UiO : University of Oslo

Does the use of diagnostic technology reduce fetal mortality?

J Grytten, I Skau, R Sørensen, A Eskild

University of Oslo, Akershus University Hospital
and Norwegian Business School

Wennberg International Collaborative
Oxford September 2017

Focus of the present work

- To evaluate clinical practice in maternity care
- To identify high value care – care that can save lives:
  - to use a methodology that has the potential to provide causal estimates
  - to provide a scientific basis for the delivery of effective maternity care

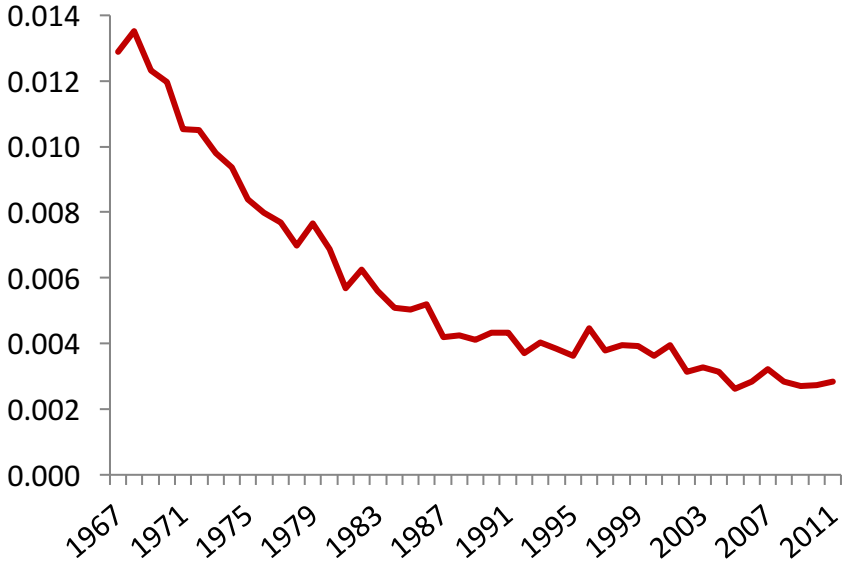
Background – fetal deaths

- Each year more than 3 million fetal deaths occur worldwide
- The incidence varies: 4 to 40 deaths per 1000 deliveries
- Fetal deaths: 60% of all perinatal deaths
- From 1970 and onwards: significant decline in fetal deaths in most western countries, Norway included

Remarkable decline in fetal mortality (Norway)

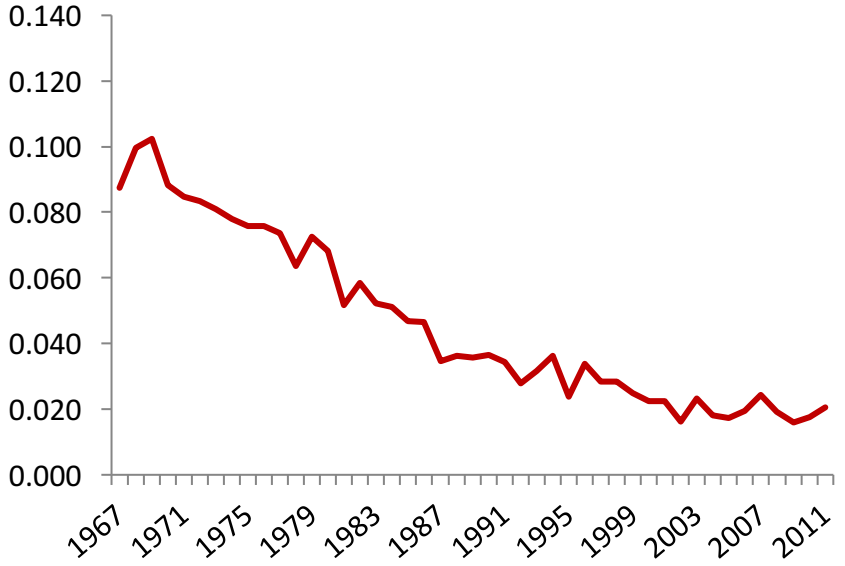
Whole population

≥ 28 completed weeks of gestation



Pre-term

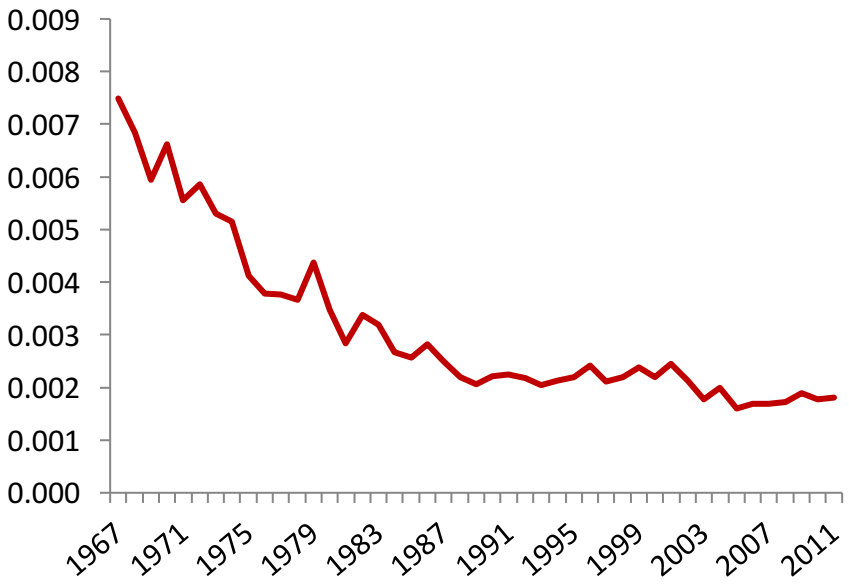
28-36 completed weeks of gestation



Remarkable decline in fetal mortality (Norway)

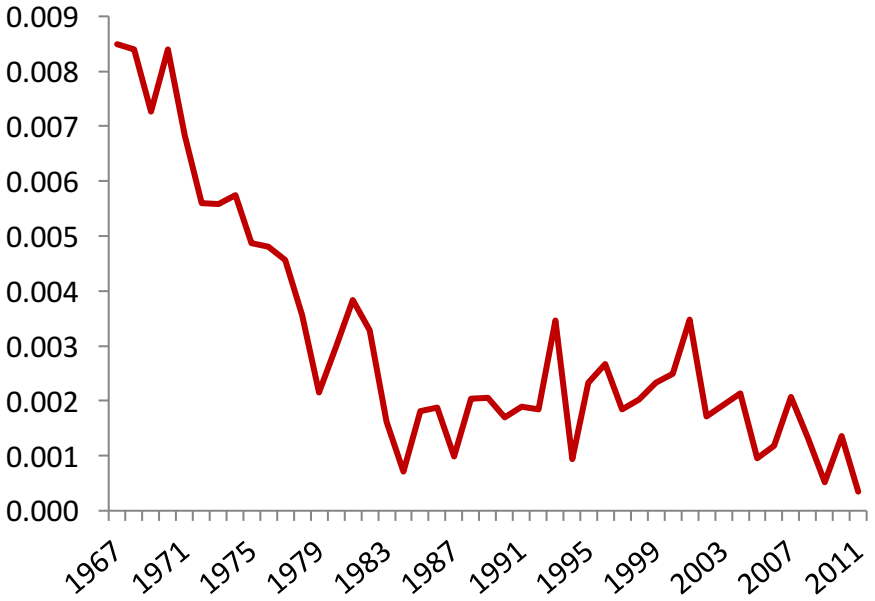
Term

37-41 completed weeks of gestation



Post-term

≥ 42 completed weeks of gestation



Is there a causal link?
Use of diagnostic technology/decline in fetal deaths

- Ultrasound and electronic fetal monitoring (EFM)
- Marked increase in the use of ultrasound and EFM 1970-1990
  - Less dependence on clinical signs, judgment, and interpretation of information from the mother for assessing whether the pregnancy/delivery is progressing without complications

Types of diagnostic technology

- Ultrasound
  - More accurate gestational age assessment
  - Detection of multiple fetuses and fetal malpresentations
  - Diagnosis of placenta praevia
- EFM
  - Monitoring of fetal heart rate and diagnosis of fetal distress, particularly in full term pregnancies and during delivery

Previous research

- Two types of study
  - Cross-sectional studies – may suffer from bias due to unobserved heterogeneity
  - Clinical trials – often questionable external validity

    Small samples and with selected groups of mothers
- Conclusion from Cochrane Reviews
  - "Much larger numbers of participants would be required to accurately measure this outcome" (fetal outcome)
    (Whitworth et al. 2010; Haws et al. 2009)
- Real life studies are lacking
  - No population studies of the contribution of the use of diagnostic technology to the decline in fetal deaths

Institutional setting – obstetric services in Norway

- Population: 5.2 million
  Number of deliveries per year: 60 000
- Women give birth in publically-owned and publically-funded hospitals (n=44)
- Mothers pay no fee, irrespective of the type of delivery
- Doctors receive a fixed salary
- No competition between hospitals for women giving birth
  - The capacity of maternity units is planned according to the expected number of births within the catchment area

Data and variables

- Medical Birth Registry of Norway
  - All deliveries 1967-1995 (about 1.2 million)
  - Outcome: Stillbirth before and during delivery
  - Control variables – risk factors of the mother
    - Mother's age, highest education and immigrant background
    - Whether she had previously had a fetus that had died, or previously had a Cesarean delivery
    - Whether the pregnancy was her first (null parity)
    - Whether she had a chronic disease
- Norwegian Medical Association's Research Institute
  - Information about use of diagnostic technology (hospital level)

Data about the use of diagnostic technology

- Questionnaire sent to all senior consultants in every maternity unit. All replied.
  - Asked to provide the following information:
    - «Enter as accurately as possible the five-year interval your maternity unit introduced the use of ultrasound and EFM»
  - Response options:
    - First interval: 1967-1969
    - Subsequent intervals: 5-year intervals from 1970 and onwards

Type of diagnostic technology and time period of implementation (n=1.2 million)

	Ultrasound		EFM	
Time period	Percentage of deliveries	Number of hospitals	Percentage of deliveries	Number of hospitals
<=1970	0	0	0	0
1971-1975	16	3	31	7
1976-1980	74	23	83	30
1981-1985	96	38	96	41
1986-1990	99	43	100	44
1991-1995	100	44	100	44

Model specification

Difference-in-difference estimation

$$Y_{ijt} = \alpha + \beta_1 Ultrasound_{jp} + \beta_2 EFM_{jp} + \sum_c \gamma_c \cdot Control_{ijt}^c$$
$$+ \sum_j \delta_j \cdot Hospital_j + \phi \cdot t + \sum_j \eta_j \cdot Hospital_j \cdot t + u_{ijt}$$

- Outcome: stillbirth before and during delivery
- Before/after design. Controls for all cross-sectional variation between maternity units that are stable over time
- t (=trend) controls for all non-measurable factors that might influence stillbirth over time
  (for example better nutrition and maternity care)
- Clustering at the hospital level
  (to take account of positive serial correlation)

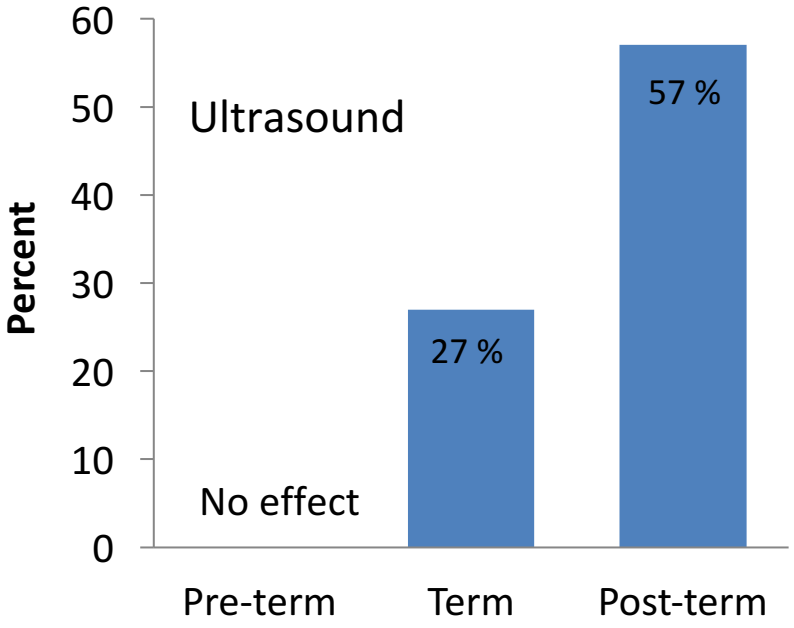
The effects of the use of ultrasound and EFM on fetal death

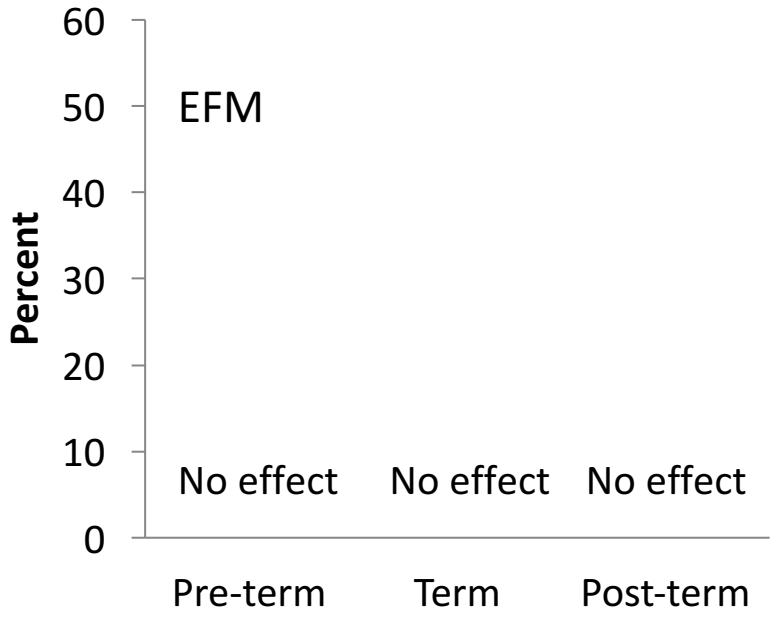
Type of technology	Whole population	Pre-term	Term	Post-term
Ultrasound	-0.0013 *	0.0010	-0.0010 *	-0.0021 *
	(0.0004)	(0.0034)	(0.0003)	(0.0006)
EFM	-0.0002	0.0040	-0.00020	0.00001
	(0.0005)	(0.0047)	(0.0003)	(0.0007)
Number of fetal deaths	8 263	4 007	3 386	631
Total [1]	1 199 475	69 365	926 041	171 207

* $p<0.05$

[1]Includes number of live born infants and number of fetal deaths

Percentage reduction in the number of fetal deaths





Robustness tests – can we trust the results?

- Pre-intervention test (placebo test)
  - To detect bias due to a third unobserved variable
  - We pretend that the use of ultrasound was introduced earlier than it actually was introduced
  - Result of the test:
    - No effect – no bias
    - Effect – bias

- Terminated pregnancies
  - Routine ultrasound examination may have increased the number of terminations of fetuses with congenital abnormalities

⬇

Reduction of the number of fetuses with a high risk of being stillborn

⬇

Bias in our results – beneficial effect of ultrasound is overestimated

Pre-intervention test: Ultrasound introduced one period earlier than it actually was introduced

Period (five-year interval) of introduction	Whole population	Term	Post-term
Pre-intervention (Lead)	-0.0008 (0.0008)	-0.0003 (0.0004)	-0.0012 (0.0014)
Introductory period (Contemporaneous effect)	-0.0016 * (0.0009)	-0.0008 * (0.0004)	-0.0032 * (0.0015)
Post-intervention (Lag)	-0.0023 * (0.0012)	-0.0011 * (0.0005)	-0.0041 * (0.0018)
Number of fetal deaths	8 024	3 386	631
Total [1]	1 166 613	926 041	171 207

* p<=0.05

[1] Includes number of live born infants and number of fetal deaths

Is there a link?
The use of ultrasound/the prevalence of infants with congenital abnormalities

Type of technology	Whole population	Pre-term	Term	Post-term
Ultrasound	0.0022 (0.0025)	-0.0020 (0.0035)	0.0031 (0.0020)	0.0007 (0.0029)
Number of infants with congenital abnormalities[1]	32 410	3 084	24 622	4 704
Total number of infants[2]	1 166 613	69 365	926 041	171 207

[1]Includes 17 abnormalities

[2]Includes all infants - both stillborn and liveborn

Conclusions

- The introduction of ultrasound made a MAJOR contribution to the decline in fetal mortality at the end of the last century
  - The effect was most pronounced for post-term deliveries
- The introduction of EFM made NO contribution to the decline in fetal mortality
  - The use of EFM can be reduced, without that leading to an increase in the number of fetal deaths
- Our results cannot be explained by an increase in terminated pregnancies as a result of the introduction of ultrasound