

Expanding maternal and infant data from EHRs for pregnancy research

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Louisa Smith PhD – Roux Institute, Northeastern University

OHDSI Open Studies Presentation

Community Call - November 15, 2022



Our team leads



Alison Callahan, PhD, MLS, Instructor and Clinical Data Scientist in the Center for Biomedical Informatics at Stanford University. Expertise in medical informatics.



Louisa H. Smith, PhD, SM, MS, Assistant Professor in the Department of Health Sciences at Northeastern University's Bouvé College of Health Sciences and the Roux Institute. Expertise in epidemiological and biostatistical methods.



Stephanie Leonard, PhD, MS, Assistant Professor in the Dunlevie Maternal-Fetal Medicine Center at Stanford University. Expertise in perinatal epidemiology.

Pregnancy is understudied despite being extremely common

- Childbirth is the #1 reason for hospitalizations worldwide (~4 million per year in the U.S.)
- Pregnant people are systematically excluded from most trials and studies despite often being at highest need of effective therapies

Inclusion of pregnant women in COVID-19 treatment trials: a review and global call to action



Melanie M Taylor, Loulou Kobeissi, Caron Kim, Avni Amin, Anna E Thorson, Nita B Bellare, Vanessa Brizuela, Mercedes Bonet, Edna Kara, Soe Soe Thwin, Hamsadvani Kuganantham, Moazzam Ali, Olufemi T Oladapo, Nathalie Broutet

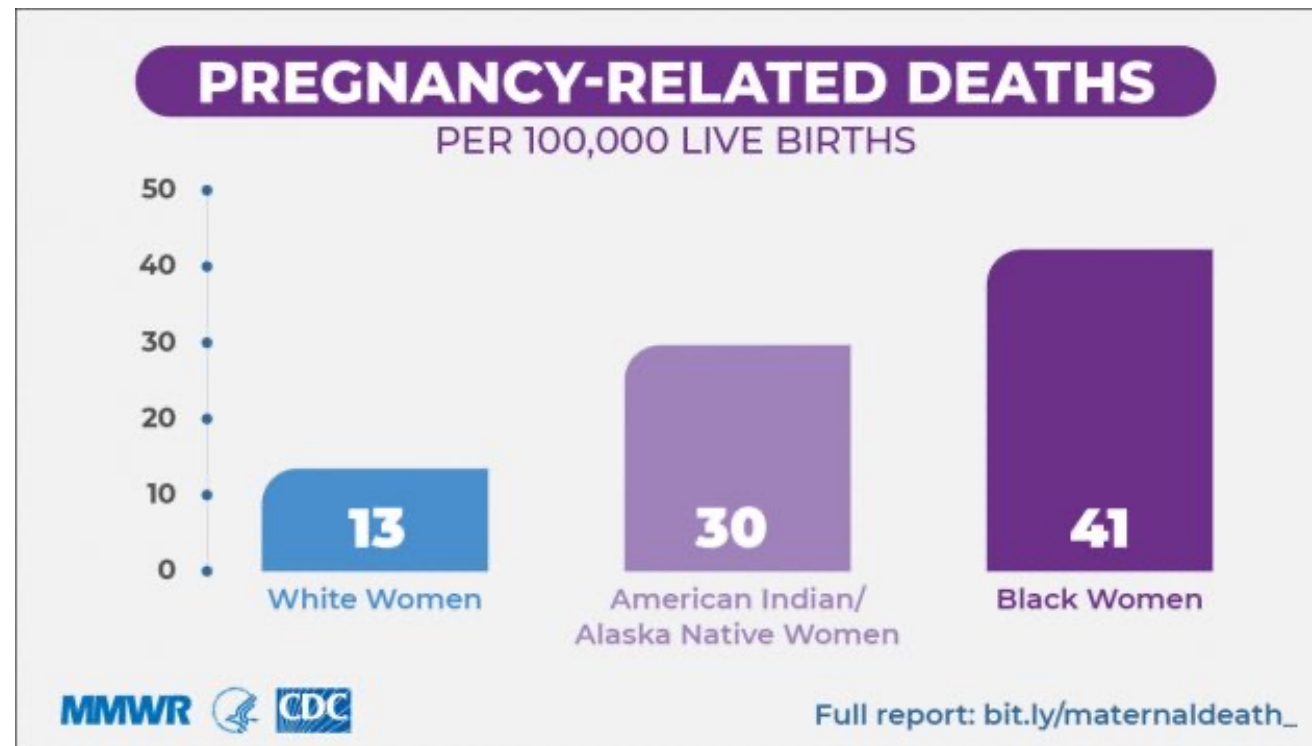


Inclusion of pregnant women in COVID-19 clinical trials would allow evaluation of effective therapies that might improve maternal health, pregnancy, and birth outcomes, and avoid the delay of developing treatment recommendations

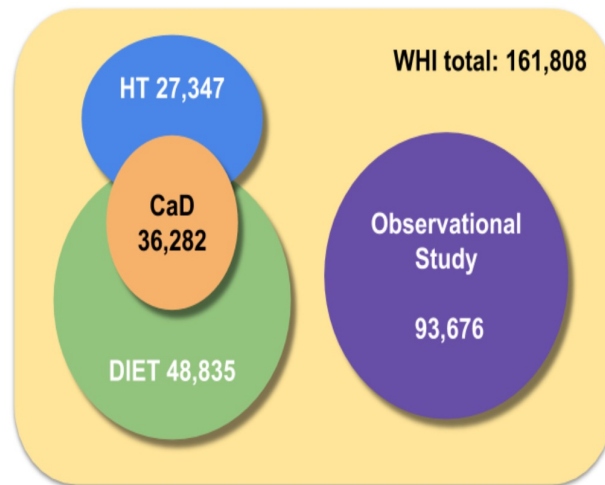
*Lancet Glob Health 2021;
9: e366–71*

Maternal and infant mortality rates in the U.S. are higher than in similar countries

- Marginalized groups are most affected by maternal and infant complications and death



Insufficient data leads to inaccurate models and gaps in knowledge



Women's Health Initiative



National Health and Nutrition Examination Survey



Clinformatics® Data Mart

IBM MarketScan Research Databases

> *Clin Ther.* 2019 Dec;41(12):2467-2476. doi: 10.1016/j.clinthera.2019.08.016. Epub 2019 Sep 25.

Safe Expectations: Current State and Future Directions for Medication Safety in Pregnancy Research

Mollie E Wood ¹, Susan E Andrade ², Sengwee Toh ³

Affiliations + expand

PMID: 31563392 PMCID: PMC6917855 DOI: 10.1016/j.clinthera.2019.08.016 [Paperpile](#)

> *Obstet Gynecol.* 2020 Sep;136(3):440-449. doi: 10.1097/AOG.0000000000004022.

An Expanded Obstetric Comorbidity Scoring System for Predicting Severe Maternal Morbidity

Stephanie A Leonard ¹, Chris J Kennedy, Suzan L Carmichael, Deirdre J Lyell, Elliott K Main

Affiliations + expand

PMID: 32769656 PMCID: PMC7523732 (available on 2021-09-01)

DOI: 10.1097/AOG.0000000000004022 [Paperpile](#)

[Review](#)

> *BMC Pregnancy Childbirth.* 2017 Nov 13;17(1):372. doi: 10.1186/s12884-017-1558-3.

Measurement properties of comorbidity indices in maternal health research: a systematic review

Kazuyoshi Aoyama ^{1 2 3 4 5 6}, Rohan D'Souza ^{7 8}, Eiichi Inada ⁹, Stephen E Lapinsky ^{10 11}, Robert A Fowler ^{12 11 8}

Affiliations + expand

PMID: 29132349 PMCID: PMC5683518 DOI: 10.1186/s12884-017-1558-3 [Paperpile](#)

[Meta-Analysis](#)

> *PLoS One.* 2018 Dec 4;13(12):e0208563. doi: 10.1371/journal.pone.0208563.

eCollection 2018.

Risk prediction models for maternal mortality: A systematic review and meta-analysis

Kazuyoshi Aoyama ^{1 2}, Rohan D'Souza ^{2 3}, Ruxandra Pinto ⁴, Joel G Ray ^{5 6}, Andrea Hill ⁴, Damon C Scales ^{2 4}, Stephen E Lapinsky ⁷, Gareth R Seaward ^{2 3}, Michelle Hladunewich ⁸, Prakesh S Shah ^{2 9}, Robert A Fowler ^{2 4}


Affiliations + expand

PMID: 30513118 PMCID: PMC6279047 DOI: 10.1371/journal.pone.0208563 [Paperpile](#)

EHRs: Challenges and opportunities

• Help

• Logout



**GME0000
Smith,
Caroline**

Sex: Female
DOB: 1940/01/01
Next of kin: John Smith

Phone: 365-565-9090
Address: 19 Provincial Rd.
Edmonton AB T6M 1R7

• Summary

Lab Results

Diagnostic

Images

Details

Notes or

Comments

Diagnosis

State

Status

Hypertension 11/1989 Ongoing

Diabetes 05/1996 Ongoing

Artery Disease 02/2002 Ongoing

Fasting lipids 12/2005 Ongoing

Exercise stress test 12/005 Ongoing

Coronary angiogram / 02/2005 Resolved

Cellulitis 02/2005 Resolved

Cholecystectomy 05/1981 Resolved

Cesarian section 01/1967 Resolved

GP Details

Name: Jones, Evans
Phone: 333-465-5545
Address: 11 Terrence Ave., Edmonton, AB T4Y 8U9

Other Healthcare Providers

Name: Diaz, Ellen
Disp: Cardiology
Fournier, Janice RN
Cohen, Richard Dermatology
Last Encounter: 01/2006
Next encounter: 07/2006
Right of Access: Y
N
N

Medications

Date: 11/1989
Medications: Hydrochlorothiazide 25 mg
Glyburide 5 mg
Metformin 500 mg
Atorvastatin 20 mg
Amlodipine 10 mg
ECASA 325 mg
Rampitil 10mg
Cloxacillin 500 mg
Beclothemason Cream
Last Filled: 12/2005
12/2005
12/2005
12/2005
12/2005
12/2005
02/2006
02/2006
05/2004

Encounter History

Date: 01/2006
Facility: GP
Specialty: Cardiology
Clinician: Diaz, E.
Reason: Hypertension
Type: Outpatient

Diagnosis

State

Status

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Cellulitis 02/2005 Resolved

Cholecystectomy 05/1981 Resolved


Cesarian section 01/1967 Resolved

Immunizations

Type: Influenza
Most Recent: 12/005
Number Received: 7
Value: 1
BP: 135/75
Urine: 0.02
Microalbumin: 0.02
Eye Exam: 05/2005
Home Gluc (average): 7.4
01/2006

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01/2006

IMPRESSION (ACC 6075491) :

addendum beginsexam association only. addendum endsbilateral diagnostic digital mammogram with computer-aided detection 3/31/2011 8:14 amright axillary ultrasound 3/31/2011 8:14 am indication: female, 73 years old, right breast lateral tenderness, no discrete **mass**. history:post-menopausal patient. comparison: 3/7/2006 (stanford hospital), 7/24/2009 (advanced medicine center) technique: full-field digital mammograms were obtained with computer-aided detection to assist in interpretation of the study, including bilateral craniocaudal and mediolateral oblique views coma with an additional right lateral view. real-time breast ultrasound was then performed targeted to

findings: mammogram: the breast tissue is largely fatty. there is a skin bb marker over a palpable abnormality in the right axillary region. there are no features to suggest malignancy. ultrasound: targeted ultrasound reveals a normal appearing lymph node in the 11 o'clock position 10 cm from the nipple in the right axillary region 9x 6 x 4 mm. otherwise no discrete solid or cystic **masses** identified. **impression:** 1. right breast: bi-rads 1, negative. left breast: bi-rads 1, negative. recommend the finding prompting ultrasound should be followed on a clinical basis alone. assuming clinical stability, recommend annual screening mammography.

Relevant information in unstructured form

Record linkage

Missing data

Prior Work: Obstetric data extractors

Patient timeline

-280 days

Birth – diagnosis codes

-5 days

+5 days

```
awk -v FPAT='[^,]*|"[^"]+"|' 'match($7,/G([0-9]+)P([0-9]+)/, ary){print
$2"\t"$3"\t"$5"\t"$6"\t"ary[1]"\t"ary[2]}' ld_progress_notes_birth_cohort_5days_07012021.csv
> birth_cohort_gravidity_parity_mentions_07062021.tsv
```

```
awk -v FPAT='[^,]*|"[^"]+"|' 'match($7,/s[S|s]ingleton/){print
$2"\t"$3"\t"$5"\t"$6"\t"substr($7, RSTART, RLENGTH)}'
ld_progress_notes_birth_cohort_5days_07012021.csv >
birth_cohort_singleton_mentions_07062021.tsv
```

```
awk -v FPAT='[^,]*|"[^"]+"|' 'match($7,/s[T|t]wins/){print
$2"\t"$3"\t"$5"\t"$6"\t"substr($7, RSTART, RLENGTH)}'
ld_progress_notes_birth_cohort_5days_07012021.csv > birth_cohort_twin_mentions_07062021.tsv
```

```
awk -v FPAT='[^,]*|"[^"]+"|' 'match($7,/([0-9]+)[w|W]([0-9]+)[d|D]/, ary){print
$2"\t"$3"\t"$5"\t"$6"\t"ary[1]"\t"ary[2]}' ld_progress_notes_birth_cohort_5days_07012021.csv
> birth_cohort_gestational_age_mentions_07062021.tsv
```

```
SELECT
*
FROM
`som-nero-phi-nigam-starr.progress.flowsheets`
WHERE
row_disp_name = 'Plurality'
""".format_map({'work_project_id': work_project_id,
'work_dataset_id': work_dataset_id})
```

Generic Nursing Flowsheet Application

Name: 2703 Patient, Mary HHH - 654545 Age: 22 DOB: 8/12/1987 Female

Code: Full Allergies: None Attending: Marcus Worthy Resident: Lisa Wadsworth Nurse: Sam Stone

Initial Information | Vital Signs | Intake/Output | IVs and Fluids | Blood Admin | Restraints | Discharge Planning

Quicklinks: Vital Signs 1100 1300 1300

Other Signs: Temperature 37.1 38.2 1300

Pain Assessment: Temperature Source: Oral Oral

Oxygen Therapy: Heart Rate 75 80

Respiratory Function: Heart Rate Source: Monitored Monitored

Height/Weight: Height 155 155

Other: Weight 130.0 130.0

BP: 130/85 130/85

SpO2: 98% 98%

AP Source: LA LA

AP Method: NIBP Cuff NIBP Cuff

Patient Position: LA = left arm RA = right arm

Abdominal Girth: Long right side O = other

Pain Assessment: Pain Score 7

Pain Goal: 4

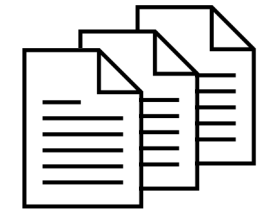
Pain Location: Abdomen

Pain Description: Throbbing, Ache

Oxygen Therapy: Oxygen 51 80

Oxygen Device: HOD (N)

Oxygen Device: HOD (N)



Progress notes

Flowsheets

- Plurality
- Presentation

L&D delivery notes

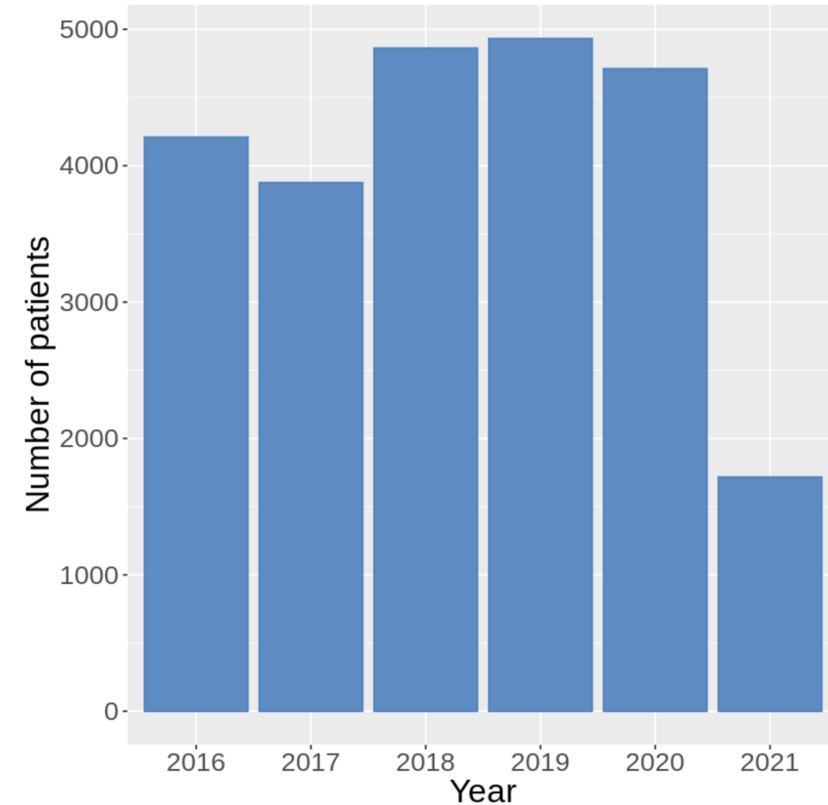
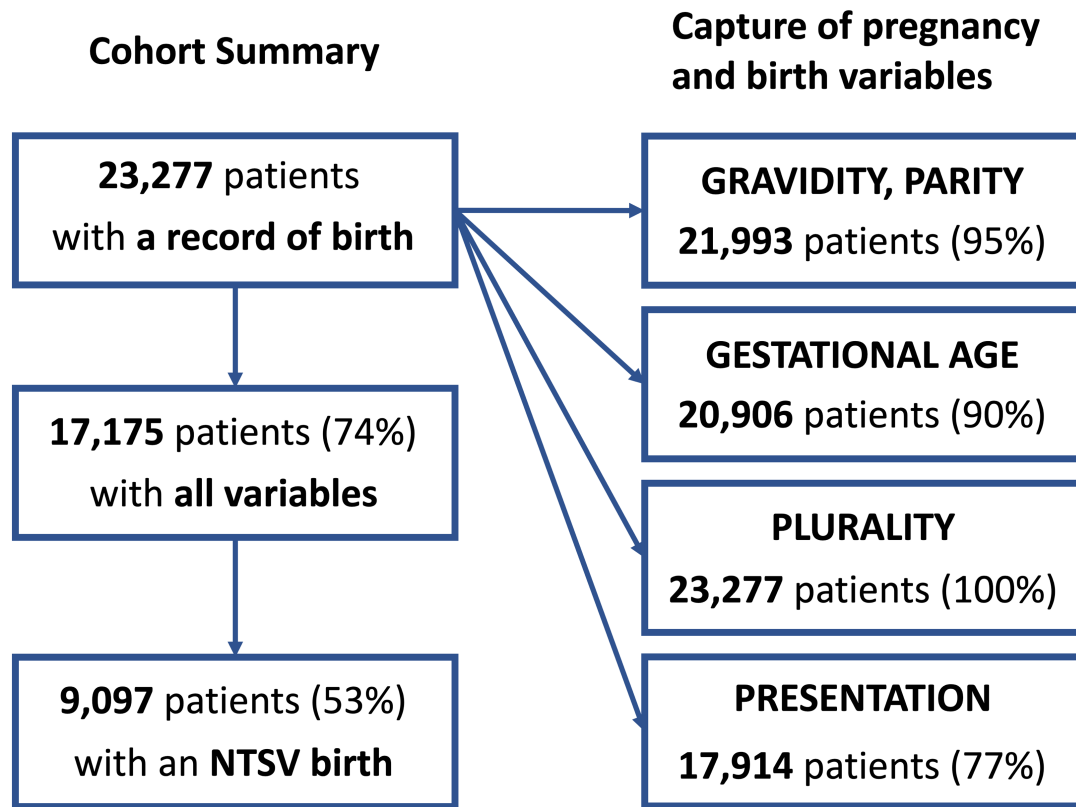
- Gravidity and parity
- Gestational age
- Plurality
- Presentation

Prior Work: Obstetric data extractors

Variable	Precision	Recall
Gravidity	0.99	0.98
Parity	0.74	0.73
Gestational age - weeks	0.95	0.88
Gestational age - days	0.76	0.70
Plurality	0.95	0.99
Presentation	0.88	0.70

Callahan A, Murugappan G, Main EK, Leonard SA. 2022. **Constructing a cohort of nulliparous, term, singleton, vertex births from electronic health records.** AJOG 226 (1 Supplement): S521-S522.

Prior Work: Identifying a low-risk birth cohort for epidemiological studies



Number of patients in obstetric cohort with a birth record, by year.

Callahan A, Murugappan G, Main EK, Leonard SA. 2022. **Constructing a cohort of nulliparous, term, singleton, vertex births from electronic health records.** AJOG 226 (1 Supplement): S521-S522.

Two grant proposals underway

1. *Leveraging informatics to study medication use in pregnancy*

PI: Callahan; Stanford pilot research award

- Expand network of continuously updated EHR-derived obstetric databases.
- Characterize use of antihypertensive, anticoagulant, antidiabetic and antibiotic medications during pregnancy and postpartum to inform retrospective drug safety and effectiveness studies.

2. *Optimizing therapy for chronic hypertension in pregnancy*

PI: Leonard; NIH K01

- Compare the overall effectiveness and safety of the most commonly used medications to treat chronic hypertension in pregnancy.
- Assess the impact of timing of initiation, dose, and patient usage on the benefits of treating chronic hypertension in pregnancy.
- Evaluate the benefits and safety of treating mild chronic hypertension in key patient subpopulations.

Join us!

- Let us know if you'd be interested to
 - Contribute data to run studies
 - Collaborate to develop methods to extract additional variables
 - Lead a study over multiple sites
- Please get in touch!
 - Alison Callahan acallaha@stanford.edu
 - Stephanie Leonard sleo@stanford.edu
 - Louisa Smith l.smith@northeastern.edu