational (pro-clinical decision support)
4. Political (fundraising for presidential candidate)

* Images adapted from Google and other sources
Richard D. Alexander (1925- )
James V. Neel (1915-2000)
Escalator temporarily stairs.
We apologize for the inconvenience.
Point-of-Care Predictive Algorithms

- Improved Clinical Outcomes
- Improved Cost Savings
- Improved Patient Satisfaction
- Personalized Predictive Power
home a baby after IVF is 18.7%. Of all women who succeed in giving birth, 24.8% are likely to have twins. On average, women who are on their 3rd cycle will have a 15.4% probability of taking home a baby, and a 22.6% probability of multiple births.

CHANCE OF HAVING A BABY

A woman’s chance of taking home a baby depends in large part on how many good quality embryos are transferred at the time of IVF, her age, duration of infertility and other factors. If a woman like you were to undergo IVF today, the estimated chance of achieving a birth based on the information you provided us would be:
- 5.63%, if 1 embryo are transferred
- 15.19%, if 2 embryo is transferred
- 17.63%, if 3 embryos are transferred
How It Works
The Functionality 1/4

- Step 1

**IVF Success Test**

*For My Odds Fertility Questions*

To get started, please select an option below.

- I am a Clinic/Healthcare Professional
- I am an Individual

**IVF Success Test Navigation**

- Fertility ?’s
- Lifestyle ?’s
- Create Account
- Choose Report
- Additional ?’s
The Functionality 2/4

Step 2

**IVF Success Test**

**For My Odds Fertility Questions**

What is patient's age at the time of the proposed cycle of treatment?

31

How many years has the patient been trying to conceive?

1

Has the patient had a previous live birth?

- Yes
- No

Has the patient ever had an ectopic pregnancy?

- Yes
- No

Has the patient ever had a miscarriage?

- Yes
- No

We assume the patient has experienced at least 1 year of involuntary childlessness following unprotected and regular intercourse, and that she has undergone, is currently undergoing, or is considering undergoing in-vitro fertilization (IVF). Based on this assumption, for the proposed cycle of treatment:

How many eggs are, or do you expect will be, available for fertilization?

3

How many embryos are, or do you expect will be, available for transfer?

3
Step 2 ...cont’d

- How many embryos do you anticipate will be transferred on the upcoming cycle?
  - 1

- How many IVF treatment cycles has the patient completed to date?
  - 1

- Is the patient suffering from endometriosis?
  - Yes
  - No

- Does the patient smoke?
  - Yes
  - No

- What medication is the patient currently taking?
  - Follistim
  - Gonal-f
  - Clomiphene citrate
  - Antagon

- Continue
We calculated the probability of the patient taking home a baby following in-vitro fertilization (IVF). The probability of a successful cycle of IVF was calculated based on the assumption that the patient’s chances of success are comparable to others in similar circumstances. For reference, the average probability of taking home a baby after IVF is 18.7%. Of all women who succeed in giving birth, 24.8% are likely to have twins. On average, women who are on their 2nd cycle will have a 16.2% probability of taking home a baby.

**CHANCE OF HAVING A BABY**

A woman’s chance of taking home a baby depends in large part on how many good quality embryos are transferred (“ET”) at the time of IVF, her age, duration of infertility and other factors. If a woman like you were to undergo IVF today, the estimated chance of achieving a birth based on the information you provided us would be:

**Chances Starting Treatment Now**

<table>
<thead>
<tr>
<th>ET</th>
<th>% Chance of Baby</th>
<th>% Risk of Multiples</th>
</tr>
</thead>
<tbody>
<tr>
<td>1ET</td>
<td>9.07</td>
<td>0.07</td>
</tr>
<tr>
<td>2ET</td>
<td>23.03</td>
<td>11.46</td>
</tr>
<tr>
<td>3ET</td>
<td>26.33</td>
<td>17.61</td>
</tr>
</tbody>
</table>

**Fast Forward: chances if Treatment Delayed by 5 years**

<table>
<thead>
<tr>
<th>ET</th>
<th>% Chance of Baby</th>
<th>% Risk of Multiples</th>
</tr>
</thead>
<tbody>
<tr>
<td>1ET</td>
<td>4.11</td>
<td>1.88</td>
</tr>
<tr>
<td>2ET</td>
<td>11.58</td>
<td>8.58</td>
</tr>
<tr>
<td>3ET</td>
<td>13.16</td>
<td>14.39</td>
</tr>
</tbody>
</table>
The Confirmation

- Doctor Verification

- Agree with treatment algorithm?
- Recommend a different treatment algorithm?
Real Example: Our Fertility Algorithm
What does this mean in terms of cost savings?

Society is Paying for Downstream Consequences:

✅ Treatments...
✅ Reducing just one ineffective cycle of treatment will save patients $15,000.
Reducing this risk to just 17% of the annual IVF patients who might otherwise receive sub-optimal care would realize a worldwide cost savings of over $1 billion per year.

❖ [15,000 *50 patients per clinic of average size (equal to 300) *500 US fertility clinics = $375 million in savings for the US alone. Another $375 million in savings for Europe and another $375 million for ROW].

✅ Outcomes...
✅ Eliminating risk of twins also means an avg. savings of over $15,000 that would otherwise be needed in the first 5 years of life, relative to singleton babies. Eliminating this risk to just 10 families per clinic per year would realize cost savings of $225 million per year.

❖ [10*500*15,000 = $75 million in the US, $75 million in Europe, and $75 million for ROW]
Users/Contributors

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21 May 2007

Dear Christopher,

Re: Analysis of HFEA Data

Thank you for taking the time to visit myself and Dr. Christopher Barratt at the HFEA during the Easter break. I am happy to re-afirm the comments previously sent by email.

In the coming weeks the HFEA will take the time to compare the raw data used in your dissertation to the current Register. As you know the HFEA does not have the resources to check the accuracy of the calculations and assumptions, so is unable to vouch for the accuracy of the output. We do however thank you for the work that you are doing, look forward to reading your published work and appreciate you providing a copy of your dissertation as well as the original data set that we gave to you in 1999.

I was very pleased to hear that your presentation to CDC went well and appreciate the contact details which you forwarded.

Yours sincerely,
David Tellis

David Tellis  
Director of Information Management & Technology  
David.Tellis@HFEA.GOV.UK
February 8, 2011

Dear Dr. Jones,

Thank you for taking the time to present the modeling capabilities of Formyodds.com. We were actually able to use your software for predicting individual chances of taking home a baby following treatments with assisted conception, and can see how this technology can be easily expanded to other disease states for which data are available. We are even more interested in your plans to expand into research, such as research into chronic diseases that plague in both the developed and developing worlds.

Furthermore, it seems that Formyodds.com could assist lesser-trained staff, some of which are in the field, to identify and treat those who are most at need. Formyodds.com could also be useful to other service corps (such as volunteer forces, national armed services, etc.) for predicting individualized chances of disease, and individualized chances of recovery.

In summary, your software service is entirely unique and I believe it will change treatment practice for the better. I have discussed it with Dr. Alekandar Bodiroza, the head of the Reproductive Health unit for the Arab States at UNFPA and we look forward to collaborating in the months ahead.

Sincerely,

[Signature]

Dr. Srdjan Stakic
Senior Technical Advisor
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United States
1. Mammography
2. Aneurysm Repair
Mammography Options

HealthCare Evaluations

Mammography Options

Ready to Start?

Let’s Begin

Tracking data anonymously.

Click here for more apps!
Does patient have a family history of breast or ovarian cancer?

YES

NO

CANCEL

Click here for more apps!
Mammography Options

Breast cancer only?

YES

NO

CANCEL

Click here for more apps!
Mammography Options

HealthCare Evaluations

Mammography Options

IBIS MODEL

Gall MODEL

BOADICEA MODEL

Claus MODEL

Do you agree with this result?

YES

NO

Click here for more apps!
BOADICEA: The Breast and Ovarian Analysis of Disease Incidence and Carrier Estimation Algorithm (BOADICEA) is a computer program that is used to calculate the risks of breast and ovarian cancer in women based on their family history. It is also used to calculate the probability that they are carriers of cancer-associated mutations in the BRCA1 or BRCA2 gene.
Mammography Options

HealthCare Evaluations

Mammography Options

IBIS MODEL

Gall MODEL

BOADICEA MODEL

Claus MODEL

Do you agree with this result?

YES

NO

Click here for more apps!
Mammography Options

HealthCare Evaluations

Mammography Options

You said you didn’t agree with the previous result. Would you take a moment to tell us why?

- Underestimates patient’s risk
- Overestimates patient’s risk
- Inappropriate selection of patient risk factors
- Not familiar/comfortable with this model
- Other (fill out text response)

NEVERMIND

Click here for more apps!
Next Scenario: More Granular
Ready to Start?

HealthCare Evaluations
Mammography Options

Ready to Start?
Let's Begin

Tracking data anonymously.

Click here for more apps!
Family History

HealthCare Evaluations
Mammography Options

Does patient have a family history of breast or ovarian cancer?

YES

NO

CANCEL

Click here for more apps!
Any benign pathological risk factors?

YES

NO

CANCEL

Click here for more apps!
Mammography Options

HealthCare Evaluations

IBIS MODEL

Gall MODEL

BOADICEA MODEL

Claus MODEL

Do you agree with this result?

YES  NO

Click here for more apps!
HealthCare Evaluations
Mammography Options

Please fill in the reason you disagree with our suggestion.

(type info here...)

SUBMIT

NO THANKS

Click here for more apps!
Claus: Developed using data from the Cancer and Steroid Hormone Study, a nested population-based case-control study conducted between 1980 and 1982 using breast cancer patients registered in eight Surveillance, Epidemiology, and End Results regions. Only uses family history to estimate risk; incorporating first- and second-degree relatives and age of diagnosis. The Claus lifetime risk tables reflect risks for North American women in the 1980s.
Review the latest research on this topic.

To be redirected to a list of the most up to date, relevant articles and findings on this subject.
Mammography Options

Review the most recent articles on this subject:

- Genetic testing for hereditary breast and ovarian cancer syndrome
- Overview of the treatment of newly diagnosed, non-metastatic breast cancer
- Breast cancer in men
- Clinical features, diagnosis, and staging of newly diagnosed breast cancer
- Breast reconstruction: Prosthetic devices
- Breast reconstruction: Autologous tissue

CANCEL

Click here for more apps!
ENDOVASCULAR versus OPEN ANEURYSM REPAIR
Surgery Options

Patient's age?

54

NEXT

CANCEL

Click here for more apps!
Was the patient transferred to this hospital?

YES

NO

CANCEL

Click here for more apps!
Does the patient have a history of COPD?

YES

NO

CANCEL

Click here for more apps!
Does the patient have creatinine levels greater than 1.5?

YES

NO

CANCEL

Click here for more apps!
Does the patient have an Iliac Aneurysm?

YES

NO

CANCEL

Click here for more apps!
Surgery Options

HealthCare Evaluations

Surgery Options

Does the patient have an ejection fraction greater than 30%?

YES

NO

CANCEL

Click here for more apps!
Surgery Options

HealthCare Evaluations

Surgery Options

OPEN

EVAR

Do you agree with this result?

[YES] [NO]

Click here for more apps!
HealthCare Evaluations
Surgery Options

You said you didn't agree with the previous result. Would you take a moment to tell us why?

- Morphology of AAA speaks for open repair
- Morphology of AAA speaks for EVAR
- Either repair is acceptable but surgeon expertise is open
- Either repair is acceptable but surgeon expertise is EVAR
- Pt strongly prefers EVAR/OPEN
- Other (fill out text response)

NEVERMIND

Click here for more apps!

**Self-Actualization** - A person’s motivation to reach his or her full potential. As shown in Maslow’s Hierarchy of Needs, a person’s basic needs must be met before self-actualization can be achieved.
Motivating Healthy Change
Incentives are great for short-term, simple change:

https://www.youtube.com/watch?v=iRb94lbL138
Burrhus. F. Skinner (1904-1990)

https://www.youtube.com/watch?v=vGazyH6fQQ4
3 Groups of Kids
Promised Good Drawing Award
Unexpected Good Drawing Award
No Award
Rewards and recognition are given when you’ve done something, incentives are given so that you do something
MESOLIMBIC DOPAMINERGIC SYSTEM
Premise: Rewards can be personalized

trUStr rewards

A fitness-rewarding smartphone app
Found on www.etsy.com

http://stockproject1.deviantart.com/art/Pocket-Watch-3663976-182511090
Coal mining, West Virginia (1908):
https://en.wikipedia.org/wiki/History_of_coal_mining_in_the_United_States
Logging

www.fs.fed.us
Life Logging

http://mashable.com/2014/03/20/lifelogging-experiment/
Thank You

Department of Surgery
Department of Economics
Global Health Economics Unit
Computational Story Lab
University of Vermont