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EHDI – Florence

Using Data in an EHDI-IS to Identify Occupational Risk Factors for Infant Hearing Loss

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 >> So... good morning, and thank you for coming. I'm the epidemiologist for Massachusetts EHDI. I'm reporting today on an epidemiologic study that was carried out with data from our EHDI information system. And... I wanted to present this study, not only because the results are interesting, and potentially important... but also, to demonstrate a use of EHDI data beyond surveillance and that is for epidemiologic research.

 Surveillance and epidemiology are two different core public health sciences that have a lot in common. Surveillance is the function that the EHDI information systems were designed to serve. It mainly focuses on tracking infants from birthday through the accomplishment of the 1:3:6 goals. Surveillance activities like data collection and data analysis are also epidemiologic activities. It's the contributions of each activity to the different sciences and... the outcomes that are focused on ‑‑ that distinguishes the two sciences.

 Surveillance wouldn't be surveillance without data collection and epidemiology wouldn't be epidemiology without data analysis. Regarding the outcomes, epidemiologic research concerns physical or mental challenges like diseases or birth defects whereas, surveillance data analysis are more likely to concern challenges to the surveillance process, itself... like lost to follow‑up.

 A point I want to make is that our EHDI data are now the best data in the world to answer questions about the epidemiology of distinguished infant hearing and the opportunity to use the data for that purpose shouldn't be passed up.

 Furthermore... when epidemiologic research develops out of a surveillance system, the epidemiologic goals benefit from the exhaustive tracking of the surveillance function. In that, that helps to ensure that the results of the data analysis will be valid.

 One of the major threats to epidemiologic research is selection bias... but there's no selection ‑‑ then there can be no selection bias.

 So... here, I've shown... a surveillance‑type data analysis at the top. Relating maternal age to the accomplishment of EHDI goal number two. And at the bottom, I'm showing you the data analysis that I conducted for my study, evaluating the association between mothers occupation and having a deaf or hard of hearing child.

 And... in both cases, the strength of the association is given by the simple fraction, A over A plus B divided by C over C plus D or in words, the prevalence of the outcome in one group as compared to that in another.

 So... now you're thinking that, epidemiologic analysis is a simple and straightforward business and that you should become an epidemiologist so that you could ‑‑ so that you could improve the population's health through fractions. But... the problem is, the difference between an experiment conducted under controlled conditions and mere observation, which is what we're usually stuck with in epidemiology ‑‑ when there's no manipulation of the independent variable, which is the variable shown on the left‑most column, in both of the tables, it's easy to draw the wrong conclusions.

 To conduct my study as an experiment, I would have to force pregnant women to do work that I think would harm their unborn children. Not a very practical or ethical proposition.

 If there's no difference between the two compared groups ‑‑ the fraction resolves to one. I will accept any deviation from one as meaningful, no... because differences will arise just by chance ‑‑ so... I'm only going to accept, as meaningful, differences, extreme enough, to achieve statistical significance.

 And... furthermore, the more significance tests one does ‑‑ the more significant findings will emerge just by chance. It's important not to go fishing in the dataset for whatever significant results might happen to pop up, but... to instead... test only prespecified biological ‑‑ biologically plausible hypotheses.

 A classic example of confounding is the associations that have been found in studies between drinking alcohol and lung cancer. Drinking alcohol doesn't cause lung cancer. If you're a heavy smoker and you just quick drinking, it's not going to affect your risk of lung cancer at all. The relationship is indirect and artifact of the causal effect of smoking on lung cancer and the strong association between smoking and drinking.

 So... studies of drinking alcohol in relationship to lung cancer have to account for smoking. To perform a multi‑varied analysis, you include term for the confounder in a statistical model for the relationship between the suspected cause and outcome under the investigation. Two independent variables ‑‑ hence, multivariate. Without the confounders, only one independent variable and the analysis would be uni‑variate.

 Why I thought mother's occupation would be due to reduced infant hearing ‑‑ the fact is, I didn't. This project arose because I had a student intern that was supposed to work with me on an epidemiologic study. After she worked with me for some months, learning about EHDI, doing some data entry and gaining an appreciation for what it is to be an epidemiologist, working in a Public Health Department, we found out that her project had to involve occupation.

 So... I said, what are we going to do with that? Babies don't work. But... in the end ‑‑ I became very grateful for an electronic link between the Massachusetts birth certificate and our EHDI information system. Because... the birth certificate collects parents occupation, but... again... I had no idea whether I should expect parents occupation to be related to reduced infant hearing.

 But... we did find some studies that had linked on the job chemical exposures in parents to birth defects in their children and other studies that have linked some occupations to deafness. In the workers themselves. Here's a list of the ototoxic or teratogenic chemicals and jobs or industries that ‑‑ in which, people encounter them.

 On the right‑hand side here, these are all the jobs and industries that were grouped, grouped together in the study to represent occupation ‑‑ occupationally‑exposed to oto toxins group. Massachusetts has been collecting these data since before Congress passed the EHDI act in the year 2000. The only babies eligible for the analysis were those born after 2011. A first pass at the data analysis took place a couple years ago when the data on 2015 births had just been finalized. But... now, finalization of the 2017 birth data is nearing completion and... so... for this first PrimeTime presentation of the study's results ‑‑ I wanted to include the 2016 births.

 To increase the sample size as much as possible.

 So... doing that, increased the sample size from 280,000 babies to more than 350,000. But... after some necessary and desirable inclusions, that large sample size yielded only 476 deaf or hard of hearing children.

 So... but... fortunately, each child had two ears. The sample size could be effectively doubled by using statistical methods that account for the correlation between the two ears of the same baby.

 By far, the most challenging part of trying to carry out this study was the occupational coding piece. I was thrilled to see the CDC NIOCCS website. When the first data analysis were done ‑‑ I auto coded the 2012 to 2015 data using NIOCCS version two. Very recently ‑‑ I tried to auto code the 2016 data and I found there was a new NIOCCS version, version three and that auto‑coded 90% of the occupations and industries that the mothers, of the babies who were born in 2016, but... again, not without error.

 So... here's an example of some of the auto coding errors I encounters. In the first example at the top ‑‑ the mother was trying to say that she was at home or a housewife, but the text string, HOE was mis ‑‑ tricks us to think she was a tool manufacturer ‑‑ that she made hoes. I traced this second one to a confusion of the software between the word lodging and logging. The birth certificate invites them to use their name instead of industry. This last woman on the table said she worked at Macy's department store and that was a common employer for the women in this study. But... the software misinterpreted that as the name of a durable goods manufacturing company. After the auto coding was complete there, were a lot of women's jobs and industries that weren't auto coded at all and many that were miscoded.

 That had to be addressed by the writing of a very long computer program to fill in the gaps and to correct the errors. If you know how to do it, multivariate analysis is easy. The only factors that can confound an association are factors related to both the, the suspected cause and the outcome under investigation. Here, I'm showing you relationships I looked at and... the asterisk in the table indicates statistical significance and in the right‑hand column ‑‑ you see prevalent ratios. If the ratio is less than one, that means the group in question is less‑likely than a comparison or referent category to have a deaf or hard of hearing baby. If it's greater than one, that means the particular group ‑‑ women in a particular group are more likely than women in the referent category to have a deaf or hard of hearing baby.

 Here, we see older women were less likely than young women to have a deaf or hard of hearing baby. That Asian women were more likely than non‑Hispanic white women to have a deaf or hard of hearing baby and that women who had achieved less than a high school education were more likely than college‑educated women to have a deaf or hard of hearing baby. But there were no relationships between insurance type and smoking status and having a deaf or hard of hearing baby.

 Here are factors strongly related to having a deaf or hard of hearing baby or deaf or hard of hearing status, I should say.

 And... one of them was the main effect of interest, which was... mothers that had worked, who had been presumably occupationally exposed to oto toxins at work. That was strongly‑related to having a deaf or hard of hearing baby and the other strongly related factors were prematurity, assisted ventilation for more than six hours.

 Let's see... conception‑assisted by fertility drugs and... antibiotic use for suspected sepsis, but... none of these factors had much potential for being ‑‑ for confounding the main effect association between occupation ‑‑ mother's occupation and having a deaf or hard of hearing baby.

 Two factors that did have some potential to confound the findings were Asian race and having less than a high school education because... those factors were related to both having a deaf or hard of hearing baby, as shown in the bottom table. And also to maternal work in a job or industry that afforded exposure to ototoxic chemicals.

 But... after controlling for those factors, this is in the bottom table, the middle column... you can see that they had ‑‑ they did have some potential to confound the findings, because... including them in the model, weakened the relationship from 3.0 to 2.7. But it was still strong and significant.

 So... the relationship, the relationship was independent of those confounding factors. Just because I had room on the slide and because I know some of you will be skeptical ‑‑ I also entered into the model, those factors that I showed you on the previous slide, that were strongly‑related to having a deaf or hard of hearing child or deaf or hard of hearing status and... you can see, the value for the relationship between ototoxic work ‑‑ ototoxic job or industry and... having a deaf or hard of hearing baby was not further affected by those additional steps.

 So... the association that I hypothesized to exist did exist. Bullet a single epidemiologic study doesn't prove causation. Even if we could be sure that the association I found represented a causal relationship... some questions would remain unanswered.

 We didn't have occupational histories for the women, just... the name of the occupation and industry, that the women had worked in most of the time, during the year prior to her baby's birth. So... we can't suggest anything about when during pregnancy or even before pregnancy ‑‑ on the job exposure to ototoxic chemicals might affect infant hearing. Nor do we know how ototoxic chemicals encounter that work, make their way into the woman's body and affect infant hearing.

 I didn't expect that noise exposure in utero, rather than after birth, would be relevant to infant hearing, but that hypothesis does exist. And I didn't test it.

 Because of the rarity of decreased infant hearing in combination with a small number of mothers who worked in any of the component occupations that were grouped together as the exposed group, considering the constituent to occupations, individually, wasn't feasible.

 And... those studies that have linked parents occupation to birth defects that I mentioned earlier in my talk... they actually had focused on fathers occupation... but I thought that a relationship between mother's occupation and... infant hearing was more reasonable.

 And... finally... the results of the study don't help us to understand the mechanisms by which exposure to ototoxic chemicals might work to act on infant hearing. Actually, the mechanisms by which well‑accepted ototoxic exposures like... infections and drugs remain unknown.

 In conclusion, babies whose mother worked preceding the birth in an occupation or industry affording exposure to ototoxic chemicals were two to three times as likely as other babies to receive a deaf or hard of hearing diagnosis. It would seem prudent for women to avoid work with ototoxic chemicals or at least to take prescribed precautions against exposure, if possible. While pregnant. Any questions? Yes, Derek?
 >> Within your data set ‑‑ do you have enough data to go back and... do that comparison of one occupation over the other to determine if something more ‑‑
 >> I'd hope to be able to do it in the future, but I'd have to collect more data. I did ‑‑ I was including originally in the presentation, an analysis I did do that... addressed that where, one at a time, I removed each constituent occupation and what happened was that the relationship, when the manicures were removed, decreased and when the pharmacists and pharmaceutical scientists were removed, that'd seem to suggest that manicures were important to that association, but... that the pharmacists were not as important.

 But... that could be explained by you know... a different level of exposure among the ‑‑ levels of exposure among the pharmacists and scientists. Probably not every pharmacist or person in that occupation has this ‑‑ has any exposure, possibly, and we know that they're supposed to take precautions and maybe some of them do take precautions, which prevents their exposure. I'm not sure how much stock to place in that. Anyone else? Yes?

 >> Is there a reason why you didn't include any permanent conductive hearing loss in the study? Would that have increased the numbers?
 >> No... it just had to do with what... you know, has been speculated about how those chemicals act and so... it didn't seem to me that they'd be capable of causing conductive loss.

 But... well... and actually ‑‑ I tried to, to kind of do a comparison of the results with sensorineural loss as the outcome versus conductive loss ‑‑ but I kind of abandoned that. We don't pay that much attention in our dataset to ‑‑ I mean, what is conductive loss? We know that babies might be diagnosed with you know... conductive loss, only, but that usually resolves itself. So... I don't have any sense of what is permanent conductive loss. Nobody tells us that. Okay!
[applause]

 >> Thank you.

 [Presentation concluded at 12:58 p.m. ET].

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