SUPERIOR COURT OF THE STATE OF CALIFORNIA

COUNTY OF SAN FRANCISCO

DEWAYNE JOHNSON,

Plaintiff,

vs. Case No. CGC-16-550128

MONSANTO COMPANY, et al.,

Defendants.

_____/

Proceedings held on Tuesday, July 31, 2018, Volume 20, Morning Session, before the Honorable Suzanne R. Bolanos, at 9:09 a.m.

REPORTED BY:

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Pages 4176 - 4310

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Volume 20

Morning Session

San Francisco, California

Department 504

Judge Suzanne Ramos Bolanos

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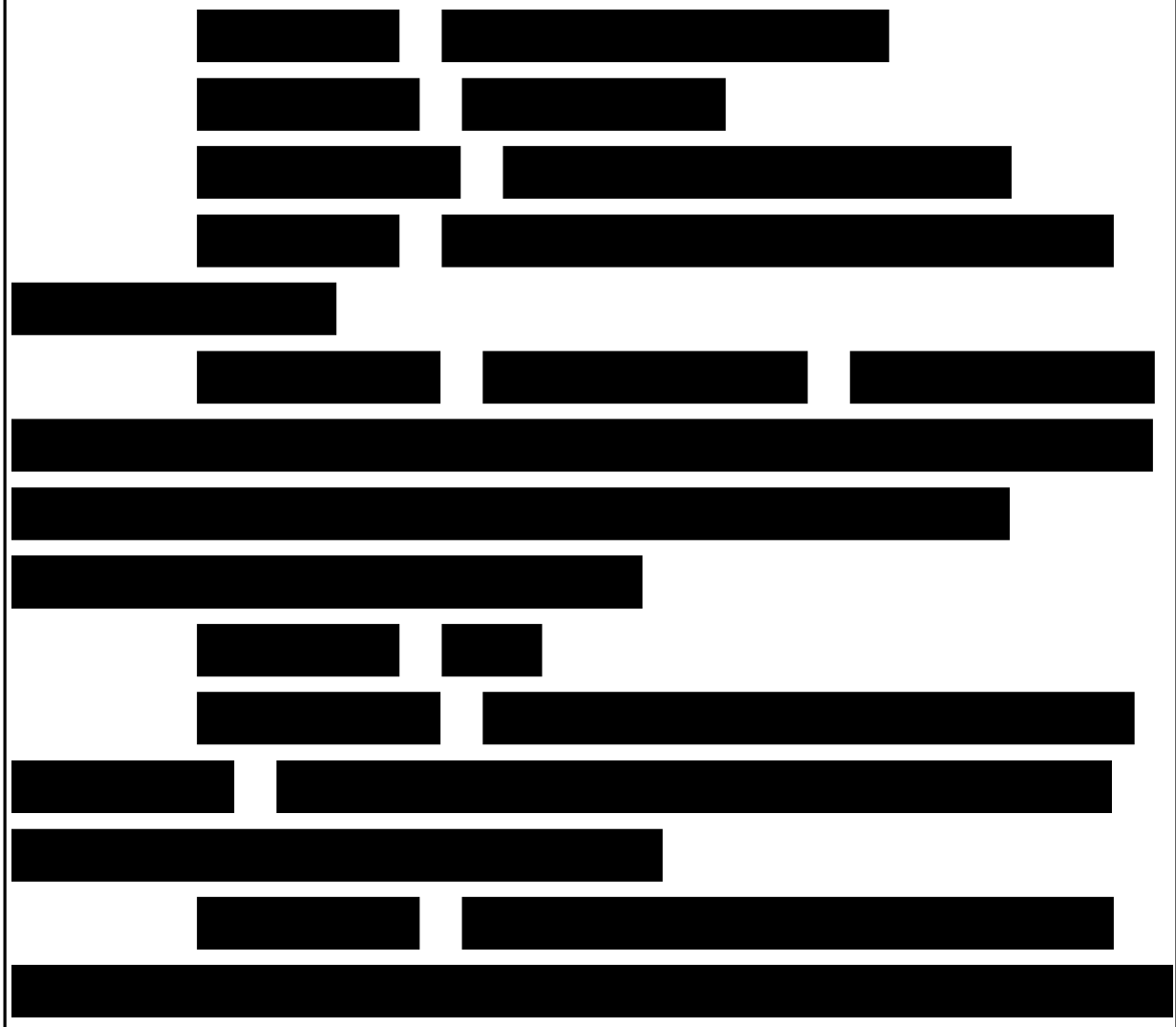

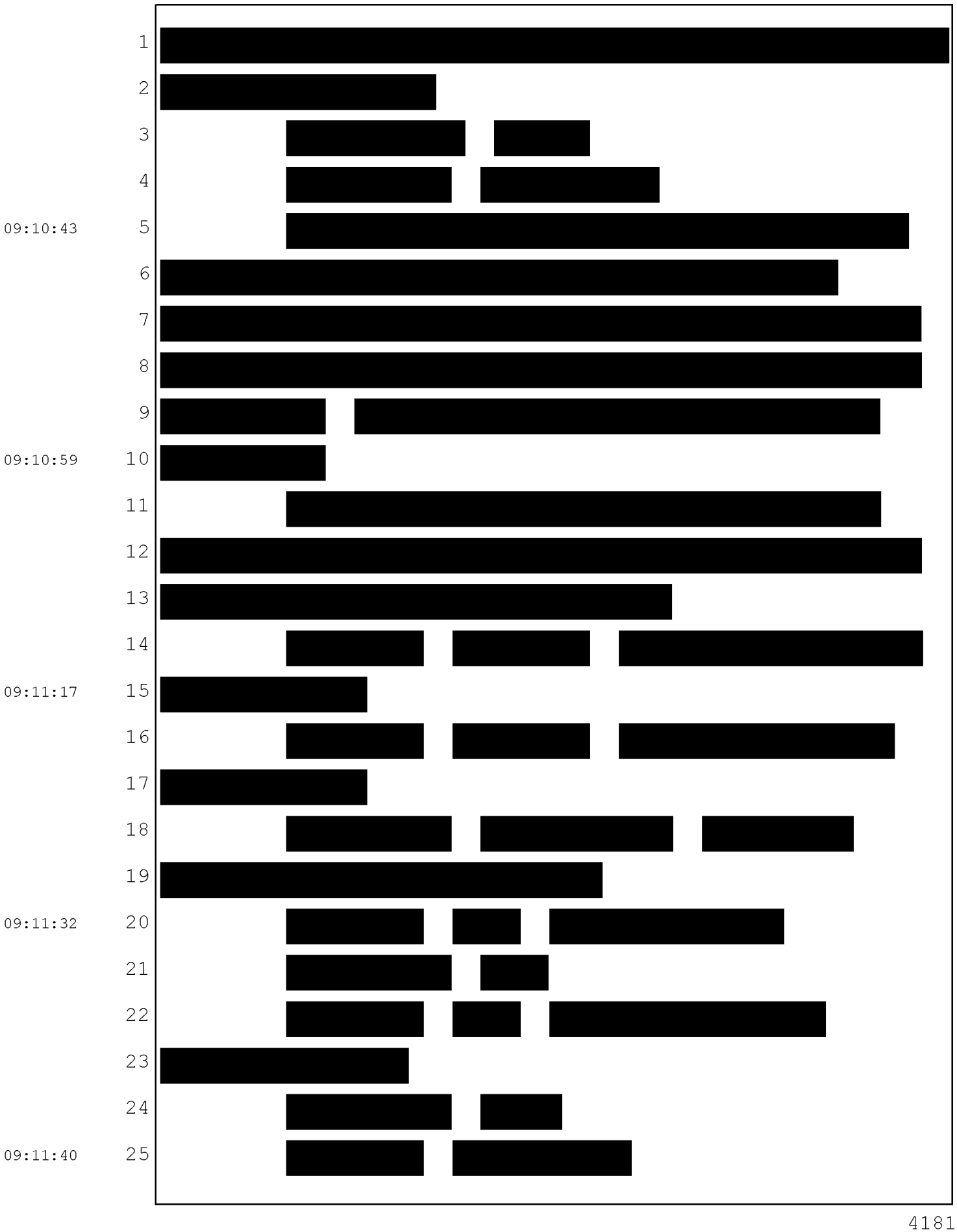
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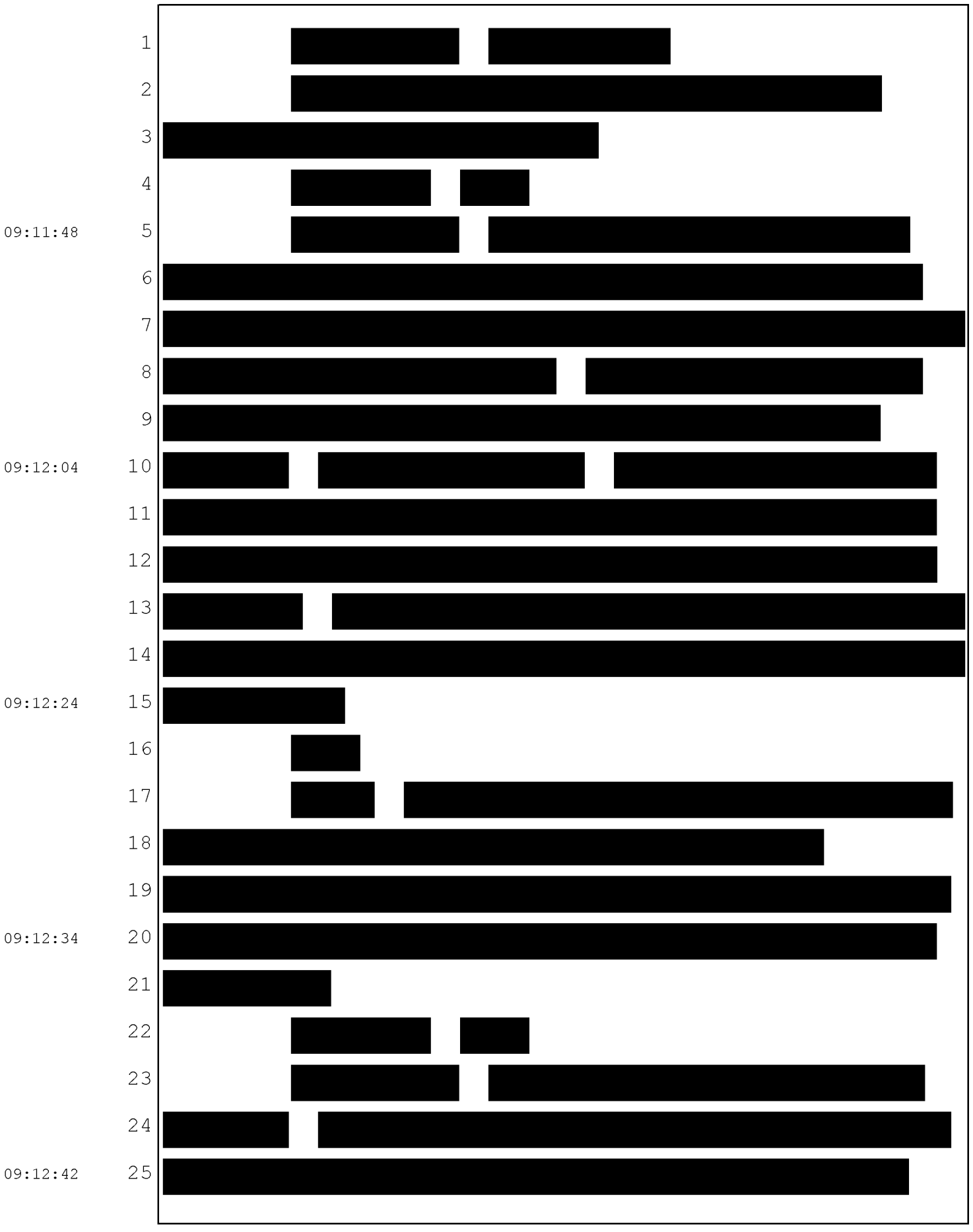
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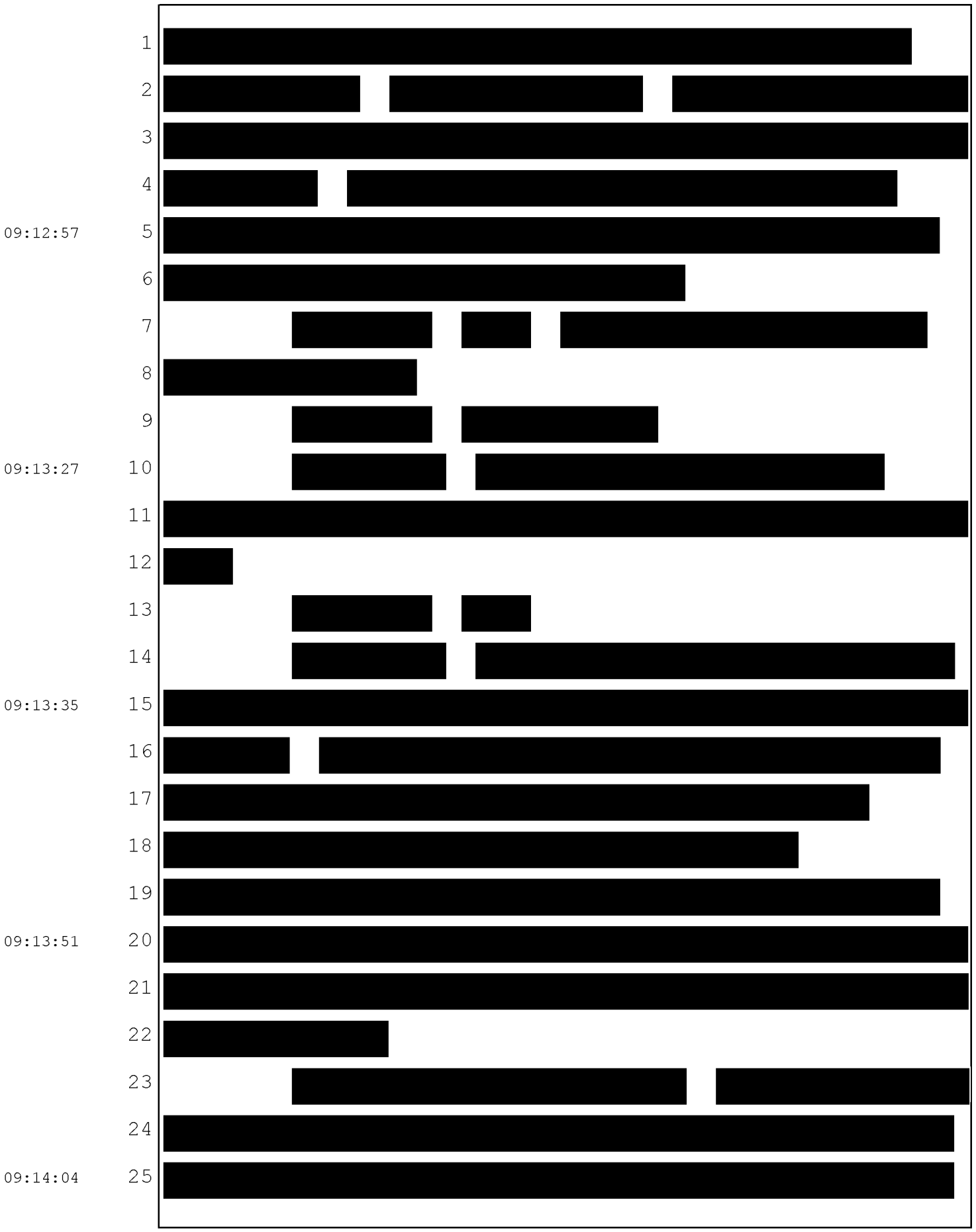
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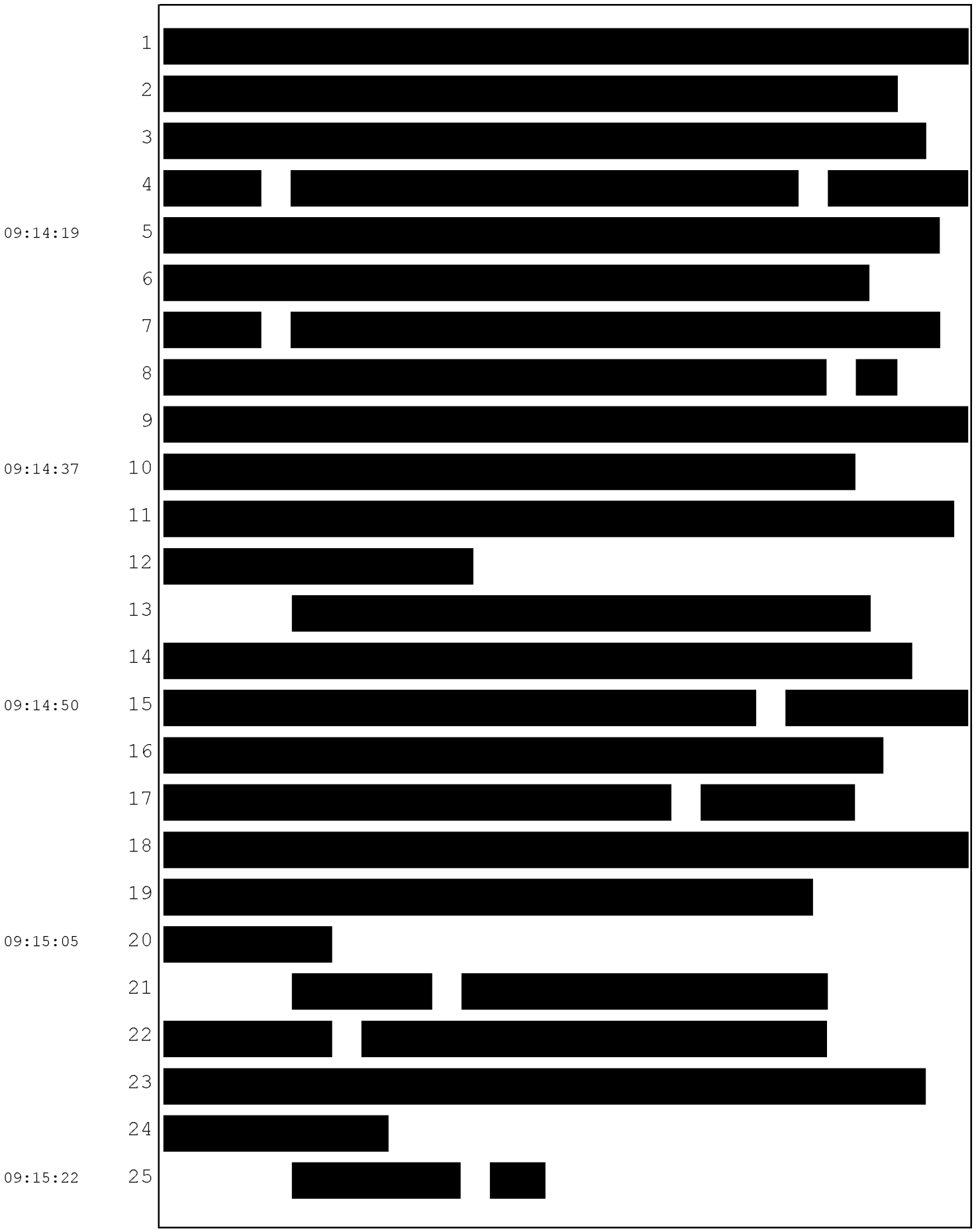
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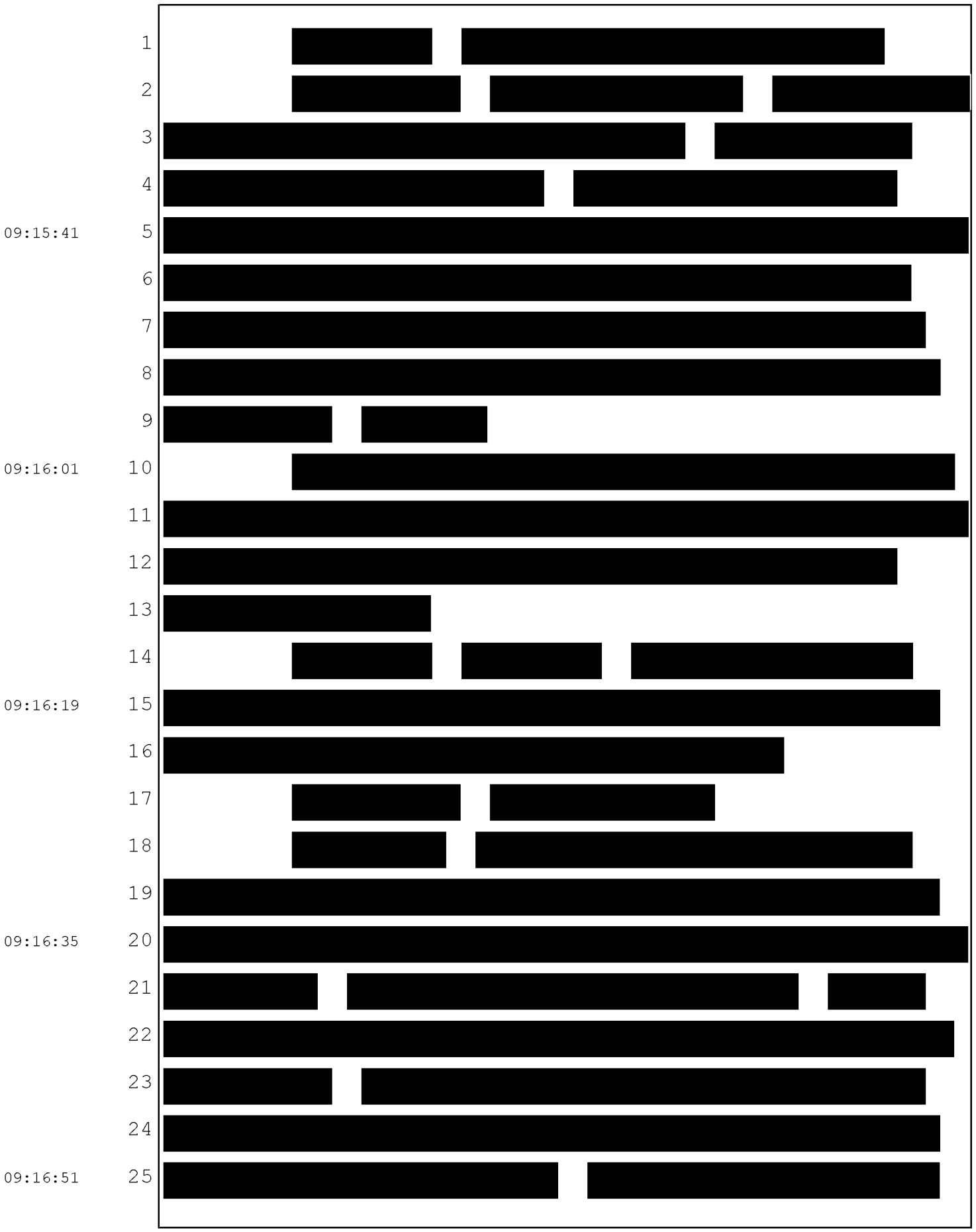
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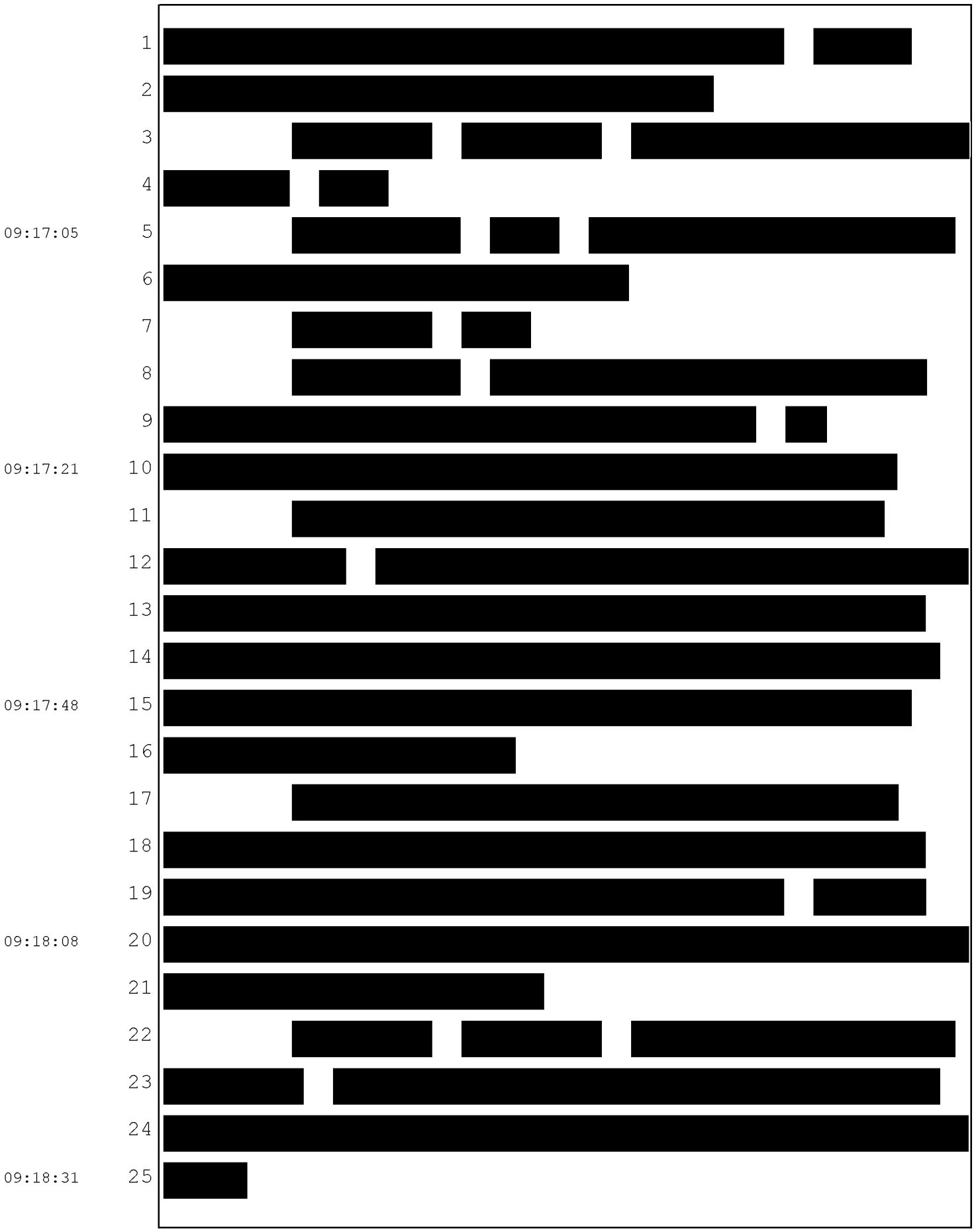
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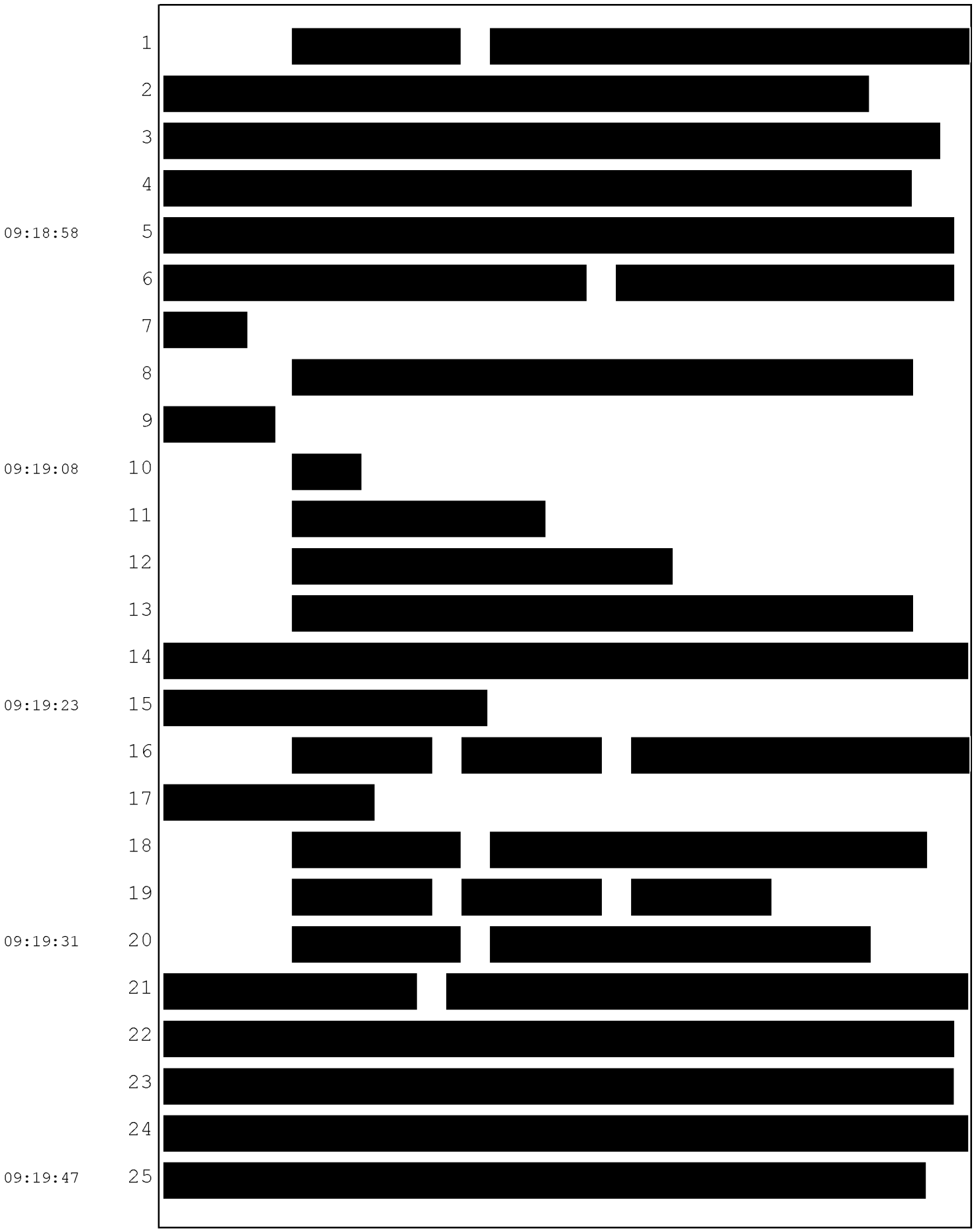
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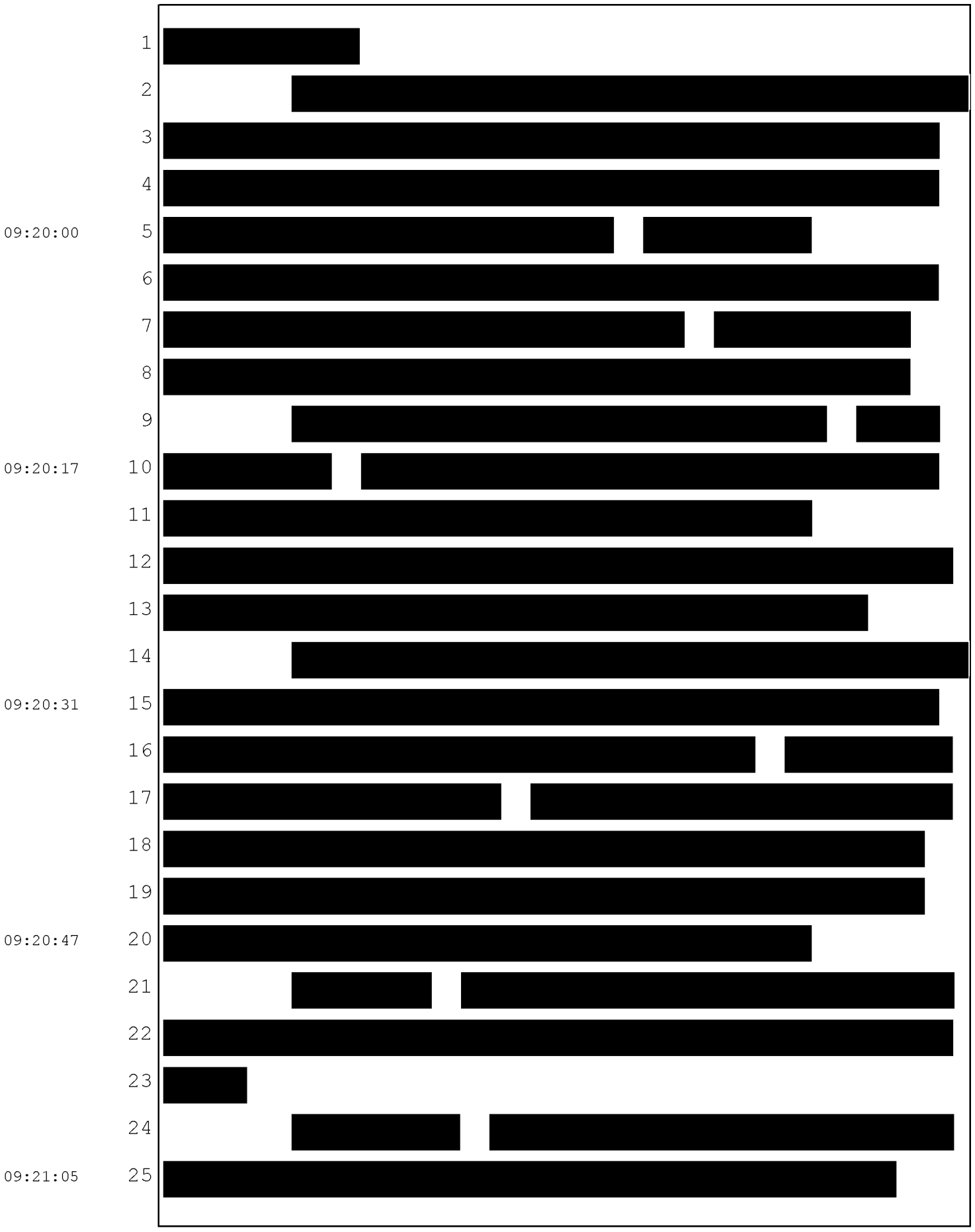
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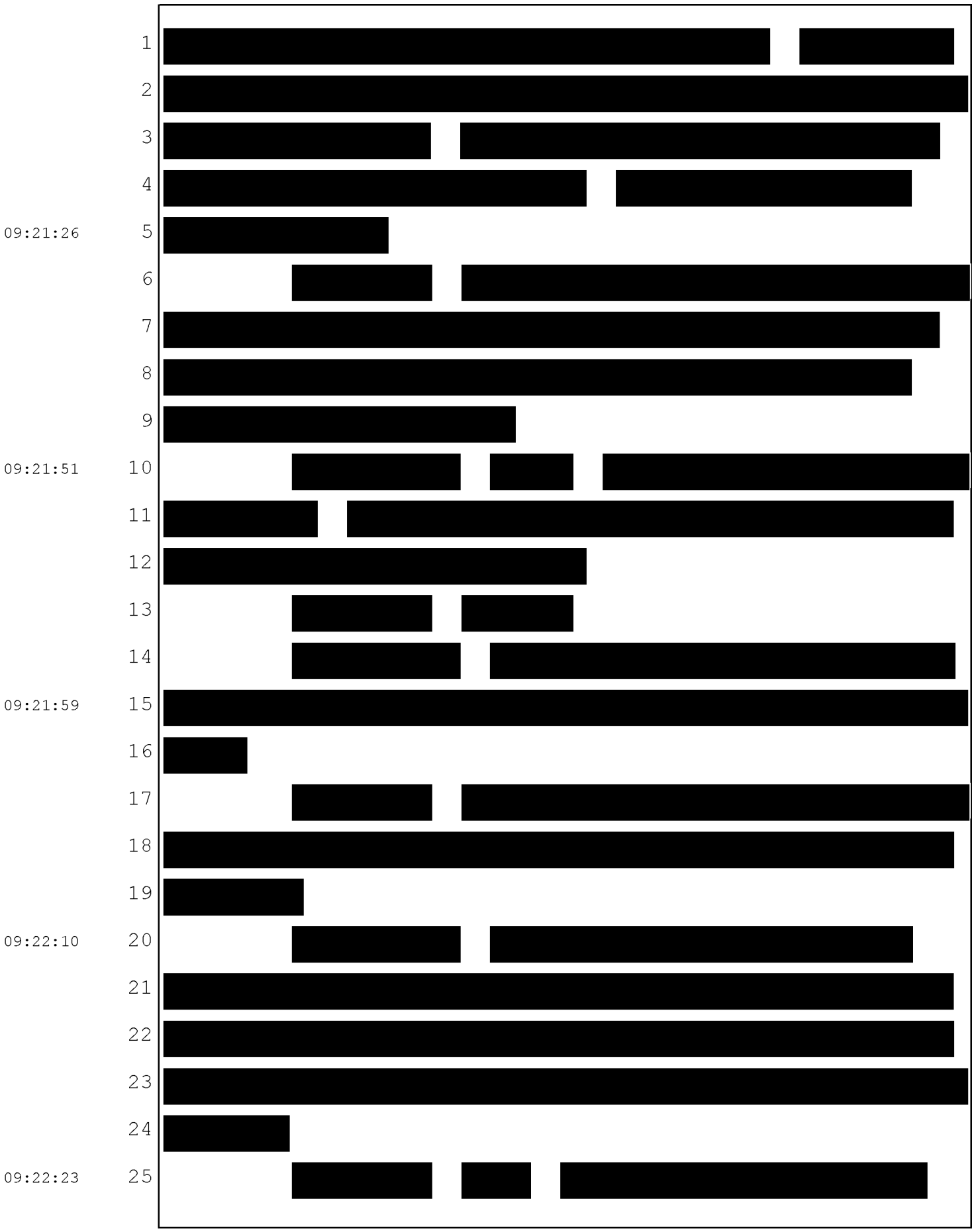
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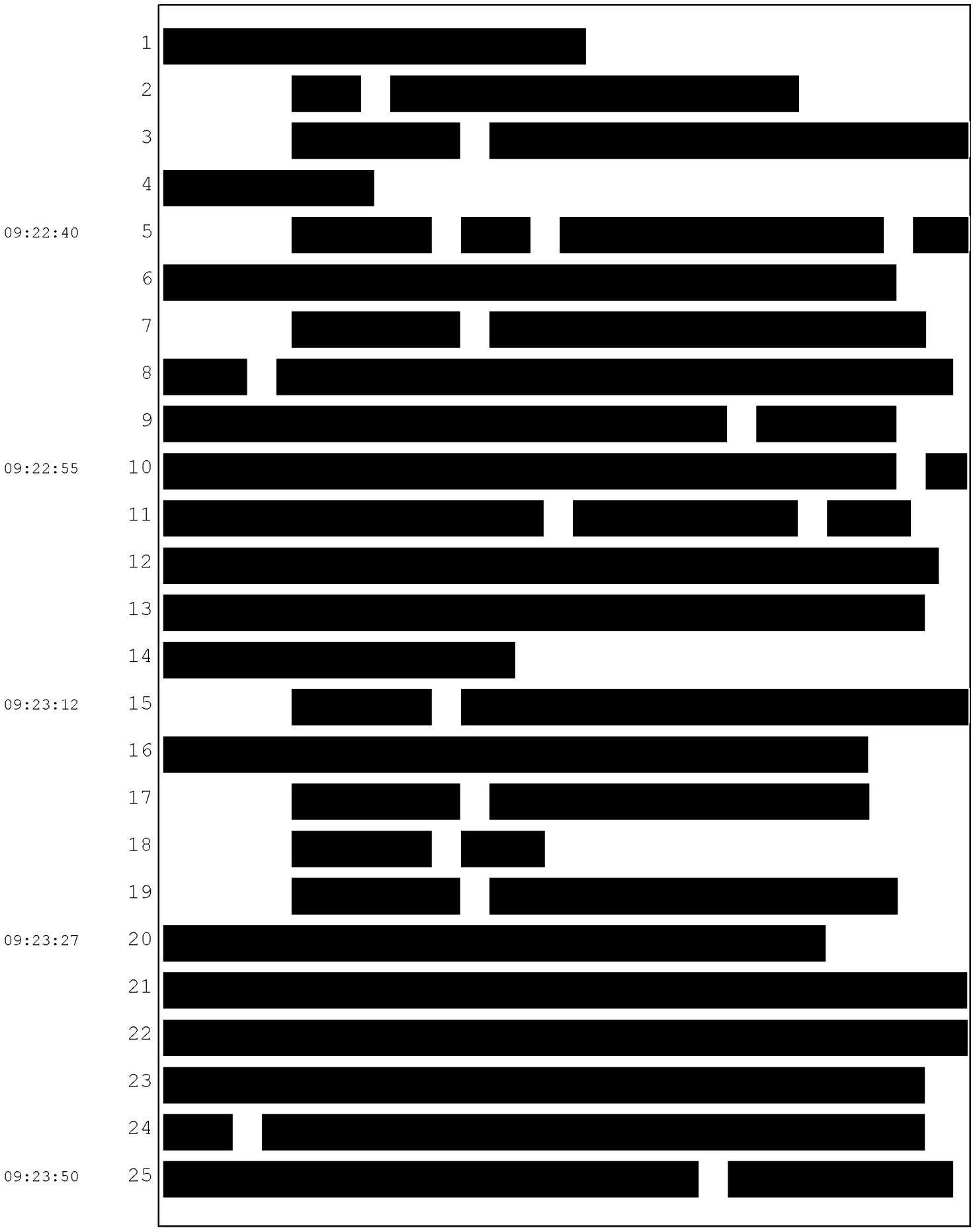
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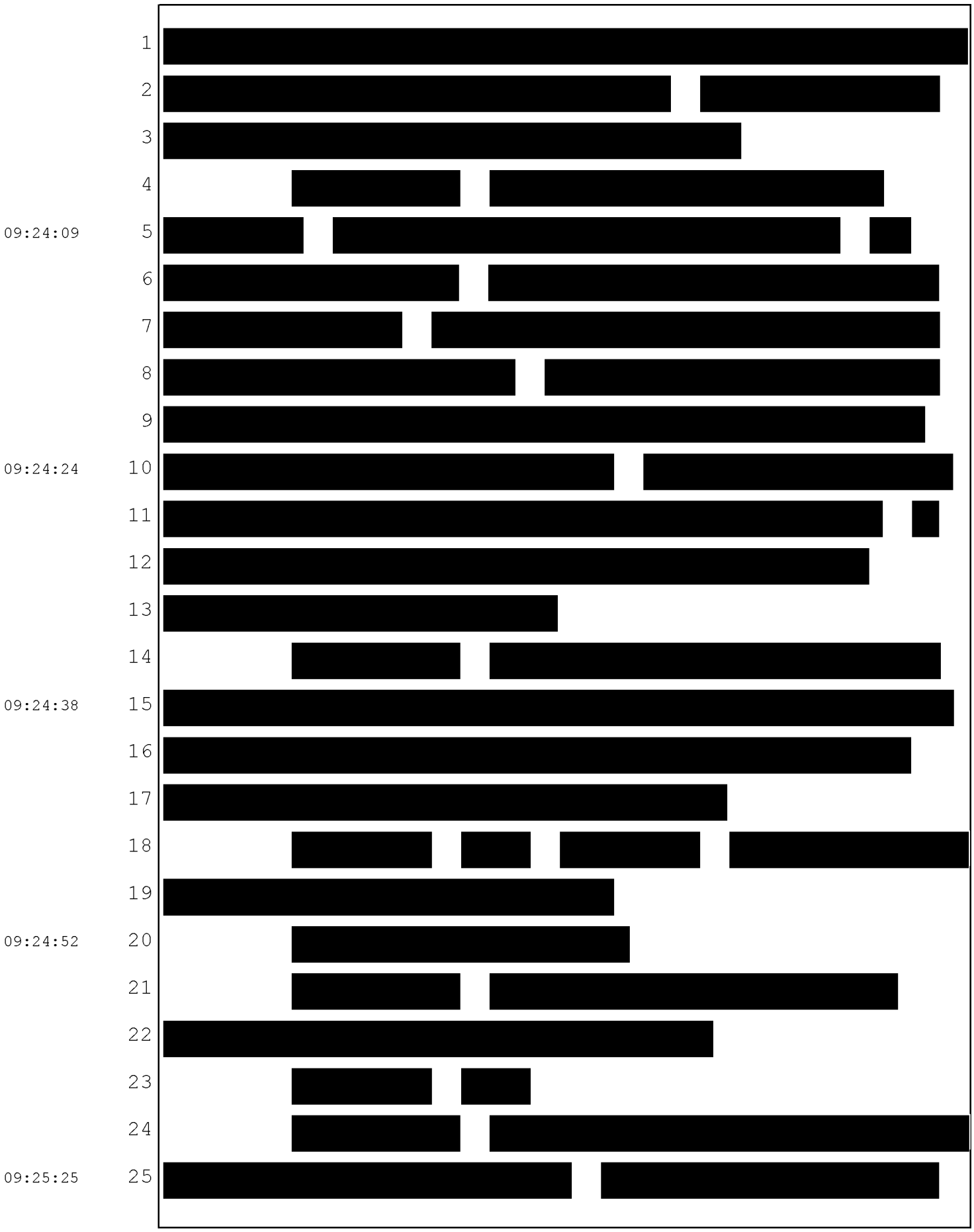
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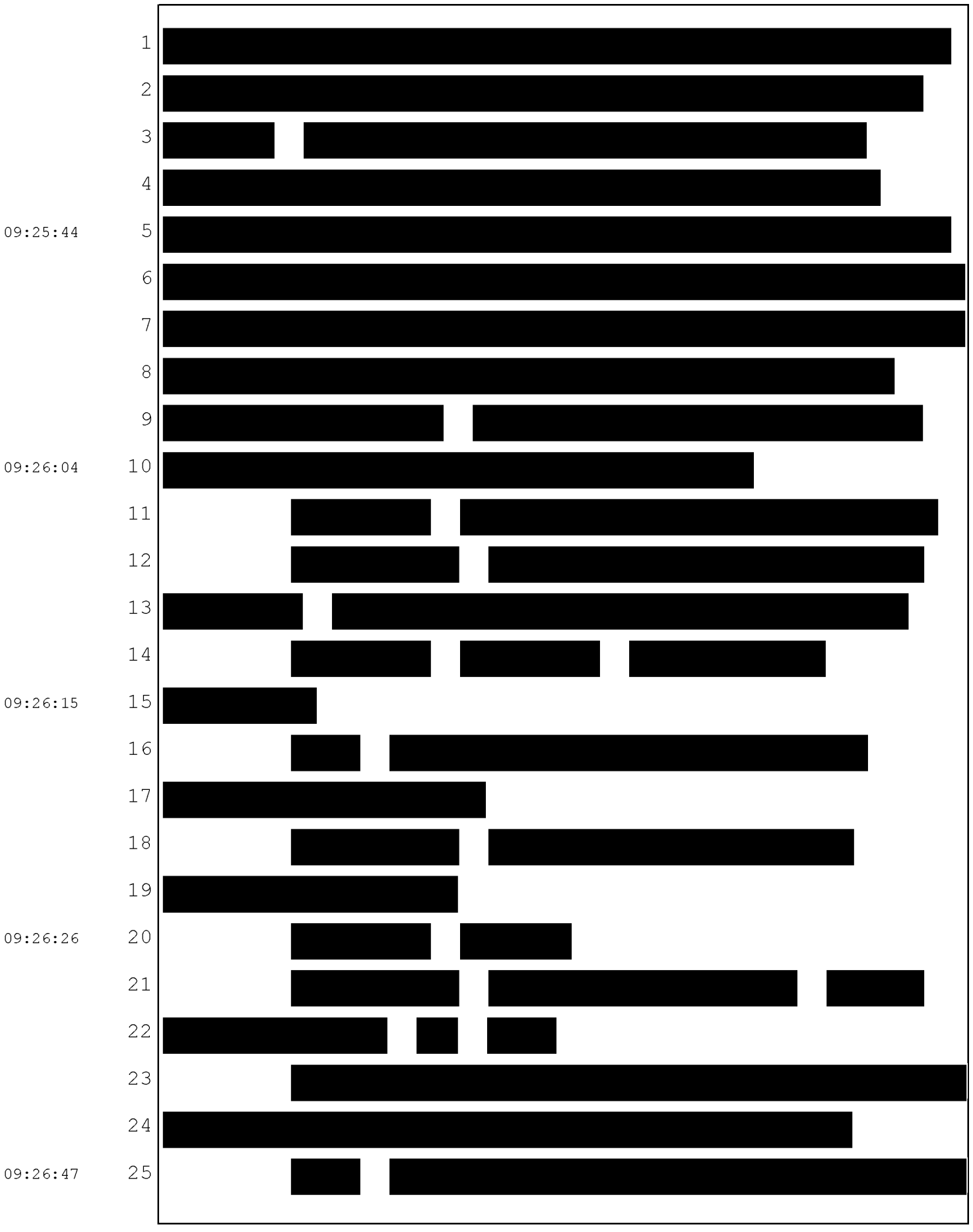
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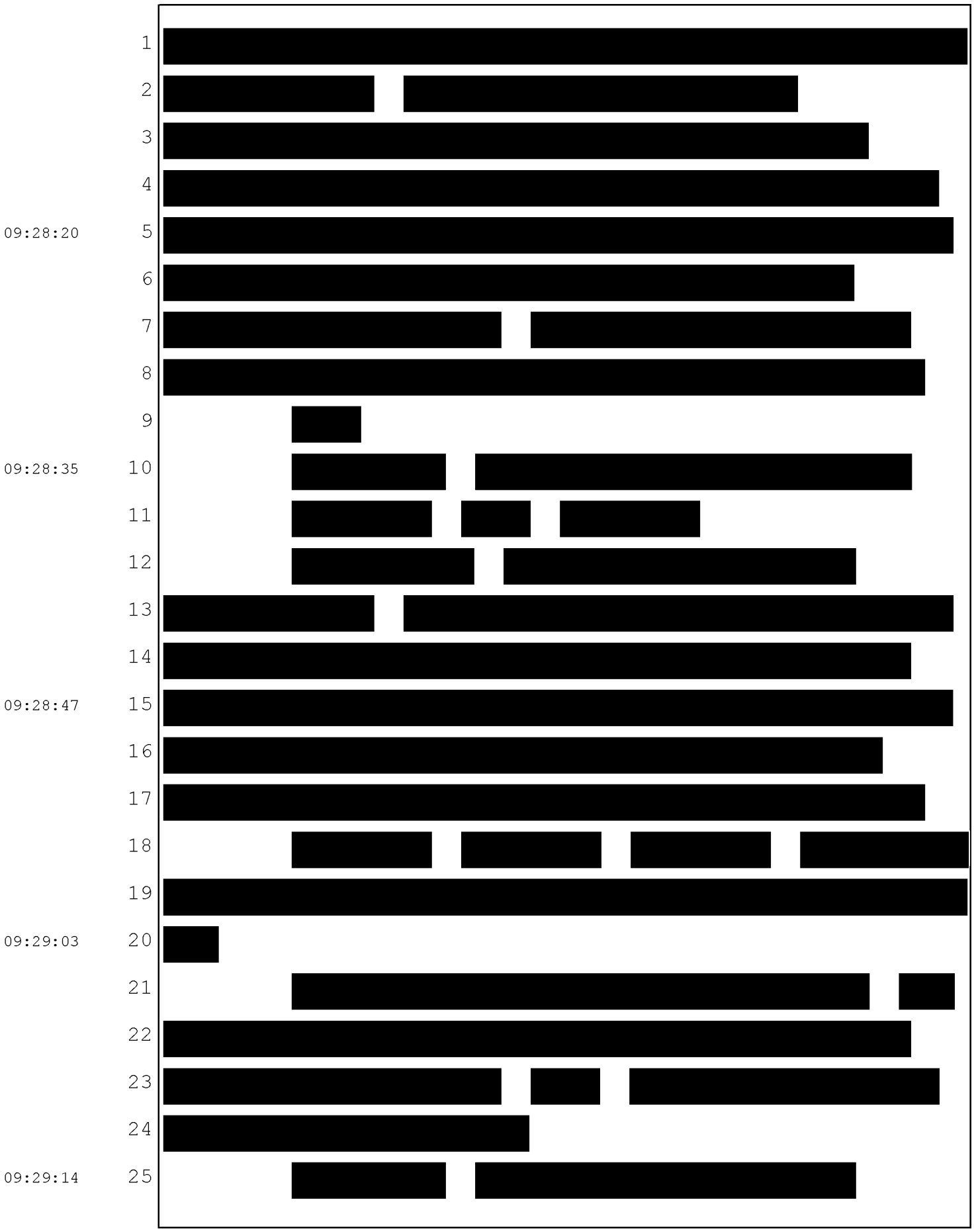
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[redacted]

(Jury enters courtroom.)

THE COURT: Good morning, Ladies and Gentlemen. Welcome back. We just have to wait for one more juror, and then we'll be able to get started right away. Thank you.

All right. Welcome back, Everyone. We'll now resume with the defense case.

Mr. Lombardi, you may call your next witness.

MR. LOMBARDI: Monsanto calls Dr. Lorelei Mucci.

THE COURT: Good morning, Dr. Mucci. If you'd please step up here to the witness stand and remain standing while the clerk wears you in.

Good morning. The clerk will swear you in.

LORELEI MUCCI,

having been first duly sworn, was examined and testified as follows:

MR. LOMBARDI: Dr. Mucci, you should have a binder in front of you.

THE CLERK: Would you please state and spell your name for the record.

09:33:26 THE WITNESS: Sure. Good morning. My name is Loreli Mucci. Loreli is spelled L-O-R-E-L-I. Mucci is M-U-C-C-I.

THE CLERK: Thank you.

THE COURT: Thank you. You may proceed,

09:33:40 Mr. Lombardi.

DIRECT EXAMINATION

BY MR. LOMBARDI:

Q. Good morning, Dr. Mucci.

09:33:42 A. Good morning.

Q. Would you please introduce yourself to the jury.

A. Yes. My name is Lorelei Mucci. I am an associate professor of epidemiology at the Harvard School of Public Health. I'm also the leader of the cancer

09:33:55 epidemiology program based at the Dana-Farber Harvard

Cancer Center.

Q. Just, in a very brief overview, describe for the jury the area that you're going to be talking to them about, please.

09:34:07 A. So I've been asked to give review of the epidemiology literature on glyphosate and NHL risk.

Q. Now, how did you get involved in this case, Dr. Mucci?

A. I was approached by the lawyers from the 09:34:23 Hollingsworth firm, who asked if I'd be interested in providing an expert opinion on this information.

Q. And did you immediately say yes?

A. No. I -- I really took some time to make sure that I could provide an independent evaluation of the 09:34:38 epidemiology studies.

Q. Now, have you ever been involved in a case like this before?

A. No, I have not.

Q. Have you ever testified before a jury?

09:34:47 A. No, I have not.

Q. Now, we'll get into your qualifications, but tell the jury: What would you call yourself, in terms of your profession?

A. I am a cancer epidemiologist.

09:34:58 Q. And what does a cancer epidemiologist do?

A. So in the field of epidemiology, it's a scientific discipline to try to understand the causes of disease. And specifically in the study of cancer.

Q. Okay. And just give the jury an idea of some things that cancer epidemiologists have done over time that they might be aware of.

09:35:12

A. Yeah. So cancer epidemiology has played, really, an important role in understanding causes for several cancers. So for example, it was epidemiology studies that established that smoking is a risk factor for lung cancer. It was epidemiology studies that identified that cervical cancer was caused by the human papilloma virus.

09:35:26

There's many, many other examples in which cancer epidemiology has been really critical to understanding the role of risk factors in cancer.

09:35:41

Q. Okay. Let's take a step back, and can you please describe for the jury your educational background?

A. Yes. I was -- I received my Bachelor's of Science from Tufts University. I received a Master's of Public Health from Boston University. And then I received my doctoral training in epidemiology from the Harvard School of Public Health.

09:35:57

Q. And that's the T.H. Chan School; is that right?

A. Yes.

09:36:09

Q. Following your doctoral degree, did you do any further work?

A. Yes. I did a postdoctoral fellowship at the Karolinska Institute in Stockholm, which has the largest department of medical epidemiology in Europe.

Q. Now, you said something about your employment. You're currently at the Harvard T.H. Chan Public Health School; is that right?

A. Yes.

Q. What are your responsibilities there?

A. So I have a number of responsibilities. I lead a research program in cancer epidemiology. I mentor doctoral students and postdoctoral fellows. I'm involved in teaching. And I also, for our school, head up our cancer epidemiology and cancer prevention program.

Q. Okay. And you also have appointments elsewhere; is that right?

A. Yes. So I have an appointment -- I lead the cancer epidemiology program at what's called the Dana-Farber Harvard Cancer Center. It's a National Cancer Institute funded cancer center. It's actually the largest cancer center in the country. I also have other affiliations as well.

Q. Okay. Now, in your professorial role, your teaching role, what classes do you teach?

A. I -- I give guest lectures in a range of epidemiology courses across the School of Public Health at Harvard, as well as outside of Harvard. I also specifically lead the course on the epidemiology of cancer.

09:37:41

Q. Give the jury an idea of -- well, I assume you have research interests as well?

A. Yes, I do.

Q. Can you give the jury -- the jury an idea of your research interests over time?

09:37:51

A. Yeah. So I have a very diverse interest in cancer epidemiology. I look at why cancer occurs, what are the risk factors, both lifestyle and genetic factors for cancer.

09:38:07

Once an individual develops cancer, I have studies going on to try to understand whether there might be lifestyle factors that might improve survival, as well as quality of life.

And I also work a lot with different biological

09:38:22

markers, including genetic factors and other factors.

Q. Okay. Tell the jury some of the diseases that you specifically have worked with in your epidemiology work.

A. Yeah. So my -- my research has investigated a

09:38:33

number of different cancer sites. I've looked at breast

cancer, colorectal rectal, bladder and kidney cancer. And more recently I've done a fair amount of work in the area of prostate cancer.

Q. Okay. And why don't you tell the jury a little bit about your work with breast cancer.

09:38:47

A. Yeah. So the work that I did in breast cancer was trying to understand the role that hormones play in the development of -- of breast cancer in women.

Q. And how about prostate cancer? Tell the jury a little bit about that, please.

09:39:03

A. So some of the research that we've done, for example, is prostate cancer has a very strong family history. So we're trying to understand: What are the genetic factors that contribute to the development of prostate cancer?

09:39:17

Also, among individuals who have cancer we're trying to understand whether things like physical activity might improve the health of cancer survivors.

Q. And have you also done work on childhood leukemia and lymphoma at times during your work?

09:39:33

A. Yes, I have.

Q. Okay. And can you describe that just briefly?

A. Sure. So while I was a postdoctoral fellow in Sweden, I worked on a study looking at whether smoking during pregnancy might influence the risk of childhood

09:39:44

cancer for that child in utero.

Q. Okay. Have you published research?

A. Yes, I have.

Q. And have you published in peer-reviewed journals? The jury's heard all about peer-reviewed journals. Have you published in peer-reviewed journals?

09:39:56

A. Yes, I have.

Q. And how many?

A. To date I've published about 300 research articles and other peer-reviewed materials.

09:40:06

Q. Okay. Have you written any books?

A. Yes, I have.

Q. And what -- tell the jury about the books that you've participated in writing.

A. So I've been in -- I've written chapters for textbooks in epidemiology. About 11 different chapters. And then in 2017 and 2018, I was an editor for two textbooks. The first was entitled "The Pathology and Epidemiology of Cancer," and the second was the third edition of "The Textbook of Cancer Epidemiology."

09:40:14

09:40:36

Q. And is this the second one (indicating)?

A. Yes, it is.

Q. Is it fun to write a textbook, Doctor?

A. It is, actually. It's really a great experience to work with a talented range of -- of scientists putting

09:40:49

together what's the current knowledge on what the causes of cancer are.

Q. Are you involved in professional organizations for epidemiologists?

09:41:02 A. Yes, I am.

Q. And what are you -- what are your activities in those organizations?

A. So, for example, I am part of the American Association for Cancer Research, which is one of the 09:41:14 international leading cancer research organizations. Also part of a number of working groups that are part of the National Cancer Institute, where we bring together colleagues from across the disciplines to look at cancer from a variety of different angles.

09:41:32 Q. And do you make presentations to professional groups?

A. Yes, I do.

Q. All right. So, Doctor, I think you're involved in something called the Health Professionals Follow-Up 09:41:42 Study; is that right?

A. Yes, I am.

Q. Can you describe to the jury what the Health Professionals Follow-Up Study is.

A. Sure. So the Health Professionals Follow-Up 09:41:52 Study is an all-male cancer epidemiology cohort study

that's been funded by the National Cancer Institute. It was actually started in 1986, and we enrolled men who were health professionals, including veterinarians, optometrists, dentists, with the idea that health professionals would provide high quality data.

09:42:11

And these men have been followed up carefully through regular questionnaires. We also found out causes of different diseases, including cancers. And currently I'm the co-principal investigator for the Health Professionals Follow-Up Study.

09:42:31

Q. Okay. And you made some reference to this, but what's the range of diseases that you're studying in that Health Professionals Follow-Up Study?

A. Yeah. So we're able to look at all types of cancers. We also within this cohort study, investigate heart disease, diabetes, Alzheimer's, Parkinson's disease. It's really unique.

09:42:45

And because of the rich data on exposures and medical outcomes, we're really able to look at a broad range of health outcomes. We're also, more recently, looking at things like cognitive function, as well as just overall quality of life among men.

09:43:02

Q. So, Doctor, why do you study cancer epidemiology? Why is that your field?

A. You know, so as a -- as a public health person,

09:43:14

cancer is one of the leading causes of death and suffering around the world. So more than 17 million individuals are diagnosed with cancer each year.

On a personal level, my family's been affected, and we've lost several family members from cancer. So it was both a personal and professional interest to be a cancer epidemiologist.

09:43:32

MR. LOMBARDI: Your Honor, I offer Dr. Mucci as an expert in cancer epidemiology.

09:43:44

THE COURT: Any *voir dire*?

MR. WISNER: Just a very short one, your Honor.

VOIR DIRE EXAMINATION

BY MR. WISNER:

09:43:48

Q. Hi, Dr. Mucci.

A. Hi.

Q. My name is Brent Wisner. I met you just briefly a second ago; right?

A. Yes.

09:43:56

Q. Never talked to you before?

A. No, I haven't.

Q. All right. I wasn't planning to *voir dire* you at all, but I actually have a quick -- you mentioned something. I want to make sure I understood it right.

09:44:02

You said you're here to offer testimony about

epidemiological literature and overall risk. What do you mean by overall risk?

A. No, I'm sorry if I wasn't clear. But my -- my -- I am here to review the epidemiology studies of the association of glyphosate and the risk of non-Hodgkin's lymphoma.

Q. Okay. So you're not going to talk about animal studies or mechanistic studies or anything like that?

A. No.

MR. WISNER: Okay. No objection, your Honor.

THE COURT: I will accept Dr. Mucci as an expert in cancer epidemiology.

DIRECT EXAMINATION (Continued)

BY MR. LOMBARDI:

Q. Doctor, are you being compensated for your time?

A. Yes, I am.

Q. And what's the rate?

A. My rate is $350 per hour.

Q. Now, the jury's heard about this before, but just so they hear it from your point of view, what do you think of epidemiology? What is epidemiology?

A. So epidemiology is the study of the causes of disease in humans. And I think that's important to think about if we want to understand why disease occurs in

humans. It's the best model to study disease in humans.

Q. How about if you want to study a product that's actually used by humans out there in the real world? How is epidemiology for studying something like that?

09:45:10 A. Right. So, you know -- you know, the difference between animal studies, for example, and human studies is that we're able to study what real life levels of exposure are in the frequency in which people are using samples in the population. So I think that's the

09:45:29 important feature.

Q. In a very basic way, how do epidemiological studies work?

A. So the -- the goal of epidemiology is -- when we're looking at whether a specific exposure causes

09:45:42 disease, is to compare -- compare a group of individuals who have the exposure to a group of individuals who don't have the exposure.

And the important factor in epidemiology is to make sure the populations are only different on that

09:45:59 specific exposure. And then we follow individuals for a certain amount of time to develop the disease of interest.

Q. Okay. And the jury's heard a lot about case control and cohort studies. Are those two of the main

09:46:10 kinds of studies that epidemiologists use?

A. Yes, they are.

Q. Do you have a way of describing epidemiology for lay people that would be helpful to the jury here?

A. Yeah. So I think to get around this idea of how
09:46:24 important it is to have the only difference be between the exposed and the unexposed group is to think about what, really, if you could have an ideal study in epidemiology would be. Which is if you could identify a population of people and follow them from the time they
09:46:40 were born until the time they died.

And let's say we're interested in whether smoking is -- is a cause of heart disease. So what we would do is the -- the entire population would be exposed to cigarette smoking. And then we'd follow them
09:46:56 throughout their lives and identify how many of the individuals had heart disease.

And then what we would ideally want to do is be able to send that population of people back in time, and they would live the exact same life that they lived,
09:47:10 except the only difference there is that they're not smoking cigarettes. And then we'd, again, find out how many people developed heart disease.

And the reason that's important is now the only difference in those two groups is the fact that one --
09:47:23 one -- in one time they were smoking cigarettes, and in

the other time period they were not smoking cigarettes. And then we can assess the causal effect of smoking on heart disease by comparing the rates of heart disease in those two --

09:47:35 Q. So in that ideal world, you could have people who were exactly the same except for the difference in the exposure?

A. Exactly. Yes.

Q. You can't do that in the real world; right?

09:47:44 A. Yes, that's right.

Q. All right. So are all epidemiological studies of equal value?

A. No, they're not.

Q. What are -- why aren't they?

09:47:52 A. Well, so for each epidemiology, when we see the results of the study, it's really important first to wonder whether the risk -- before thinking about causality, whether the results that you see could be due to three factors: Bias, confounding and chance.

09:48:06 Q. Okay. And we're going to jump into that in just a second.

But just to give the jury some perspective, how did epidemiology get started?

MR. LOMBARDI: Can you put up Slide 2, please?

09:48:18 May I publish, your Honor, Slide 2?

THE COURT: Yes.

THE WITNESS: So there's -- if you look throughout history, there are examples, even 1,000 years back, where people were doing, sort of, epidemiology-type of studies. But I think really one of the nice early examples is the John Snow -- the John Snow study of cholera in the 1850s in London.

Q. BY MR. WISNER: And you've got a demonstrative here. I assume that's John on the left; right?

A. Yes.

Q. And what is the right here?

A. So Dr. Snow was a physician in London at the time of a very large outbreak of cholera, which is a type of infectious disease. And this particular map shows different outbreaks of cholera that were in different households in London.

And what you can, sort of, see is that there were some households where they were occurring, and then one street over there were household where there were no cases of cholera.

And so what John Snow did was he went around and interviewed both the households -- and this was, sort of, an early case-control study. He went and identified houses where cholera had happened. He interviewed them about diet they were eating, about different lifestyle

factors. And then, also, this was a time in which water didn't come directly into the home. You had to go to a well pump to get water supply. And so he asked them about where they got their water. And similarly did this
09:49:44 for the households that didn't have cholera.

And what he was able to do was identify that the source of the outbreak of cholera was actually one of these water pumps. And so they were able to close it down and stop the cholera epidemic.

09:49:57 So I think that's a really nice early example of a case-control study.

Q. Okay. Now, you mentioned three things that epidemiologists try to avoid in their studies. Can you repeat those again, and then we'll go through them in
09:50:10 more detail.

A. Right. So the three issues would be: Bias, confounding and chance.

Q. All right. Let's talk about confounding first. The jury has heard something about this before, but just
09:50:19 so they hear your perspective on it.

What is confounding in the context of epidemiology?

A. So, I mean, confounding can be thought of as a mixing of the facts. And so it's -- it's, you know, in
09:50:30 the fact that people -- for example, the study of smoking

and heart disease, the people who smoke might also have potentially a less healthy diet. They may be more likely to have other health conditions.

And so what can happen when you see an association between smoking and heart disease, you might worry that it's -- the fact that smoking is also correlated with these other exposures, and what you're seeing from the association is -- the question is: Is it -- is it correlated -- is the reason you're seeing an association due to the fact that you have this mixing effect of other lifestyle factors with heart disease?

Q. And what's the problem that confounding creates in epidemiology studies for an epidemiologist?

A. So it will create a biased relative risk element. With confounding, it may either overestimate or underestimate our relative risk if confounding is present.

Q. Okay. Have you brought a slide to help illustrate what confounding would be in a hypothetical study?

A. Yes, I have.

MR. LOMBARDI: And, your Honor, I'd ask to publish Slide 3?

THE COURT: Very well.

Q. BY MR. WISNER: And what's the study that you're

depicting here -- the hypothetical study you're depicting here?

A. Yeah. And, actually, this is a real-life example of confounding. In several early studies, there had been interest in whether regular consumption of coffee could be a risk factor for heart disease. And there were several studies that had shown that individuals who were drinking coffee had a higher positive association with heart disease.

09:51:49

But what these early studies didn't account for was the differences in smoking. And so what these early studies showed were the people who were drinking coffee were actually a lot more likely to be smoking cigarettes also. And so, actually, smoking is a well-established relative risk for heart disease.

09:52:02

09:52:18

And so it wasn't the positive association between coffee and heart disease occurred because the coffee drinkers were smoking. So it wasn't that coffee was associated with heart disease; it was the fact that they were more likely to be smokers.

09:52:31

Q. And so you might get an affect -- a confounding effect that coffee was actually causing the disease in your example?

A. Exactly.

Q. And then what would an epidemiologist do to try

09:52:40

to eliminate that problem?

A. Right. So I think of -- of the three things that I mentioned, bias, confounding and chance. In a lot of ways, confounding is the issue that is the most easy for us to address, because there's actually mathematical models that are used in epidemiology that allow us to be able to disentangle the confounding when we're looking at an exposure to disease.

09:52:54

Q. Okay. Is that called adjusting?

09:53:09

A. Yes. Yes.

Q. All right. And without getting into -- we don't need to get into the details of mathematical models, but just describe what these mathematical models for adjusting accomplish.

09:53:20

A. Right. So when you -- what you would do with these models is to put in the exposure of your interest into the model, together with all of the potential confounders that you're concerned about, as well as the outcome.

09:53:34

And then what you can do, also -- what's nice about epidemiology is you can compare your model when you only have the exposure in the model and what the relative risk is, to what the relative risk is when you have coffee and these confounders in the model.

09:53:49

And if you see differences in those relative

risk estimates, you -- it gives you information that there was confounding in your data.

Q. Okay. And epidemiologists try to avoid confounding; is that right?

09:54:04 A. Yes.

Q. All right. So do you have an example that's a little closer to what we're talking about in this case that you can show the jury?

A. Yes, I do.

09:54:10 Q. Let's go to Slide 4. And explain to the jury first, before you go through it, what we're talking about in this illustration.

A. Right. So in this example here, our exposure of interest would be glyphosate. Our outcome of interest 09:54:26 would be non-Hodgkin's lymphoma. And then our potential confounders would be use of other pesticides.

Q. Okay. And why would other pesticides be a potential confounder here?

A. So for the -- for a confounder to actually -- to 09:54:43 be a confounder of your data, the confounder has to be in some way correlated with glyphosate so people who used glyphosate would be more likely to be using other pesticides.

And then even among people not using glyphosate, 09:54:59 there has to have been some sort of positive association

or association between the use of other pesticides and non-Hodgkin's lymphoma. So both of those -- if those -- both of those are true, then there would be confounding in the data.

09:55:12 Q. Okay. So let's say you -- you got -- you're studying glyphosate, and you got a result without adjusting for the confounders. What would -- what would an epidemiologist like yourself think about the result for glyphosate in that instance?

09:55:30 A. Well, you would be concerned that potentially there could be confounding of that estimate if you've not adjusted for other pesticides.

Q. And if you're concerned about confounding, are you getting a true picture of whether glyphosate, in that 09:55:44 instance, is actually causing the disease?

A. No. And, in fact, I think this is a really important factor: Is that just in epidemiology, just because we see a statistical association, does not mean that it's a causal association.

09:55:57 And that's what I was meaning earlier, when I said that when you see a statistical association in the data, we first need to say: Is there bias present? Was there confounding of our data? Or could chance have played a role?

09:56:11 And so in that case, we'd be worried about

confounding.

Q. Okay. Now, to be a confounder, from the standpoint of an epidemiologist and from the standpoint of adjusting, do you have to have a known carcinogen?

09:56:23 A. No.

Q. So the other pesticides, they don't have to be known carcinogens in order to be treated as confounders in the --

A. Exactly. Right. So there's a lot of examples

09:56:35 of this. So, for example, in epidemiology studies, we often will adjust for a factor such as race, but -- you know, in the study of cancer. But we know that it's not race causing cancer, for example, but race is standing in for potentially things like social inequity, or it could

09:56:56 be even biological factors.

So we can adjust for factors even if they, themselves, are not the actual cause of the disease.

Q. Okay. So on your illustration, you have farming. What are -- what are you depicting there?

09:57:10 A. Right. So in this example, you know, we adjust -- by adjusting for other pesticides, we're actually also -- also adjusting for other factors related to farming that -- that may be the ones that are the actual causes of non-Hodgkin's lymphoma.

09:57:27 So it's -- one of the advantages of these

mathematical models is by adjusting for one factor, you may deal with the other confounding present, because other pesticide use is -- is correlated itself with these other things, like farming practices.

09:57:44 Q. Okay. And is it proper to adjust for potential confounders?

A. Yes, it is.

Q. Now, Doctor, we've heard the term "adjustment" for other pesticides. In this example, how would you

09:57:57 adjust for other pesticides?

A. We would -- well, I think the approach that one would want to take is first to say: Are there pesticides in my data that are more commonly or less commonly occurring in people who are using glyphosate? So that

09:58:14 would be the first step.

The second step would be: From the literature, are there other pesticides that have been shown to be associated with non-Hodgkin's lymphoma? And you would pick a list of potential confounders. And then you can

09:58:29 actually evaluate in your model whether or not those other pesticides led to confounding in your data. Because, again, you can compare the unadjusted estimate, when you're only looking at glyphosate, with the adjusted estimate, where you put those other pesticides in the

09:58:46 model. And if you see a difference, that would suggest

that confounding was present.

Q. Okay. So last question on confounding for a while here. But if you have a study that doesn't adjust, for instance, for other pesticides in this example, does that give the epidemiologist reason for concern?

09:58:59

A. Yes, it would.

Q. Now, the second category you talked about, I believe, was bias?

A. Yes.

09:59:08

Q. Okay. Bias is another thing that epidemiologists are concerned about?

A. Yes.

Q. Can you define bias in the context of epidemiology?

09:59:16

A. Well, so confounding we think of as one very specific form of bias. But there's actually many other types of bias that we might be concerned about in epidemiology studies.

For example, if we're collecting information

09:59:30

from questionnaires, we may wonder how reliable that information is.

There are other types of bias where the ways -- particularly with case-control studies, the way in which we recruit our cases and controls into our study can lead

09:59:51

to a type of bias called selection biases. Selection

goes into selecting cases and controls.

Q. It's probably obvious, but bias is not a good thing; is that right?

A. That's correct.

10:00:01 Q. What can bias do to results, if it exists in a study?

A. Right. So depending on the type of bias, the bias actually be either predictable, meaning can understand its effect on our estimate of relative risk,

10:00:16 or it might not be predictable. Because it might either overinflate or underestimate our relative risk.

Q. Okay. Can you -- is there a particular kind of bias that you're going to be talking about a fair amount today?

10:00:27 A. Yes. I'm going to be talking specifically about the role that proxy biases may have played in some of the case-control studies.

Q. What is proxy bias?

A. Right. So -- so as I mentioned to you, in both

10:00:43 case-control studies and cohort studies, oftentimes we're collecting information from questionnaires.

In the case of the cohort studies, you know, we're able to collect information before the disease occurs. But in case-control studies, we're recruiting

10:00:59 individuals after they've already been diagnosed with

cancer.

And in some cancers, the -- you know, people are dying fairly quickly or become too ill to actually directly participate in the study. And so what some of
10:01:13 the earlier case-control studies would do would be to get the information not from the case themselves, but from a proxy.

So usually they would ask a spouse or other family member to provide information about the different
10:01:28 exposures that that case was engaged in.

Q. So a proxy, then, as defined in this situation, is what?

A. The proxy would be the -- the spouse -- the data from the spouse or other family member.

10:01:44 Q. Okay. And when you go to a spouse or other family member or other proxy, what does that do to the quality of information, at least potentially?

A. Yeah. So what it potentially does -- and actually we know from a study by Dr. Blair, actually, the
10:02:02 impact that proxies have on reporting different pesticides -- but what can happen is really two things: One is that, as you might expect, there's some exposures that may be much more challenging for a spouse or other family member to report accurately on for the
10:02:18 participant. They just may not know the extent to which

somebody might be using specific factors.

Secondly and specifically for case-control studies, when you lose a family member to a disease like cancer, you really may wonder what caused that cancer to occur. And so what can happen is that the proxies are going to remember information differently for the cases and -- maybe more thinking. It's called ruminating. They ruminate about the cause of cancer differently than the controls would.

10:02:52 Q. Okay. So generally speaking, how do epidemiologists -- and this is generally speaking.

How do epidemiologists think about responses from proxies?

A. Right. So I think there -- as an

10:03:02 epidemiologist, we would be very concerned about the quality or reliability of the data from the proxies.

And, in fact, most case-control studies that are conducted now do not rely on proxy data because of that reason.

10:03:16 Q. Okay. You prefer not to use proxies?

A. Yes, correct.

Q. All right. The third category you talked about of concerns for the epidemiologist is chance; right?

A. Yes.

10:03:27 Q. When you talk about chance in the context of

epidemiology, what are you referring to?

A. Right. So chance refers to how likely the finding that you observed in your own data is due, actually, to chance -- a chance finding. So it's not a real finding.

Q. Okay. So obviously you want to avoid chance findings?

A. Yes.

Q. Are there factors in the design of epidemiological studies that can contribute to the role of chance?

A. Yes. So chance is much more likely to occur when you have a smaller study. So in particular, not only the total number of cases that you're studying in your study, but also the number of exposed cases.

So the larger the study is, the less likely that chance is going to have led to a specific finding. So that's one factor.

Q. Okay. Let me ask you -- you threw a term out there that I want to make sure we define for the jury. Exposed cases. What does that mean?

A. Right. So in -- in -- if they have in our study a total of 1,000 cases and 100 of them have been exposed to glyphosate, the number of exposed cases would be 100.

So it simply refers to the number of cases that

have the exposure that we're interested in in this case.

Q. Okay. And it's -- is exposed cases more important in terms of the power of the study, or is the number of people who are actually in the study more important?

10:05:01

A. Right. So, actually, the number of exposed cases plays a really critical role in what we call the statistical power of the study and -- and also the likelihood that chance may play a role.

10:05:12

So just as an example, if we had two studies, each of which had 1,000 individuals, one study had 200 cases, and the other study had 200 cases, but then that first study only had 10 exposed, the second study has 100 exposed, that 100 exposed is going to be a lot more powerful than the study that only had 10 exposed cases.

10:05:35

Q. So you look at exposed cases when you evaluate cases?

A. Right. So we look at -- we do look at everything. But one of the important factors really is the number of exposed cases in our study.

10:05:45

Q. Are there other aspects of study design that can affect the contribution of chance to results?

A. Yes, there are.

Q. And what's another one?

10:05:57

A. So another important factor is, actually, the number of relative risks that you're estimating your data with or the number of comparisons that you're making in your data.

10:06:09 You know, when you're looking in a study at 50 to 100 different relationships between exposures and diseases, you might end up getting what we call a false positive finding, meaning a finding that's positive just by chance.

10:06:27 So the more tests you do, the more likely you are to find something by chance. And just to give you a sense, we talk -- we estimate sometimes in our studies P values. And usually a P value of .05 is considered, sort of, the cut point for significance.

10:06:46 What a P value of .05 would mean is that you'd expect by chance 1 in 20 times in your study to have a positive finding, even though -- even if there's really no association.

So if you looking at 100 different comparisons, 10:07:01 then you might expect 5 due to chance.

Q. Okay. The jury has heard about confidence intervals.

A. Yes.

Q. Can you tell the jury your -- what the 10:07:12 epidemiologists' thinks a confidence interval is?

A. Right. So in our epidemiology studies, we estimate the relative risk. And that's comparing the risk in the exposed group and the risk in the unexposed group. But because of the role of chance and the role
10:07:29 that the sample size and number of exposed cases plays in how reliable our estimate is, we calculate confidence intervals to give us a sense of how likely the relative risk in our study that we see is the actual relative risk in the study. Or how much -- how likely it might be due
10:07:50 to chance.

MR. LOMBARDI: Your Honor, would it be permissible for Dr. Mucci to step down and draw on the board here?

THE COURT: Yes. Yes.

10:08:06 MR. LOMBARDI: And, your Honor, would it be permissible for me to stand behind Mr. Wisner?

THE COURT: That's fine.

Q. BY MR. LOMBARDI: All right, Doctor. Can you give the jury an example of confidence intervals?

10:08:29 A. Yeah. Sure. So -- so let's say we have -- we have two different studies. And let's say they're case-control studies. And let's say there are 1,000 cases in each of the studies and 1,000 controls in each of the studies. This is study A, and this would be study
10:08:56 B (indicating).

So in study A, let's say that of the 1,000 cases, only 100 were exposed. So we have -- out of 1,000, 100 exposed cases.

And then in the second study, which has 1,000 cases and 1,000 controls, we actually have 500 exposed cases.

10:09:12

And so what we can do is we can calculate our point estimate, which is a relative risk. And let's say for this -- for these two specific studies, they both find that the relative risk of -- of a specific factor and the disease gives us a relative risk of 1.5 in both studies.

10:09:30

Q. Let me stop you right there. The number 1 with relative risk is an important one in epidemiology; is that right?

10:09:47

A. Yes, it is.

Q. And what does 1 signify?

A. Right. So when we're calculating the relative risk, what we're doing is we calculate -- we say: What is the risk of the disease in the people who have the exposure? So that's -- that's -- what's the risk of -- of the disease we're looking at in the people who have the exposure? And then we divide that by the risk of the disease in those who are unexposed.

10:09:56

10:10:15

And so that gives us a relative measure. And so

if the risk of disease in the exposed group is the same as the risk of disease in the unexposed group, then you're going to see a relative risk of 1.0, meaning there's no association between the exposure and the
10:10:32 disease.

And so a relative risk of 1.0 suggests there's no association. So we'll draw that here (indicating).

Q. Okay. Continue with your example, please.

A. Right. So in this case, let's say these are the
10:10:47 relative risks here (indicating), and then I'm going to draw the confidence intervals around it.

So in each study, the relative risk was 1.5. But because this is a smaller number of exposed cases -- and maybe this isn't -- let's say it wasn't -- well, 100
10:11:03 is fine. Let's say -- and I don't know. I'm just -- just as a comparison, saying the confidence interval might looking something like this (indicating) in terms of the bounds.

And this would give you a range of values that
10:11:18 are consistent with the data for that study. Whereas for this study, we have a lot more certainty in the estimate, because we have power. We have more exposed cases. Even though the relative risks are the same, we actually have more confidence that -- in the data here, than we do
10:11:36 here, because the confidence intervals are much more

narrow.

So in this case, the range of values that are consistent with our study is much more narrow. So we think this estimate is a lot more reliable than we do for a study that has a lot fewer exposed cases.

Q. Okay. Just to step back and make sure we have our terms.

On the top one, just point where the confidence interval is.

A. Right. So we have -- with the confidence interval, we have the lower bounds, and we have the upper bound. So this is the 95 percent confidence interval.

Q. And so for an epidemiologist, generally speaking, is a bigger confidence interval indicative of a more reliable study or a smaller confidence interval?

A. No. A smaller confidence interval would definitely mean it was a more reliable study. And that's because we have more information. It's less likely due to chance.

Q. Okay. Now, on the -- the top example, you drew just an illustration confidence interval that crosses 1.

A. Right.

Q. What is the significance of that to an epidemiologist?

A. Right. So when -- when the lower bound of the

confidence interval crosses 1, it -- it says that it's not statistically significant, meaning that the -- you know, when we -- when we set out a hypothesis to test, the -- the -- we call it the null hypothesis, meaning
10:12:55 there's no association. And then the P value gives you a sense of how likely or not likely that null hypothesis is true. Again, meaning there's no association.

So in this case, our P value would be more indicative that there's no association than this P value
10:13:15 would.

Q. Okay. And is the fact that a study has a confidence interval that crosses 1, do you, as an epidemiologist, then just throw that study out and not pay attention to it?

10:13:28 A. No. Definitely not.

Q. So what use do you make of it, even though it has a confidence interval that crosses 1?

A. Right. So the other thing I should have mentioned was that when we estimate confidence intervals
10:13:41 or P values, it's important in that calculation that there's no bias or confounding presence. That's really critical.

So if we are concerned about bias or confounding, this confidence interval becomes not valid.
10:13:56 So I think that's one important thing.

So the other thing that you were just mentioning is when you have -- when you're less certain about the reliability of information, you would take that as one piece of information. And in epidemiology, we would never want to rely solely on one study to make a determination about whether something causes something or not. You really want to look at all of the epidemiology studies together.

Q. Okay.

A. So this one would be less reliable.

Q. Okay. And you'd factor that into your consideration of the study as a whole?

A. Exactly.

Q. Now, you referenced this with respect to the top. But generally speaking, does a confidence interval tell you anything about whether there is confounding in a study or bias in a study?

A. No, it doesn't. No.

Q. So -- so on the bottom one, even though you have a tighter confidence interval, which is better, does that tell you that that study is necessarily giving you a reliable result?

A. A confounded or bias result, it does not, no.

Q. Okay. You may resume your seat. Thank you.

So is -- do epidemiologists always look at

confidence intervals when they look at studies?

A. It's one of the important factors we look at in our studies.

Q. And are there confidence intervals in all of the studies we're going to be talking about today?

10:15:30

A. Yes, there are.

Q. All right. Let's talk about -- let's turn to the studies themselves.

What generally are the studies that you're going to be talking to the jury about today?

10:15:37

A. So I'll be talking about the case control and cohort studies that have published results on glyphosate and non-Hodgkin's lymphoma.

Q. Okay. So as we get to those studies, what led to those studies being done in the first place?

10:15:52

A. So there had been case-control studies that were done back about 50 or 60 years ago that had shown that farmers -- people who were farming had a higher risk of non-Hodgkin's lymphoma specifically.

And so that led researchers to wonder whether certain types of farming practices, including pesticides, might increase the risk of non-Hodgkin's lymphoma.

10:16:13

Q. So when did glyphosate go on the market, approximately?

A. 1974.

10:16:30

Q. And when did this association between farmers and non-Hodgkin's lymphoma first get noticed?

A. It was identified years before that.

Q. Okay. So did glyphosate have anything to do with that association that was observed initially?

10:16:44

A. No, it could not.

Q. Okay. Now after this general connection was made between farming and non-Hodgkin's lymphoma, what happened next in the epidemiological literature?

10:16:57

A. So the next step were a number of case-control studies done in different farming populations and non-farming populations to look at a range of factors, including different pesticides, exposure to farm animals and other types of activities.

10:17:15

And so those were the initial exploratory case-control studies. But they weren't specifically focused on any one hypothesis.

Q. Okay. And have you brought a chart to help illustrate the studies that we're going to be talking about?

10:17:29

A. Yes, I have.

MR. LOMBARDI: Your Honor, permission to publish Slide 5, please?

THE COURT: Very well.

10:17:43

MR. LOMBARDI: And maybe Slide 4. I might have

this wrong.

No, Slide 5. We'll start here.

Q. Okay. You called these exploratory pesticide studies. We're going to fill this chart out with other studies as we go along; isn't that right, Doctor?

10:17:54

A. Yes.

Q. So exploratory pesticide studies, what does that term mean?

A. So as I mentioned, you know, when the first case-control studies were being designed to try to understand what it might be about farming that was associated with the higher risk of non-Hodgkin's lymphoma, the -- the researchers put together studies where they looked at, you know, several dozens, if not 100, different exposures within each of these studies.

10:18:06

10:18:23

So they weren't testing any specific hypothesis about any one pesticide or any one farming practice. It was really exploratory, meaning they -- they were looking at multiple hypotheses or multiple -- yeah, multiple hypotheses.

10:18:44

Q. And were any of these studies focused on glyphosate specifically?

A. No, they weren't.

Q. And is that -- what is the significance of a study being exploratory in epidemiology? Excuse me.

10:18:51

A. So I think there are two, you know, main issues we want to think about in epidemiology with respect to exploratory studies.

The first is that the -- remember, we talked about the idea of chance finding. So if you're looking at 100 different factors in your study by chance, you may end up seeing 5 that are positive, even though -- and that's really just due to chance. So that's the first thing.

10:19:07

10:19:24

The second thing is that the design of your study and the design of the statistical analyses we would do, you know, wouldn't be specific to something like glyphosate. It would be more general. And so the design of the study would not always be the best design when you're doing a much more hypothesis-based study.

10:19:43

Q. Okay. Are exploratory studies generally used to establish causation?

A. No, they would not be.

Q. Okay. Now, have you put together -- these are -- you see there are five studies there. Those are all case control; right?

10:19:56

A. Yes, they are.

Q. And the jury has heard about those studies. Have you put together a table to help the jury follow your analysis of the studies?

10:20:07

A. Yes, I have.

Q. Let's go to Slide 7.

All right. Let's describe for the jury -- I take it you can -- you also have a monitor right there, if that's easier for you to see, Doctor, but let's explain for the jury what you've done here. Obviously, the left-hand column is the name of the study; is that right?

A. Yes.

Q. And so going across, you have other columns for information you're going to provide. Can you describe those columns to the jury, please?

A. Yes. So the first column will include the years that the cases of non-Hodgkin's lymphoma were diagnosed with cancer.

Q. Okay. And can that be an important factor?

A. Yes, it can be. And the reason it could be important is with studies of cancer, we think about something called a latency period, and many different factors may take years, if not decades, to occur, so, for example, smoking may take 20 or more years from the time that someone starts smoking until lung cancer develops.

So the latency period is important to think about how much time there might be between someone when they're exposed and when they get diagnosed with the

disease.

Q. Okay. It has an impact on what your study can actually show you; is that right?

A. Yes, exactly.

10:21:31 Q. All right. Exposed cases. You talked about that. That's going to be one of the pieces of information you're going to talk about?

A. Yes.

Q. Respondents, what are you referring to there?

10:21:40 A. This is the case of where -- whether or not the case-control studies included information both from proxies as well as the actual cases and controls or if it's just the cases and controls themselves.

Q. Okay. Then adjustment for other pesticides,

10:21:55 what are you going to indicate in that column?

A. Right. So this is the column where you indicate whether the studies did, in their mathematical models, adjusted for other pesticides.

Q. And finally, relevant risk confidence interval,

10:22:07 and you've got a line for 1 there. What are you going to show in that column?

A. Right. So we'll be providing for each of the studies the relative risk that was presented in the study for people ever exposed to glyphosate versus never

10:22:20 exposed, the relative risk and the confidence interval

around it.

Q. Okay. Let's start with Hardell 2002. First, just tell the jury generally some background on the Hardell 2002 study.

10:22:31 A. All right. So this is one of the exploratory case-control studies. It was a population-based study that was conducted in Sweden.

Q. Okay. And let's go ahead and go to the next slide.

10:22:42 MR. LOMBARDI: If we may publish, your Honor?

THE COURT: Yes. You may proceed.

Q. BY MR. LOMBARDI: And we've filled in some information. There's a variety of things there. What are the most important things, from your perspective, as

10:22:53 an epidemiologist?

A. Right. So I think the three important factors that I would look at in this study would be first the number of exposed cases. It's quite low. Secondly, there was a high proportion of participants where the

10:23:11 data came from proxies, and then third there was an incomplete adjustment for other pesticides. In fact, most of the results in the study are not adjusted for other pesticides.

Q. Okay. And so then let's move to the confidence

10:23:28 interval. Does the confidence interval reflect any

concerns about chance?

A. Right. And so the result of the fact that there were only eight exposed cases -- you can see in how wide this confidence interval -- with the lower bound being 0 -- a relative risk of 0.55 up to 6.20, so this is a really wide confidence interval, so we don't have a lot of reliability in the results of this study?

Q. Okay.

MR. LOMBARDI: Your Honor, may I publish from the study itself, the Hardell 2002 study.

MR. WISNER: No objection.

THE COURT: You may proceed.

Q. BY MR. LOMBARDI: And so there's the title of the study; is that right, Doctor?

A. Yes.

Q. And what does the title of the study tell you about whether this is an exploratory study or not?

A. Well, the title itself doesn't talk specifically about glyphosate. It's really exposure to pesticides of suspectant for non-Hodgkin's lymphoma and hairy cell leukemia, which is considered a form of non-Hodgkin's lymphoma.

Q. And, in fact, does the study consider many different pesticides?

A. Yes, it does.

MR. WISNER: Your Honor, just for the record, this is Exhibit 2584.

MR. LOMBARDI: I'm sorry. Yes. My mistake, your Honor.

10:24:44 THE COURT: Thank you.

MR. LOMBARDI: Defendant's Exhibit 2584, and let me go to Table 1, which is on the second page of the exhibit.

Q. And what are we showing there?

10:24:55 A. Right. So this table -- these are the odds ratios in 95-percent confidence intervals for a number of different pesticides -- actually, these weren't the only pesticides they looked at, but looking at a number of pesticides in the study, these are all unadjusted for

10:25:16 other pesticides.

Q. Okay. So over here is a list of at least some of the pesticides that were being considered in this study?

A. Right.

10:25:23 Q. Okay. And you also see that odds ratios tended to be above 1 for everything. What does that tell you as an epidemiologist?

A. Right. And so when you start to see results, especially in an exploratory study, where the majority of

10:25:39 the results are positive, suggesting positive

associations, and particularly where we were already worried about some of the biases due to confounding and also proxy bias, we start to think there's a systematic bias in this type of study, so there's a systematic
10:25:56 reason that we're seeing so many positive associations.

Q. Okay. And that's just this column here, the OR column; is that right?

A. Yes.

Q. All right. I'll take that down. Let's go back
10:26:05 to your table.

And so in summary, Hardell, what's -- what are your thoughts about Hardell as far as how indicative it is of any associations?

A. Hardell really provides very limited information
10:26:24 on the topic of glyphosate and non-Hodgkin's lymphoma.

Q. Okay. Let's go to the next line, the McDuffie study.

MR. LOMBARDI: Permission to publish the next slide, your Honor?

10:26:34 THE COURT: Very well.

Q. BY MR. LOMBARDI: Let's go to the next slide, and the information that's gone out on that next slide, Doctor, can you describe -- first, generally, what was the McDuffie study? Where was it and so forth?

10:26:45 A. Right. So the McDuffie study was a

population-based case-control study from Canada, and it was -- it recruited cases between 1991 and 1994.

Q. Okay. And what are the significant aspects of this study, from your standpoint as an epidemiologist?

10:27:07 A. Right. So you can see here that the number of exposed cases, while it's much larger than Hardell, it's still a fairly small number of exposed cases, but still larger. One of the issues, though, is still that there was a large proportion of the cases where the data came

10:27:29 from proxy respondents, and then also they did not adjust for other pesticides in this study.

Q. Okay. And so what does that tell you as an epidemiologist that they didn't adjust for other pesticides?

10:27:44 A. That there may be a concern for confounding other pesticides.

Q. Okay. And let's look at the relative risks and the confidence interval. What is shown there, and what's your analysis of it?

10:27:56 A. Right. So you can see as compared to the Hardell study, the 95-percent confidence interval is much more narrow because of the 51 exposed cases, so that estimate is more reliable, but still we would be concerned that there may be confounding due to other

10:28:13 pesticides or that the proxies may have let to bias in

this study. So we're -- we can't rule out that this relative risk and confidence interval is due to bias or confounding.

MR. LOMBARDI: Your Honor, permission to publish on the Elmo Defendant's Exhibit 2779, which is the McDuffie study?

10:28:27

THE COURT: Very well.

Q. BY MR. LOMBARDI: Okay. And again, Doctor, what does this study tell us about whether this is a study that's specifically targeted towards glyphosate or is a exploratory study?

10:28:41

A. Right. So again, this -- the title of this study, looking at specific pesticide exposures, really goes to the fact that it's an exploratory study.

Q. Okay. And again, I want to take a look at a table within. Go to Table 2 on page 4 of Exhibit 2779. And what do you see in that left-hand column?

10:28:54

A. Yeah, I'm sorry it's so challenging to read these small numbers, but if you look through the results -- so again, remember these are all odds ratios that have not been adjusted for other pesticides, and you start to see across the results -- this is the table for herbicides. You see a number of the odds ratios are elevated above 1. If you looked also at fungicides and some of the other types of pesticides, they were also

10:29:14

10:29:31

above the 1 value. So, again, it makes you concerned about the idea there may be a systematic bias or a systematic reason for all of these positive associations.

Q. Okay. So this is just a table on herbicides, and it lists a number of them; is that right?

10:29:45

A. Yes, exactly.

Q. And there are separate tables on insecticides and fungicides; is that right?

A. Yes, exactly.

10:29:56

Q. In the McDuffie study, some of plaintiff's experts have made reference to Table 8, I believe. So I'm going to put that up here, and I'm going to try to --

And do you see -- I'll get a highlighter, but do you see glyphosate there?

10:30:16

A. Yes, I do.

Q. All right. Let me -- it's among a bunch of other herbicides; is that right?

A. Yes, it is.

Q. And insecticides and pesticides, I guess; right?

10:30:28

A. Yes.

Q. And there's glyphosate, and here is the portion that plaintiff's experts have pointed to. If it's not visible, there's a greater than 2 there, and then there's an odds ratio here. Let's just explain to the jury what you're looking at. It says, "Days year greater than 2."

10:30:47

What does that indicate?

A. Right. So this particular -- what they were trying to look at was whether there might be a dose response, and in epidemiology, what we're thinking about is when we start to see that higher levels of an exposure are more likely associated than lower levels, that would indicate a dose response association.

And so this particular analysis looked at a measure looking at the number of days per year in which the individuals were using glyphosate, and in particular, for this group it was greater than two days per year.

Q. Okay. And so what was -- did you consider this information in evaluating this study?

A. Yes, I did.

Q. And how did you evaluate this information?

A. So I think -- so as you can see, the odds ratio was 2.12. It was a statistically significant finding. However, I think there are two factors really to think -- or three factors, actually, to think about. One is although this is a statistically significant finding, is it due to confounding by use of other pesticides since these are not adjusted? Is it due to the proxy bias?

And then the final factor is actually the actual measure of dose that they chose to look at. So in this case, they're only looking at days per year, so if a

person only used it for 1 year versus 20 years, they would still be categorized as two days per year. So the number of the pesticide studies that have looked at the appropriate measures of dose would not have relied on this as the measure of dose to look at.

10:32:30

Q. Okay. So the overall conclusion was that glyphosate is not associated with NHL; is that right?

A. For the ever/never comparison, yes.

Q. Okay. And then for this particular one, there was an elevated risk. How does that affect your analysis of whether this study shows that glyphosate is associated with NHL?

10:32:43

A. Right. So again, it's a study that we need to consider and think about. We need to incorporate our -- the results and think, again, we see this positive association for this measure of dose, but is it -- is it due to confounding? We can't really rule out that bias confounding for playing a role here.

10:33:01

Q. Let's go back to Slide 9. And again, the ever/never comparison showed that there was no statistically significant showing of an effect, and so --

10:33:23

A. Yes.

Q. -- given the lack of adjustment for other pesticides, the use of proxies and the size of the study, how do you evaluate McDuffie?

10:33:36

A. Right. So I think the information provided in this study also is fairly limited in terms of the association between glyphosate and NHL risk.

Q. Let's go to the next one, Orsi.

10:33:51 MR. LOMBARDI: And if we can go to the next chart, please. Next slide. Thank you.

Q. And just, again, give the jury a general idea of what the Orsi study is.

A. All right. So this was a French case-control

10:34:03 study. It was actually different than the other two where they selected their cases and controls from hospitals. Still a very small number of exposed cases, only 12, and they also did not adjust for other pesticides in this analysis.

10:34:17 Q. Okay. And -- and what was the relative risk confidence interval for the Orsi study?

A. Right. So the relative risk here was 1.0. You can, again, see because only 12 cases, a fairly wider 95-percent confidence interval.

10:34:33 Q. Okay. And how do you assess the Orsi study in terms of its ability to tell us something about whether glyphosate causes NHL?

A. Right. So again, you know, here concerned about whether there could be residual confounding present,

10:34:49 because they did not adjust for other pesticides. There

are a lot of other types of issues. I haven't talked about the potential biases in using hospital-based controls. And only 12 exposed cases. And although this particular relative risk did not show positive
10:35:05 association, there are actually a number of positive associations with other pesticides they looked at. So again, this is -- has limited value in -- as a finding here.

Q. Okay. Let's go to the next study, which is
10:35:17 Eriksson, and if we could move the slide along to Number 11. Let's describe, again, just generally what the Eriksson study was.

A. So this was another case -- population-based case-control study that was done in Sweden. It was
10:35:37 conducted between 1999 and 2002. It was a fairly large study in terms of the number of cases overall, but only had 29 exposed cases in total. They -- most of their analyses were not adjusted for other pesticides. There is one table where they do, but it's not clear, and it's
10:36:02 not complete adjustment for other pesticides.

The other important thing that Eriksson did that the other case-control studies did was the way they defined the unexposed group. What they did in Eriksson here was that normally what we would do is we would
10:36:20 compare people using glyphosate to people not using

glyphosate. What they did here instead was to compare the people using glyphosate to people using no other pesticides, and so what that might do is induce confounding, because all the people using glyphosate, then, would have to be using some other pesticides as well, so it actually introduces more confounding.

10:36:36

Q. Okay. So the definition of unexposed respondents actually creates a problem for ever adjusting in this --

10:36:50

A. Yes, it does.

MR. LOMBARDI: Your Honor, ask permission to publish Defendant's Exhibit 2505, which is the Eriksson study?

THE COURT: Very well.

10:37:02

Q. BY MR. LOMBARDI: Put that up. And there we see it again, Doctor. And what does the title indicate to you about whether this is an exploratory study or a study targeted towards glyphosate?

A. Right. So, again, this is one of the exploratory studies.

10:37:19

Q. Okay. And I want to go and show you, if I can find it, the language that you were just referring to. Get the highlighter here.

This is where the language about the definition of unexposed is contained; is that right?

10:37:39

A. Yes.

Q. So let me -- okay. And could you explain to the jury what this highlighted portion is indicating?

A. Right. So, again, when they -- they were comparing individuals using glyphosate, they were actually -- the comparison group was people using no other pesticides, so, then, you can see that already, then, the glyphosate users are by definition going to be using some other pesticides as well. Then we worry that this has introduced confounding.

Q. Okay. And does that -- you said there was one adjusted result in this whole study; is that right?

A. Yes.

Q. Even with that result, are you confident that adjustment is able to be done given this definition?

A. No, because this is a situation where they've potentially introduced more confounding than would have been present if they just compared it to the unexposed group, and the reason is one of the other things about confounding is how much confounding is there is based on how -- how different -- you know, how strongly the confounder is correlated with the exposure. Now, it's made that link stronger by -- because everybody -- none of the unexposed group would be using any other pesticides.

Q. Okay. Let's -- let's go to a portion that plaintiff's experts referred to, and that's from Table 2, I believe.

Do you see Table 2?

10:39:19 A. Yes.

Q. And what, generally, is depicted in Table 2?

A. So these are the results looking at dose response, and here what they've done is to present -- for glyphosate, they've looked specifically at -- looking at

10:39:37 less than ten days of use versus more than ten days of use, and these are all unadjusted for other pesticides.

Q. Okay. So let me just get glyphosate highlighted here.

And you can see reference -- this is another

10:39:55 study where a bunch of other pesticides are referred to; is that right?

A. Yes.

Q. And is there -- I think you just said this, but in this table for these results, is there any adjustments

10:40:07 for the other pesticides?

A. No, there -- no, it's not.

Q. And what do you see about the odds ratios for virtually every one of the herbicides that are talked about here?

10:40:15 A. Yeah, you can see that there's -- the majority

of odds ratios in these tables are elevated, so, again, it makes you concerned. Is there some, sort of, systematic bias? And one of the systematic biases may be confounding.

10:40:31 Q. Okay. Now, there was one table where they did a calculation that attempted to adjust for other pesticides?

A. Yes. Table 7.

Q. All right. I'll put that up. Just so the jury 10:40:44 knows, this says, "Table 7 multi-variate analyses." What is a multi-variate analysis?

A. Multi-variate analysis is the statistical model where you're adjusting for other factors in the models, in this case adjusting for other pesticides.

10:41:01 Q. And uni-variate, what does that mean?

A. Uni-variate is just the unadjusted associations or not adjusted for other factors.

Q. Okay. So in -- in this table, when you have an unadjusted study for glyphosate, what does it show?

10:41:16 A. The unadjusted estimate shows a relative risk of 2.02. That is statistically significant.

Q. And what happens when you actually adjust to take out the effect of the other pesticides?

A. Right. So you can see that when you put these 10:41:29 other pesticides in the model, the relative risk is

adjusted -- is attenuated closer to the null value.

MR. LOMBARDI: Okay. All right. Let's go back to Slide 11, if we could, please.

Q. And so let's go back to Eriksson. You've used the unadjusted result there --

10:41:47

A. Yes.

Q. -- for your consideration.

Given everything that we've talked about with Eriksson, the various weaknesses in that article, is that an article that establishes that glyphosate causes non-Hodgkin's lymphoma?

10:42:01

A. No, it doesn't.

Q. Okay. Let's turn to the next one, De Roos 2003, and this is the last of the exploratory studies; is that right, Doctor?

10:42:16

A. Yes, it is.

MR. LOMBARDI: All right. And again, if we could go to the next slide, Slide 12, and put the information up there.

Q. Before we jump into that information, give the jury an idea of what De Roos 2003 was. They've heard about it before, but if you could just describe it.

10:42:23

A. Yeah, sure. So there were three different case-control studies of pesticides that were done in the United States, and De Roos 2003 pooled the data together

10:42:36

for these three case-control studies, and, yeah, so it's a population-based study in four different states.

Q. Okay. And so we haven't -- you and I haven't yet talked about pooled studies. What does that mean in epidemiology?

10:42:57

A. So with a pooled study, what we do is we get access to the actual original data from each of the studies, and we're able to pool it together and analyze the data all together.

Q. Okay. And, again, did you say where the geographic location --

10:43:10

A. So four different states in the United States.

Q. All right. So in this one, the years of diagnosis of non-Hodgkin's lymphoma is earlier than in the other studies; right?

10:43:28

A. Yes, it is.

Q. And again, just remind the jury, what does that mean? It says, "Years of diagnosis: 1979 to 1986." What does that indicate?

A. Right. So if -- if -- glyphosate was first introduced in 1974 in the US, and if you, I guess, assumed everybody who used glyphosate in the study started using it on the first day that it was introduced, then the cases would have had at most, in terms of the latency period in terms of exposure, between 5 and

10:43:38

10:43:59

12 years, and that, again, is assuming if everybody started using it on the day that it was first introduced --

Q. Okay.

10:44:09 A. -- to the market, so a much shorter latency period from -- for the exposed group of individuals.

Q. And was De Roos a study that was focused -- targeted on glyphosate?

A. No. Again, it was one of the exploratory

10:44:25 studies, and they were looking at about 40 to 50 different pesticides.

Q. Okay. How does the years of diagnosis affect the way you look at this study?

A. So I think, again, you have to think about the

10:44:36 latency period necessary for cancer to occur and whether that would be a sufficient amount of time from when people were first exposed to glyphosate to an NHL risk, so it's just something you need to be thinking about.

Q. So glyphosate approximately went on the market

10:44:56 when?

A. 1974.

Q. Okay. And it's -- how does 1979, the start of the diagnosis period, affect your evaluation of whether this could actually be detecting any effects of

10:45:07 glyphosate?

A. Right. So for those particular cases -- and, again, we don't -- we don't in this study and in none of these case-control studies do we have information on when some of the necessarily -- well, maybe some of them we did actually. Sorry. I misstated that.

But here we don't have information necessarily when they first started looking at glyphosate, so the maximum amount of time they could have looked at -- been exposed to glyphosate would have been between 5 years for the earlier cases and 12 years for the later cases, so a pretty small amount of latency period.

Q. And does that affect the way you look at this study in terms of whether it shows that glyphosate is associated with NHL?

A. Yeah, it assisted -- it's more limited in how much information it can really provide because of the short followup.

Q. Okay. And exposed cases, how do you assess that?

A. Yeah, so 36 -- by pooling together these three studies, they had 36 exposed cases, so, again, not a really large study.

Q. Okay. And then under the respondents category, you say, "Proxy respondents." Can you describe the De Roos study in that respect for the jurors?

A. Yeah, so then more than a third of the data in this study came from proxy respondents. So, you know, more than 33 percent of the participants had their data from the proxy respondents.

10:46:28 Q. Which -- how does that affect your evaluation of that study?

A. Right. So we're concerned that potentially the proxies may have introduced bias into the study.

Q. All right. And then under "Adjustment for other

10:46:41 pesticides," you say, "Yes." Can you explain that?

A. Yeah. So they -- they took what -- the approach they took -- so because they were actually not looking at any one pesticide, they were really looking at these 40 to 50 different pesticides, they used an approach called

10:46:57 hierarchical regression where they basically adjusted for all 40 of these pesticides all together in one model.

Q. Okay. And -- and which -- which result did you report under relative risk confidence interval?

A. So this is the adjusted or odds ratio for the

10:47:16 ever versus never comparison.

Q. Okay. And what does that show?

A. So in that analysis, the relative risk is 1.6. It's not -- it's what we would call borderline statistically significant, so it's not statistically

10:47:32 significant, but it's -- the confidence interval is not

as wide as what you see in Hardell, but it's, you know, it's -- the confidence interval is what it is.

Q. Okay. And actually, in the De Roos study, did the authors comment on what they thought needed to happen in terms of the epidemiological research related to pesticides and NHL?

10:47:49

A. Yes, they did.

MR. LOMBARDI: Permission to publish Defendant's Exhibit 2193, which is the De Roos 2003 paper, your Honor?

10:48:02

THE COURT: Very well.

Q. BY MR. LOMBARDI: And one more time, Doctor, this is -- the title says, "Integrated Assessment of Multiple Pesticides As Risk Factors." Does that indicate that this was focused on targeting glyphosate or something else?

10:48:19

A. No. Again, this is an exploratory study.

Q. All right. And after doing this study, peer -- I'm going to go to the last page. On Page 8 of the exhibit -- and this is -- the last couple of lines, can you read that for the jury?

10:48:34

A. "A chemical-specific approach to evaluating pesticides as risk factors for NHL should facilitate interpretation of epidemiological studies for regulatory purposes. However, the importance of additionally

10:48:51

considering multiple correlated exposures is clear."

Q. Okay. Now, that first sentence, what does that indicate to you about what the authors think about these studies of many, many pesticides?

10:49:08 A. Right. So I think what the authors have done here is -- is what we appropriately do in epidemiology, which is not to rely on any one single study and say, you know, there's some -- potentially something in which we need to have a much more focused hypothesis-driven

10:49:29 approach to be able to really understand whether any of these pesticides that were positively associated with risk are actually doing so in future study. So really, the importance of having a hypothesis-based approach to studying pesticides.

10:49:45 Q. Okay. Let's go back to Slide 12, if we could. And, Doctor, that's the completed table related to the exploratory case-control studies; is that right?

A. Yes, it is.

Q. And so you've looked at all of those, you've

10:50:02 gone through your assessment. Can you talk -- bring it all together and tell the jury your conclusions, based, at this point, just on the exploratory NHL studies?

A. All right. So I think, you know, looking at all five of these epidemiology studies, I think the

10:50:20 information presented here was fairly limited, and we're

concerned that there may be still bias, confounding and potentially chance in explaining these findings. And so it's really critical that future studies would be done specifically addressing the hypothesis.

10:50:39 Q. Okay. And the bias that you're worried about you see primarily from the "respondents" column; is that right?

A. Yeah, it's the proxy bias. But also, the other type of bias -- confounding is a type of bias, a very

10:50:51 specific type of bias. So confounding also is really a critical issue as well.

Q. And confounding, you're concerned from the "adjustment for other pesticide" column?

A. Exactly. Yes.

10:51:00 Q. And the chance, both the small size and the way the confidence intervals?

A. Yes.

MR. LOMBARDI: Okay. Thank you, Doctor.

And, your Honor, if this would be a breaking-off

10:51:12 point before we go to the next section.

THE COURT: Sure. Okay. Very good.

Then, Ladies and Gentlemen, we're going to take our morning recess now. We'll be in recess for 15 minutes and resume again at 11:05. Please do not

10:51:25 discuss the case.

(Recess.)

THE COURT: Welcome back, Ladies and Gentlemen. Dr. Mucci remains under oath, and, Mr. Lombardi, you may proceed.

11:06:06 MR. LOMBARDI: Thank you, your Honor.

Q. We've put up Slide 13. We're back to your slide on the type of studies you're going to be discussing. We've finished the exploratory pesticide studies. Now we're going to something called glyphosate pooled

11:06:17 studies. What do you mean by that?

A. Right. So in the case of De Roos 2003, we talked about what a pooled study was. What I'm specifically referring to here are the studies -- the study from the North American Pooled Project, a pooled

11:06:36 analysis specifically addressing the hypothesis of glyphosate and NHL risk.

Q. Okay. So when you say "specifically addressing the hypothesis of glyphosate and NHL risk," is that different than what was going on in the exploratory

11:06:47 studies?

A. Yes, it is.

Q. Okay. And what are the studies that are being pooled in the North American Pooled Project? We should explain: North American Pooled Project is NAPP. Some

11:07:00 people refer to it as NAPP; is that right?

A. Yes.

Q. Who is Pahwa? Why is that name there?

A. So Dr. Pahwa is the lead investigator on this project.

11:07:09 Q. So what studies are being pooled?

A. So it includes the three US case-control studies that were part of the De Roos 2003 pooled analysis. And then, in addition, it includes the McDuffie study from Canada. So there are four total case-control studies,

11:07:26 three from the US and one from Canada.

Q. Have you brought a chart that shows the geographical distribution of the participants in the study?

A. Yes, I have.

11:07:35 Q. Okay. Let's show Slide 14.

And what does this slide show?

A. So this shows the four states from where the three case control studies from the US were done, and then there were -- for McDuffie, there were six provinces

11:07:52 in Canada that were included. In the US and Canadian -- were all population-based studies.

Q. Okay. Now, the NAPP study the jury has heard something about. Who funded that study, or who were among the funders of that study?

11:08:11 A. Right. So the NAPP study has been funded by the

National Institutes of Health.

Q. And on the authors' -- the jury heard from Dr. Aaron Blair yesterday by video. What's his involvement, if any, with this study?

11:08:31 A. He was a part of a number of the case-control studies in the US, and has been a co-author on the NAPP study.

Q. Okay. Have you brought some slides from the NAPP study that will help the jury understand what the

11:08:48 results are?

A. Yes, I have.

MR. LOMBARDI: I ask permission to publish?

THE COURT: Any objection.

MR. WISNER: I thought we agreed no.

11:08:54 MR. LOMBARDI: We didn't agree, but if you have an objection, we can talk about it.

THE COURT: Do you wish to approach?

MR. WISNER: This was the agreement this morning.

11:09:06 (Sidebar.)

[redacted]

11:09:28


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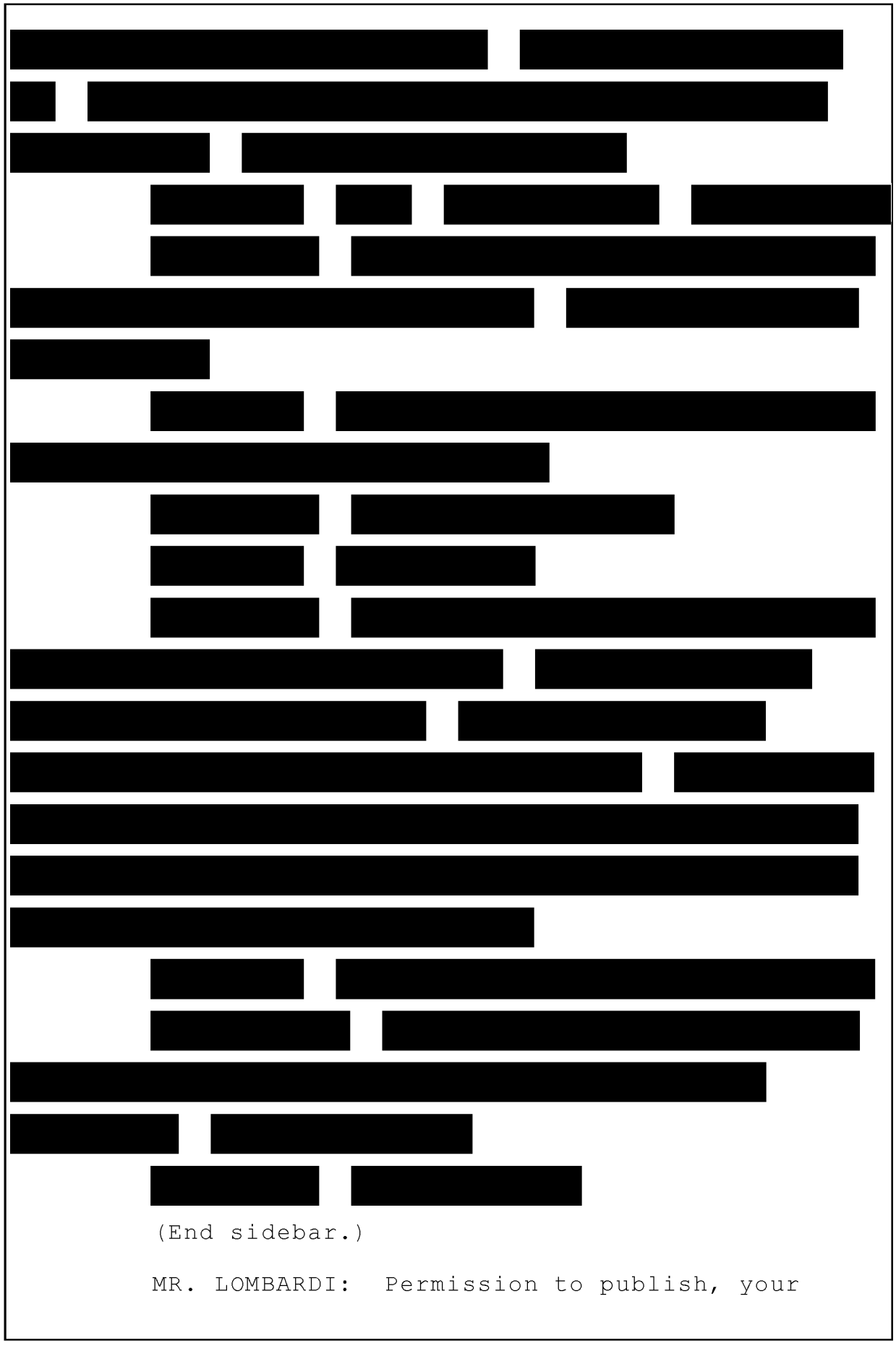

(End sidebar.)

MR. LOMBARDI: Permission to publish, your

Honor?

THE COURT: Yes.

MR. LOMBARDI: May I have the ELMO first, please? This is Defendant's Exhibit 2867. And let me get it focused a little better here, Doctor.

11:12:21

Q. What is this?

A. This is a set of slides presented on the North American Pooled Project at a conference in Brazil.

Q. And is that a way epidemiologists frequently present data that they've collected?

11:12:41

A. Yes. Oftentimes, before studies get published in a peer-reviewed journal, the data are presented at international or national meetings.

Q. Okay. And were there actually multiple PowerPoints, then, culminated in -- in these?

11:12:58

A. Yes, there were.

Q. All right. So this one is -- what's the date?

A. August 31st, 2015.

Q. And Aaron Blair is listed as one of the authors?

11:13:07

A. Yes, he is.

Q. And do you understand that he was the chairman of the Working Group 112 that worked on the glyphosate issues?

A. Yes.

11:13:14

Q. Okay. Let's go back to the slides.

MR. LOMBARDI: Permission to publish Slide 15, which is a table from the presentation, your Honor?

MR. WISNER: Objection. If he's going to publish it, publish the document. Not these made up slides.

11:13:27

MR. LOMBARDI: Well, I can show you the slides, your Honor, it's just to make it faster, but it's because they are just of the slides.

THE COURT: All right. Is this a slide from the preparation that you just referenced?

11:13:36

MR. LOMBARDI: It is.

THE COURT: All right. The objection is overruled.

MR. LOMBARDI: Slide 15. Okay.

11:13:46

Q. What does this table -- this is a slide from the presentation; is that right?

A. Yes, it is.

Q. What does this table depict?

A. So in this slide here, Dr. Pahwa presented the

11:14:00

results looking at the association between --

MR. WISNER: Objection. Lacks foundation. She was not at the presentation. She cannot testify about Dr. Pahwa.

MR. LOMBARDI: Okay. Just --

11:14:08

THE COURT: Overruled.

Q. BY MR. LOMBARDI: Go ahead.

A. So and this slide is looking at the association between ever exposure to glyphosate and risk of NHL, looking at NHL as one disease. There are actual 60 different subtypes of non-Hodgkin's lymphoma, and so with this study, they also looked at four of the subtypes.

11:14:23

Q. Okay. And so overall relates to what?

A. It looks like -- at all of the subtypes together of non-Hodgkin's lymphoma.

Q. And then there's some -- I guess there are three categories and an other. What does that refer to?

11:14:37

A. Right. So these are -- there are three different subtypes of non-Hodgkin's lymphoma, and then the fourth one is combining all the other subtypes together.

11:14:51

Q. Are those subtypes, any of those mycosis fungoides?

A. No, they're not.

Q. Okay. So let's focus on overall. And there are two columns of results. What's the first column?

11:15:00

A. Just one thing to note also is as you can see by pooling these studies together, we have 113 exposed cases, and so it's larger than the other exploratory studies.

Q. Okay. And so there are two columns. What's the

11:15:15

first column?

A. So the first column is the odds ratios and 95-percent confidence intervals. They've adjusted for lifestyle factors and a few other factors, but not if other pesticides.

Q. And what's the second column?

A. So Column B is the column where they additionally adjust for other pesticides, and specifically, they took a very focused approach and adjusted for the three most commonly used pesticides that were associated with glyphosate, NHL -- sorry -- 2,4-D, dicamba and malathion.

Q. Okay. And when you don't adjust for other pesticides, what is the results you see?

A. You can see here that the exposure to glyphosate ever was associated with a odds ratio of 1.43. That was statistically significant.

Q. All right. But what happens when you, then, do adjust for other pesticides? What result do you get?

A. You can see that the odds ratio is attenuated to the null value and is no longer statistically significant.

THE COURT: Mr. Wisner?

MR. WISNER: Your Honor, brief sidebar.

THE COURT: Very well.


(Sidebar.)
11:16:45
11:16:58
11:17:12
11:17:26
11:17:42

[redacted]

(End sidebar.)

THE COURT: All right. You may continue, Mr. Lombardi.

MR. LOMBARDI: All right. Thank you, your Honor.

Q. Based on this page, these results right here on this page, what's your conclusion about whether it shows that glyphosate use causes NHL?

A. Right. So I think -- there's two things. One, I think, the results from this study show that confounding duties of other pesticides was present, and when you take into account this confounding, there's no evidence of a positive association between ever use of glyphosate and the risk of non-Hodgkin's lymphoma.

Q. Okay. All right. Is there another table from

this presentation that you referred to in your opinions?

A. Yes.

MR. LOMBARDI: Okay. Let's go -- your Honor, permission to publish Slide 20, which is another table from the same presentation?

11:19:04

THE COURT: Yes.

MR. WISNER: With our continuing objection.

THE COURT: Yes. Noted.

Q. BY MR. LOMBARDI: Okay. Slide 20.

11:19:10

And what is shown on this page?

A. So there's two different things that are being shown here. One is on the left, in addition to looking at ever versus never use of glyphosate, the -- there's also information on three different measures of dose response. So first is looking at the overall number of years someone used glyphosate. Secondly, is the number of days per year, and the third one is the most informative measure of dose response, which is looking at the number of days of use of glyphosate over a person's lifetime.

11:19:30

11:19:44

And then secondly, to address the issue of whether proxies could have biased the estimates, what is shown here are the relative versus 95-percent confidence intervals for the full set of cases and controls, and then when you're eliminating the data that came from the

11:20:05

proxies and just looking at the respondents alone.

Q. Okay. Well, let's start with that. You referenced concern with the case-control studies about whether use of proxies bias the results?

11:20:17 A. Yes.

Q. Was it four of the case-control studies are included in this?

A. Yes.

Q. And so what does it tell you about whether

11:20:28 proxies in those studies actually bias the results?

A. Well, what you can see from the results, for example, for the ever/never is that when you eliminate the information from the proxies, the relative risk is even further attenuated towards the null value. So it's

11:20:46 a small amount of bias that was present, but still a small amount of bias might have been present.

Q. Okay. All right. So they have a column that's proxy/self-respondents, that shows the results when you have both together, and then they have self-respondents.

11:21:03 And what does that show?

A. Right. So, again, there's no evidence of a positive association between exposure the glyphosate and non-Hodgkin's lymphoma.

Q. Okay. Now, let's look at -- and you're

11:21:14 referring up here to the ever/never?

A. Yes.

Q. Okay. So you said there's some indications of usage of -- of glyphosate in the other three categories. Which of those, if any, are important to you?

11:21:28 A. So the information that's combining not only the average number of days per year that someone's using it, but also the overall number of years that somebody's using it really gives you a sense of the exposure to glyphosate cumulative over a person's lifetime, so that

11:21:49 is the metric that is -- is the most informative.

Q. Okay. All right. And what does that show you about glyphosate and any potential relationship with non-Hodgkin's lymphoma?

A. All right. So again, these are all -- these

11:22:01 odds ratios and 95-percent confidence intervals are all compared to people not using glyphosate, and so what you can see is there's no evidence of a positive association for either 0 to less than 7 lifetime days of use or even greater than 7 lifetime days of use. And there's no

11:22:24 evidence of a trend of any positive association.

Q. Okay. All right. So what is your takeaway from the glyphosate pooled study that we've just referred to, the North American Pooled Project?

A. Right. So I think one of the strengths of this

11:22:36 analysis is twofold. Well -- two of the strengths are

twofold. One is they took a very standardized approach for adjusting for confounding by other pesticides, and then secondly, they address the issue of whether the proxies might have biased the results, and so when you take into -- those factors into account, you see no evidence of a positive association between glyphosate, including higher levels of glyphosate exposure, and the risk of NHL.

Q. Does that also give you information about the exploratory case-control studies we just looked at?

A. It does. So these data, these -- remember these were included in De Roos 2003 and also McDuffie, and so provides some information that the exploratory studies may have had some bias and confounding that was present in those exploratory studies.

Q. Okay. All right. Let's go back to your overall chart of studies, Slide 25.

MR. LOMBARDI: I ask permission to publish, your Honor. It's the same slide we've been looking at.

THE COURT: All right.

Q. BY MR. LOMBARDI: And now we're down to glyphosate cohort studies. That's the last one on the list. What are the glyphosate cohort -- what are you referring to when you say, "glyphosate cohort studies"?

A. So all of the other studies we've been talking

about have been case-control studies. The epidemiology for cohort studies have been published in two studies, and both of these studies were based on data from the Agricultural Health Study.

11:24:10 Q. Okay. All right. So is there a reason an epidemiologist would move from case-control studies to a cohort study?

A. Yeah, so a case-control study can provide some, sort of, hypothesis generating for wanting to investigate

11:24:28 data and future in a cohort study, and the reason is that cohort studies have more -- they tend to be less susceptible to different types of bias, so they're not susceptible to a number of biases that the case-control studies may be susceptible to.

11:24:47 Q. Are cohort studies susceptible to the proxy bias you were talking about?

A. No, they're not.

Q. How about the recall bias that's tied in with that proxy?

11:24:58 A. No.

Q. How about the power, generally, of cohort studies?

A. Well, so power, it might be low or it might be high. What's important with cohort studies is that they

11:25:07 tend to be going on for several years, if not decades,

and so they can become more informative over time as more people in the cohort get diagnosed with cancer.

Q. Okay. And the jury's heard a lot about the Agricultural Health Study. Just briefly remind them what the Agricultural Health Study is.

11:25:25

A. So the Agricultural Health Study is a study funded by the National Institutes of Health and the US Environmental Protection Agency. It was designed specifically to look at whether pesticides farming exposures could increase the risk not only of cancer but other health outcomes, and it was studied in farmers and other pesticide applicators.

11:25:45

Q. Okay. And the basic size of the study, can you remind the jury about that?

A. Right. So for these two publications, the size of the study was over 50,000 individuals.

11:26:00

Q. Okay. And the length of time covered by the study, what's that? Can you describe that, please?

A. Yeah. Sure. So the study participants were first enrolled between 1993 and 1997, and then they were -- none of them had cancer at the time the study started, and then they were followed prospectively to see which of the participants were diagnosed with cancer, and they used data from the state cancer registries. These participants were coming from Iowa and North Carolina.

11:26:17

11:26:39

And so for the most recent study you have new cancers that were diagnosed between 1993 up to 2013, so 20 years, but, actually, at the baseline questionnaire, they collected information not only about pesticides they were currently using, but pesticides they had been using well into the past, so 20 to 30 years before. So they were able to really collect a very rich and long-term history of pesticide exposures and a very long-term follow-up for cancer incidents.

11:27:14 Q. Okay. And what was the population of interest that they were working with here?

A. Yeah, so it was farmers and other pesticide applicators.

Q. Okay. All right. So have studies based on the 11:27:25 Agricultural Health Study been published?

A. Yes. Several publications from the Agricultural Health Study have come out, both on cancer and non-cancer endpoints.

Q. How about studies related specifically to 11:27:39 glyphosate and cancer?

A. Yes. So to date, there are these two publications that have come out from the Agricultural Health Study.

Q. All right. Let's look at --

11:27:49 MR. LOMBARDI: Permission to publish Slide 26,

which is a callout from De Roos 2005?

THE COURT: Very well.

Q. BY MR. LOMBARDI: And what have we shown here on the screen?

11:28:02 A. This is the -- the title of the study, the authors who were part of the publication and the name of the journal and the year in which it was published.

Q. Okay. And just one note about the authors. There's De Roos. Is that the same De Roos that did

11:28:18 De Roos 2003?

A. Yes.

Q. Okay. All right. And so this was back in 2005. What was the data they were reporting on then?

A. So this was looking at cancers that occurred

11:28:34 between the baseline enrollment and follow-up through 2001.

Q. Okay. Have you done a table similar to the one we talked about -- we used for the case-control studies with respect to these cohort studies?

11:28:48 A. Yes, I have.

Q. All right.

MR. LOMBARDI: Permission to publish Slide 27?

THE COURT: Yes.

Q. BY MR. LOMBARDI: All right. Doctor, we've got

11:28:57 the same kind of information here. Can you just describe

for the jury these key points from the De Roos 2005 study?

A. Right. So I -- I mentioned already that the cases were diagnosed with non-Hodgkin's lymphoma between 11:29:10 1993 and 2001. And during this time, there were 92 cases of non-Hodgkin's lymphoma. So -- so fairly small.

However, one of the strengths of -- of the -- studying farmers and pesticide applicators is that you have individuals where some of them were not exposed to 11:29:30 glyphosate, but then you also have some individuals exposed to very high levels of glyphosate.

And so we actually have a total of 71 exposed cases. So it ends up being the second largest of these studies of exposed cases. All of the data coming from 11:29:47 self-reported data. There's no proxies. And the statistical analyses adjusted for other pesticides.

Q. Okay. And so what is your analysis of the relative risk and the confidence interval?

A. Right. So this is -- the relative risk shows 11:30:04 there's no association between use of glyphosate and the risk of non-Hodgkin's lymphoma.

Q. Did the authors of the De Roos 2005 study concerning the Agricultural Health Study come to a conclusion themselves?

11:30:18 A. Yes, they did.

MR. LOMBARDI: And permission to publish Slide 28, which is a callout from that study?

THE COURT: Yes.

Q. BY MR. LOMBARDI: And could you just -- again, this is from the De Roos study; is that right?

11:30:29

A. Yes.

Q. 2005.

And would you read to the jury the conclusion that De Roos and co-authors came to?

11:30:39

A. "No association was observed between NHL and glyphosate exposure in any analysis. Including an analysis comparing the highest with the lowest quintile of exposure."

And so just to note, that the highest level of

11:30:55

exposure in the study was more than 108 lifetime days of exposure, which is considerably higher than what the NAPP study showed. And you can see that the relative risk had a 95 percent confidence interval there.

Q. All right. So that is De Roos 2005. Is there

11:31:16

another study based on the Agricultural Health Study --

A. Yes.

Q. -- that you're going to be talking about?

All right. And when was that one published?

A. That was published earlier this year, in 2018.

11:31:27

MR. LOMBARDI: And permission to publish

Slide 29, your Honor, which is a callout from that study?

THE COURT: Very well.

MR. WISNER: Your Honor, we're not making a record here, so these are just slides. There's no exhibit numbers. There's no pages. I don't even know what he's referring to here.

11:31:37

I mean, I know the study, but, I mean, could we just create a record? I'm losing you here.

MR. LOMBARDI: All right. That's fine. No problem. And I'm happy to -- the De Roos 2005 study for the record, that we just talked about and were on the slides, is Defendant's Exhibit 2191.

11:31:49

MR. WISNER: And that callout that you showed the jury, what page was that?

MR. LOMBARDI: I can get that for you. I believe that should be reflected right on the slide you have.

11:32:02

THE COURT: Have you provided --

MR. LOMBARDI: Page 3.

THE COURT: -- Mr. Wisner with copies of all of these?

11:32:09

MR. LOMBARDI: He does have copies.

MR. WISNER: Yeah, I just don't know -- I was looking at the exhibit, and I couldn't find it. So I just wanted to know what he was referring to. Thank you.

11:32:16

MR. LOMBARDI: So that was page -- page 3.

Q. All right. So here, this is Slide 29. And the Journal of National Cancer Institute 2018 study is Defense Exhibit 2052.

11:32:34 Do you see that, Doctor?

A. Yes.

Q. And this callout is from page 1; correct?

A. Yes.

Q. And what are we showing on this callout?

11:32:40 A. So this is -- the title of the study and the authors of the study.

Q. Okay. Now, again, these -- we don't need to go through all of them, but are all of these authors independent of Monsanto or any industry entity?

11:32:56 A. Yes.

Q. Are they mostly government?

A. So from the National Institutes of Health, as well as -- I think it was the University of Iowa. So academic institutions as well.

11:33:07 Q. What happened between the De Roos 2005 study, based on AHS, and this study?

A. So the De Roos 2005 study followed individuals for cancer development up until 2001. What this study was able to do was to extend the follow-up an additional

11:33:25 11 to 12 years, between 2012 and 2013. And you'll see

that really increased the overall number of non-Hodgkin's lymphoma cases.

The second feature of this study is that they included information on a follow-up questionnaire that
11:33:44 was sent to participants about, on average, five years after the baseline questionnaire, which collected updated information. So if people changed their exposures, changed their pesticide use, that was captured in this second questionnaire.

11:33:58 Q. Okay. I want to focus for a minute on the Journal of the National Cancer Institute.

Are all journals viewed the same way by people in cancer epidemiology?

A. No. The potential impact of the journal varies
11:34:15 considerably.

Q. Okay. And how -- how is the Journal of the National Cancer Institute viewed by people in your field?

MR. WISNER: Objection. Speculation and hearsay.

11:34:24 THE COURT: Overruled.

You may answer.

THE WITNESS: So the Journal of the National Cancer Institute is ranked among the highest of oncology journals, based on its impact factor. It was originally
11:34:39 the journal from the actual National Cancer Institute.

It's one of the premier oncology journals.

Q. BY MR. LOMBARDI: Okay. And are the articles in this journal peer reviewed?

A. Yes, they're all peer reviewed.

11:34:49 Q. Okay. Does the Journal of the National Cancer Institute generally publish sloppy articles?

MR. WISNER: Objection. Speculation.

THE COURT: Sustained.

Please ask a different question.

11:34:58 Q. BY MR. LOMBARDI: Okay. Let's go through -- we put together a table -- or did we continue our table with results from this particular study?

A. Yes.

Q. Okay. Let's go to Slide 30.

11:35:14 MR. LOMBARDI: Permission to publish, your Honor?

THE COURT: Very well.

Q. BY MR. LOMBARDI: All right. And then at the bottom, you've added a line; is that right?

11:35:19 A. Yes.

Q. And it says, "JNCI 2018." That's this study; is that right?

A. Yes, it is.

Q. Okay. So first thing, under "Years Diagnosed," 11:35:30 you have two different entries. What does that indicate?

A. So as I mentioned, the cancers were diagnosed by collecting the information from each of the state cancer registries.

So in North Carolina, the follow-up ended in 2012. And in Iowa, it ended in 2013.

You would really see with all of -- the 11 or 12 more years of follow-up, the number of NHL cases went from 92 up to 575. And of whom 440 reported being exposed to glyphosate ever in their lifetime.

11:36:08 Q. Okay. And let's focus on that for a moment. The number of exposed cases in JNCI 2018, how does that compare to any of the other studies we've looked at so far?

A. It's far and away the largest in terms of the 11:36:21 number of exposed cases. It's almost four times as large as the number of exposed cases from the NAPP study.

Q. Okay. And just to be complete, the respondents -- any problem with proxies here?

A. No.

11:36:32 Q. And how about adjustments for other pesticides? Was that done?

A. Yes. In this analysis, they adjusted for ten -- use of ten different pesticides.

Q. Okay. Let's actually look at the actual -- a 11:36:48 clip from the actual study itself, which is Exhibit 2052

at Page 5, and it's Slide 31, from Table 2.

MR. LOMBARDI: Permission to publish, your Honor?

THE COURT: Very well.

11:37:01 Q. BY MR. LOMBARDI: And what are we looking at here, Dr. Mucci?

A. Right. So these are the results where they looked at a measure of dose response. And so what this particular set of data here are, it's not only

11:37:16 information on the lifetime number of days of glyphosate that were used, but also accounting for what was called the intensity algorithm that included information on use of protective gear, the method of application of the pesticides, et cetera.

11:37:32 So these -- the -- the comparison group, again, is people not using glyphosate. And then what we often do in epidemiology when looking at dose response is we'll divide a continuous exposure into four equal categories, which is what we've done here.

11:37:51 So the highest level of glyphosate exposure would be those in the Quartile 4, or the Q4, would be the highest. And then going down to Q1 is still exposed, but the lowest level of exposure. And then no exposure.

Q. Okay. So none of these people who weren't

11:38:06 exposed to glyphosate at all; is that right?

A. Correct.

Q. And then it's an ascending amount of exposure from Q1 to Q4?

A. Yes.

11:38:13 Q. And just so that it's clear what we're looking at here, Table 2, the numbers in this column under "No," period, what do they refer to?

A. This is the total number of cases in each category.

11:38:25 Q. Okay. So what are the results for non-Hodgkin's lymphoma and glyphosate exposure?

A. All right. So there's -- there's no evidence of any association, and definitely no evidence of any positive association, for any of the categories of

11:38:43 exposure of glyphosate.

And then on the right, there's a P value for trend. And that's a P value specifically to test whether there's evidence of a dose-response trend. There's no evidence of any trend.

11:39:00 Q. Okay. All right. I just want to ask you a question while we're here.

There was a suggestion made at some point during the trial -- I actually can't even remember when -- the numbers are below 1?

11:39:09 Do you see that?

A. Yes.

Q. And there's a suggestion made, well, this study's absurd, because it tells you that you should pour glyphosate on your cereal or something. Protect you from NHL. Is that how an epidemiologist would read these results?

11:39:19

A. No, that's not correct.

Q. Okay. What is incorrect about that?

A. These -- these data are consistent with their being no association between glyphosate and NHL risk. When you look at both the relative risk and the 95 percent confidence interval, there's no association.

11:39:28

Q. Okay. And what does the confidence interval specifically show you about these results?

A. That they are not statistically significant.

11:39:42

Q. They cross the 1?

A. They cross the 1 value, yes.

Q. Okay. And so it could be anywhere between .59 and 1.18 in that instance on Q1; right?

A. Yes.

11:39:55

Q. Okay. All right. Now, how does the thoroughness of this JNCI study compare to other studies we have discussed?

A. The -- there are a number of different analyses that the Agricultural Health Study investigators did to

11:40:09

test whether there were specific biases present that could have accounted for the results.

And so it's really one of the most thorough analyses investigating the association of glyphosate and NHL risk.

Q. Okay. So let's -- we've heard a lot from plaintiff's experts in this case about imputation. Are you familiar with imputation?

A. Yes.

MR. LOMBARDI: Your Honor, do I have 15 minutes? Is that right?

THE COURT: You have 20 minutes.

MR. LOMBARDI: I have 20 minutes. Thank you very much.

Q. Okay. What is imputation in the context of an epidemiological study?

A. In our epidemiology studies, we often have to deal with missing data in our questionnaires. And multiple imputation is a well-recognized statistical tool that's used to, essentially, impute the missing data and deal with this issue of missing data.

Q. Okay. And imputation is a pretty standard technique that's used?

A. Yes, it is.

Q. Okay. And was it used here?

A. Yes, it was.

Q. And why was it used with the JNCI 2018 article?

A. So -- so in this case, we had 54,000 individuals in the study. They all completed the baseline questionnaire. And as I mentioned, there was a follow-up questionnaire about five years later. And 63 percent of the individuals -- of the 54,000 completed that second questionnaire. Meaning that 37 percent of the individuals did not.

11:41:33

11:41:47

Q. Okay. And imputation then was used for what purpose?

A. So the imputation was used to impute the missing data for that 37 percent of individuals.

Q. Okay. Now, there have been a number of criticisms made by plaintiff's experts. I want to talk about a couple of them.

11:42:01

Are you familiar with testimony made about an article referred to as Heltshe, H-E-L-T-S-H-E?

A. Yes.

Q. And without being too specific, you understand that there was a claim made that Heltshe shows there is as much as a 20 percent error in the imputation of glyphosate that could cause a 20 percent error in the JNCI article?

11:42:16

A. Yes.

Q. You understand that?

A. Yes.

Q. Okay. I wan to -- do you agree?

A. No.

11:42:41 Q. All right. Let's -- let's talk about Heltshe.

MR. LOMBARDI: And, your Honor, I'd ask -- sorry about that, your Honor. Heltshe is DX 2598.

Counsel and Doctor, 2598, it should be in your binder, but I'm gonna ask permission to publish it, your

11:43:34 Honor, Defendant's Exhibit 2598, which is the Heltshe article.

THE COURT: Very well.

Q. BY MR. LOMBARDI: All right. Doctor, I'll put this up on the Elmo.

11:43:49 And do you see the first author there is Sonya Heltshe, followed by numerous others? Is that right?

A. Yes.

Q. All right. So that's why we call this the

11:43:58 Heltshe article; correct?

A. Yes.

Q. All right. And what was Heltshe -- what were Heltshe and the co-authors doing in this study, generally?

11:44:09 A. Right. And so -- so first, you know, when we're

imputing data in our epidemiology studies, we should be concerned about whether imputation leads to bias.

And I think what's important with this study is the Agricultural Health Study investigators directly

11:44:31 examined whether the imputation method introduced bias.

Q. And so in a general sense -- and I know it's hard to see the highlighting, but I highlighted here. We don't need to get into all the statistical details, Doctor, but what were Heltshe, her co-authors, doing to

11:44:54 test whether imputation created a bias problem?

A. Right. So what they were able to do was to actually take a 20 percent random sample of the individuals who had actually completed both questionnaires, and then they were able to directly

11:45:10 assess whether the imputation -- if they imputed on those 20 percent, are they getting the same value as what was self-reported? So they were directly able to see how well the imputation method worked.

Q. Okay. And I just highlighted here -- I'm not sure whether --

A. No, that's okay. I can read it.

Q. It will be hard to read it.

Okay. So what were the results that they achieved generally and reported in the abstract of this

11:45:32 article?

A. "They observed an imputed prevalence of any pesticide use in the holdout data set were 85.7 percent and 85.3 percent, respectively."

Q. Okay. And what does that indicate about the quality of the imputation, generally?

11:45:45

A. So this would suggest that the imputation worked quite well.

Q. Okay. Now, let's talk specifically about glyphosate. There's information about the imputation with respect to glyphosate use; is that correct?

11:45:57

A. Yes, there is.

Q. And that's where the claim was made that a 20 -- I'm just going to ask you to assume it's correct that there's a 20 percent error within the article -- shown within the article about glyphosate use.

11:46:12

Does that translate into a 20 percent error in the JNCI article?

A. No, it does not.

MR. LOMBARDI: Your Honor, may the witness come down and use the board again?

11:46:22

THE COURT: Yes.

Mr. Lombardi, would you mind pulling the board a little further back?

MR. LOMBARDI: Okay. Is it good enough?

11:46:43

THE COURT: Yes.

Q. BY MR. LOMBARDI: Okay, Doctor, can you explain the issue and -- and why you don't come to the same conclusion?

A. All right. So there were 54,000 individuals who
11:47:02 answered the baseline questionnaires. We have a total of 54,000 individuals here. Of the 54,000 individuals, we know that 37 percent did not complete the baseline questionnaire. So we had to do the imputation for that 37 percent here.

11:47:26 You have 37 percent of people that did need the imputation. And that would mean that for the 63 percent, we didn't have to do the imputation for them.

Of these 37 percent, we know that three-quarters of the individuals were exposed to glyphosate at
11:47:45 baseline. So that would translate into about 9 percent of the individuals of -- 9 percent would be -- sorry.

Q. That's a quarter of the 37 percent.

A. Yeah, a quarter of the 37. So basically, since three-quarters are exposed, it means that one-quarter is
11:48:06 not exposed, and that translates into 9 percent of the all 54,000 people.

So if we take -- assume there is 20-percent error when we do this imputation here, 20 percent of that 9 percent really turns into 1.8 percent in total. So you
11:48:23 can see that although there might be a relative error of,

say, 20 percent in the imputation, that relevant error is only meaningful for that 9 percent of individuals who were not exposed to glyphosate already at the baseline questionnaire. So we're really talking about a very small overall proportion of the 54,000 that are affected.

11:48:44

Q. Okay. Thank you. And you may resume the stand, please.

To continue with Heltshe, Doctor, Heltshe -- can you tell when Heltshe was published?

11:49:10

A. This study was published in 2012.

Q. Okay. And do you recognize these authors?

A. Yes.

Q. And are they -- many of these authors also on the JTI 2018 article?

11:49:26

A. Yes. Dr. Koutros, Dr. Freeman, Dr. Alavanja, Dr. Sandler, et cetera. Dr. Andreotti.

MR. LOMBARDI: Okay. And I'll overlay, with the Court's permission, Defendant's Exhibit 2052 on the Elmo.

THE COURT: Very well.

11:49:45

MR. LOMBARDI: All right. Let's see if I can make this work.

Q. So you can see a number of the authors are overlapping here, Koutros?

A. Yeah. Andreotti.

11:49:56

Q. Andreotti.

A. Sandler.

Q. Sandler.

A. Dr. Freeman.

Q. Alavanja.

11:50:04 A. Yeah.

Q. Okay. So when was -- the JNC article came a few years after the Heltshe article?

A. Yeah, 2015.

Q. Okay. And is there any reason to believe that

11:50:18 the people who wrote the Heltshe article and then wrote the JNC article forgot what they said?

A. No.

Q. Okay. And, in fact, in the Andreotti article, is there any reference to a concern that there might be a

11:50:33 20-percent error in the glyphosate results?

A. No, there's not.

Q. Now, let's go back to imputation. Heltshe was about imputation; correct?

A. Yes.

11:50:45 Q. Did the authors of the JNCI 2018 article do other things to determine whether their imputation was accurate?

A. Right. Yes, they did.

Q. Okay. What did they do?

11:50:54 A. Again, I think this highlights the approach that

really they rigorously wanted to ensure that the results were not due to bias, confounding and chance, and so they were able to do what we call a sensitivity analysis.

Q. And specifically about the imputation point?

11:51:11 A. Yes.

Q. And how many sensitivity analyses did they do about the imputation point?

A. So there were three different sensitivity analyses done directly to test whether the imputation led

11:51:22 to any bias.

Q. And I'm not going to go through the details of each of the three. But in general for the three, what was the conclusion of what the sensitivity analyses showed about the accuracy of the imputation?

11:51:33 A. Right. So in all three sensitivity analyses, the results were virtually identical to what they saw in the analysis when they included the imputation, and there was no association between glyphosate and NHL risk.

Q. Okay. I want to talk about one of those

11:51:49 sensitivity analyses specifically. Have we brought a slide that calls out one of them?

A. Yes.

MR. LOMBARDI: All right. Permission to display Slide 32, which, again, is the Journal of National Cancer

11:52:02 Institute 2018 study, Defendant's Exhibit 2052 at page 4.

THE COURT: Very well.

MR. LOMBARDI: And that's Slide 32, please.

Q. Okay. Let's explain to the jury what you have displayed here.

11:52:16 A. So as I mentioned when I was drawing that figure, we know that 63 percent or about 37,000 -- or 34,000 of the participants actually completed both questionnaires, so none of them had to have the imputed data in that analysis. And so what the authors did was

11:52:36 to analyze the association between glyphosate and NHL risk in these 34,000 individuals where they have complete data.

Q. Okay. So they limited the analysis to the 34,000 who completed both questionnaires. What happened

11:52:51 to the total number of cases -- or exposed cases, the relevant consideration, when they limited it that way?

A. Right. So it was reduced. So this is the total number of cases. The number of exposed cases would be about 220.

11:53:05 Q. Still compared to the other studies we've looked at, how does that compare?

A. Still the largest of any of the studies.

Q. And what was the result they got when they only considered individuals for whom there were no imputed

11:53:20 results?

A. Right. So this result is looking at the highest quartile, or highest level of it, of glyphosate exposed compared to those not exposed, and there's no association seen for glyphosate and NHL risk.

11:53:35 Q. Okay. Now, let's go back to your table, Slide 33.

MR. LOMBARDI: And this is just a continuation of the table we've been looking at, your Honor. Permission to publish?

11:53:44 THE COURT: Very well.

MR. LOMBARDI: A little late. Sorry.

Q. You've added there something next to which you've added, "No imputation." What do you mean by that?

A. Yeah, so this is the result that we just

11:53:56 discussed in the earlier slide.

Q. Okay. And so you're showing a result for imputed and a result for when there is no imputation; is that right?

A. That's right.

11:54:06 Q. All right. And what is your conclusion based on the JNCI 2018 study?

A. So the -- first, that imputation is unlikely to have led to a bias in the study, and then secondly, that there's no evidence of a positive association between

11:54:22 glyphosate and NHL risk.

Q. Okay. There was a statement made at some point, I think last week in this trial, that the JNCI study is just about farmers who worked -- who apply glyphosate while in a tractor that has an enclosed cab. Do you understand what I'm talking about?

11:54:39

A. Yes.

Q. Is there anything in the Agricultural Health Study or the JNCI 2018 article that supports that statement?

11:54:47

A. No, there is not.

Q. Okay. How extensive is the exposure data among the population study in the JNCI?

A. It's very extensive. There's really detailed information about whether individuals were mixing

11:55:01

pesticides, what type of application method they were using. It's very detailed.

Q. Okay. All right. And did the authors of the Journal of National Cancer Institute article 2018 come to conclusions themselves about whether their study showed

11:55:19

that glyphosate causes non-Hodgkin's lymphoma?

A. Yes, they did.

Q. All right. Have we brought a slide that has that clip?

A. Yes, we have.

11:55:28

MR. LOMBARDI: All right. Ask permission to

publish Slide 34, which is Defendant's Exhibit 2052, page 7.

THE COURT: Very well.

Q. BY MR. LOMBARDI: All right. And let's just read the first sentence to the jury, please.

11:55:38

A. "In our study, we observed no associations between glyphosate use and NHL risk overall or any of its subtypes."

Q. Okay. And so NHL overall, meaning any form of NHL; is that right?

11:55:54

A. Yes.

Q. And all of its subtypes, means there's no showing of any association for any of the subtypes of NHL as well?

A. Yes, correct.

11:56:03

Q. All right. And then the next sentence, if you could just read that to the jury and explain what that means about the type of analysis that was done.

A. Sure. So: "This lack of association was consistent for both exposure metrics." What's meant by -- there was not only did they look at this algorithm where they weighted the cumulative days by intensity, but they also looked simply at just the total number of cumulative days, so there was no association in either of those analyses.

11:56:15

11:56:35

"Either in the unlagged or lagged analysis." So what the investigators did was to look at whether -- glyphosate more short term or longer term. So what they did was to look at whether glyphosate use over 5 years, 10, 15 years or 20 years, whether the shorter or longer term time periods were associated with risk of NHL, and they were not.

11:56:49

"After further adjustment for pesticides linked to NHL in previous AHS analysis," which addresses the confounding, "and when we excluded multiple myeloma from the NHL grouping," and the reason for that was the definition of non-Hodgkin's lymphoma has change over time.

11:57:08

Q. And so based on all of that, they concluded that -- well, let me just ask you this: Has any other study done this amount of analysis on glyphosate and NHL?

11:57:22

A. No. This is really the most comprehensive analysis.

Q. Okay. Doctor, let me -- in the brief time we have left, let me turn to something called meta-analysis.

11:57:37

MR. LOMBARDI: You can take that down, Armando? Thank you.

Q. The jury's heard something about meta-analysis.

A. Yes.

Q. What is meta-analysis, M-E-T-A, dash, analysis,

11:57:47

in epidemiology?

A. So a meta-analysis is a commonly used statistical tool to summarize data across multiple studies. It's different from pooled studies, in that we're just taking the relative risks and 95 percent confidence intervals that are actually reported in each individual study, and then we weight the importance of the information based on the size of the study. Specifically the number of exposed cases.

11:58:02

11:58:17

Q. And why would an epidemiologist do a meta-analysis?

A. Meta-analyses are done to provide, really, a summary picture of the information across each of the studies.

11:58:32

Q. Okay. And do -- does meta-analysis get rid of the underlying problems with the individual studies?

A. No. Because -- because we're relying on the relative risk and 95 percent confidence intervals that are published in the studies.

11:58:43

It's all those relative risks are potentially going to be biased or confounded, if there's bias or confounding present.

Q. Okay. And have you done meta-analysis here?

A. Yes, I have.

11:58:56

MR. LOMBARDI: Permission to publish Slide 35,

which is Dr. Mucci's meta-analysis?

THE COURT: Very well.

MR. LOMBARDI: Let's put that up.

Q. So, Dr. Mucci, you did a meta-analysis. Are you aware that IARC did a meta-analysis related to some of the studies?

A. Yes, I am.

Q. Did you use the method they used?

A. Yes, I did.

11:59:12 Q. Okay. Except you used different studies; is that right?

A. Yes. So there were two studies that IARC did not have available when they did their meta-analysis.

Q. Okay. And you -- which two are they in your list there?

11:59:24 A. So it would be the JNCI 2018 study and the North American Pooled Project study.

Q. All right. How did you decide what studies to include in your meta-analysis?

11:59:34 A. So I included the -- always, which is standard in doing meta-analysis, the most updated analysis.

So, for example, because there were two publications of the Agricultural Health Study, I relied on the more recent study that had the largest number of

11:59:55 cases. And that's a standard approach.

Similarly, for the North American Pooled Project, I included that study rather than including De Roos 2003 and McDuffie, because, again, it was the most updated and best estimate of glyphosate.

12:00:12 Q. And, actually, are De Roos 2003 and McDuffie included within NAPP?

A. Yes, they are. Yes.

Q. Okay. Why -- you didn't -- I don't believe you have the Hardell 2008, the eight exposed cases study

12:00:26 here. Why not?

A. Right. So that's the only study that IARC included that I did not include. I felt that the -- the quality and reliability of the information, because it was only based on eight exposed cases, and given the

12:00:38 issues with proxy bias and, finally, I just didn't feel that it was a reliable study to include.

However, I can tell you that it doesn't change the results if I do include it.

Q. Okay. Would you describe the results you came

12:00:50 to, for the jury, please?

A. Right. So the summary meta relative risk is presented as the diamond there. And so the way you can think about this is that the center of the diamond gives you the -- the summary relative risk across all of these

12:01:10 studies.

And then the width of the diamond is the 95 percent confidence interval bounds.

Q. Okay. And so what does -- what does your result show you?

12:01:19 A. So the -- and, again, we have to think that the summary meta relative risk does not get rid of the bias and confounding that may be remaining. But, still, the summary meta relative risk does not show any positive association between exposure to glyphosate and the risk

12:01:37 of NHL.

And all of these estimates here are for the comparison of ever versus never exposure.

Q. Okay. All right. Doctor, based on everything you've looked at that we've talked about, and we won't

12:01:48 repeat it all, have you come to a conclusion about whether the epidemiological evidence shows that glyphosate causes NHL?

A. Yes, I have.

MR. LOMBARDI: Permission to publish Slide 36?

12:01:59 THE COURT: Yes.

Q. BY MR. LOMBARDI: And what's your conclusion, Doctor?

A. So based on the epidemiological evidence, there is no causal association between exposure to

12:02:12 glyphosate-based herbicides and NHL risk.

MR. WISNER: Your Honor, I'm going to object to that. We can discuss it right after.

THE COURT: All right.

MR. LOMBARDI: I have no further questions. Thank you, Doctor.

12:02:21

THE COURT: All right. Thank you.

All right, Ladies and Gentlemen. We're going to break now for the lunch recess. Please remember: Do not discuss the case, do not do any research. And we will resume again at 1:30. All right?

12:02:33

Thank you. And we'll see you at 1:30, Dr. Mucci.

THE WITNESS: Thank you.

THE COURT: And, Counsel, do you want to approach?

12:02:36

(Sidebar.)

[redacted]

12:03:11

12:03:43

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12:03:52 [redacted]

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12:04:13 [redacted]

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(End sidebar.)

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12:04:47 [redacted]

(Time Noted: 12:04 p.m.)

REPORTER'S CERTIFICATE

I certify that the proceedings in the within-titled cause were taken at the time and place herein named; that the proceedings were reported by me, a duly Certified Shorthand Reporter of the State of California authorized to administer oaths and affirmations, and said proceedings were thereafter transcribed into typewriting.

I further certify that I am not of counsel or Attorney for either or any of the parties to said Proceedings, not in any way interested in the outcome of the cause named in said proceedings.

IN WITNESS WHEREOF, I have hereunto set my hand: July 31st, 2018.

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Leslie Rockwood Rosas
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