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Late Effects of Childhood Cancer

Developed by Kristen Salena and Dr. Stacey Majerrison for PedsCases.com. Many thanks to Lauren Beals for assistance with audio recording

Introduction:

Kristen:

Hi everyone and welcome to PedsCases! My name is Kristen Salena and I am in my final year of medical school at McMaster University in Hamilton, Ontario. I have been collaborating with Dr. Stacey Marjerrison, a pediatric oncologist at McMaster Children's Hospital, to develop a podcast in which we discuss the late effects of childhood cancer. Dr. Marjerrison is currently the Medical Director of the McMaster Children's Hospital POGO AfterCare Program – one of several specialized clinics in Ontario dedicated to monitoring and promoting the health of pediatric cancer survivors.

Dr. Marjerrison:

Hi everybody!

Objectives:

Kristen:

Dr. Marjerrison and I would like to ground this discussion in several learning objectives. By the end of this podcast, the learner should be able to:

1. Relate the incidence of childhood cancer in Canada.
2. Discuss the most common childhood cancers and the therapeutic modalities used to treat childhood cancer.
3. Identify late effects of childhood cancer treatment.
4. Describe how clinicians can monitor for late effects of childhood cancer treatment.
5. Discuss the health resources and programming offered to survivors of childhood cancer.

Dr. Marjerrison:

In order to tackle these learning objectives, let's start our discussion with a clinical case scenario. We'll go over the scenario, give you an overview of the late effects of childhood cancer, and then revisit the scenario to apply what we have learned. Let's get started!

Clinical Case:

Kristen:

Okay, here's our case.

Nora is a 9 year old girl who is originally from England, where she lived with her family until recently. Earlier this year, Nora and her family immigrated to Canada.

When Nora was 4 years old, she was diagnosed with a unilateral Wilms Tumour – one of the most common early childhood cancers and the most common childhood renal malignancy.[1] She originally presented to the Emergency Department at the Great Ormond Street Hospital, with a firm, non-tender mass in the left upper quadrant of her abdomen. A CBC and differential showed a mildly decreased hemoglobin of 86 g/L, but no other abnormalities. Electrolytes, extended electrolytes and liver enzymes were all within normal limits, as were her urea and creatinine values. At the time of presentation, an abdominal ultrasound demonstrated that the mass was arising from the left kidney, with no involvement of the vasculature. A chest X-ray showed one concerning lung nodule in the right upper lobe. Urinalysis showed only trace blood. She was admitted to hospital under the Pediatric Hematology/Oncology team for further investigations.

After she was admitted to hospital, she underwent a CT scan of her chest, abdomen and pelvis. The CT results showed a 'claw sign' in the left kidney, consistent with a Wilms tumour. There was also irregularity along the posterior side of the tumour concerning for tumour rupture and spillage, with two enlarged lymph nodes nearby. Her liver and other organs looked uninvolved, but she did have three lung nodules in her chest, the largest 1.5x2cm, that were worrisome. Given these findings, she was determined to have stage 4 disease. She did not have any of the history or physical exam findings concerning for a Wilms tumour predisposition syndrome. As Nora was in the UK, therapy there follows the International Society of Pediatric Oncology (SIOP) approach to treatment that starts with pre-operative chemotherapy, and delayed tumour resection. This is different from the North American approach through the Children's Oncology Group (COG) where resection is done upfront if feasible. Nora was started on treatment per the then closed SIOP-2001 protocol, a regimen consisting of 6 weeks of

pre-operative chemotherapy, which included dactinomycin, vincristine and doxorubicin. During her operation to resect the bulk of the tumour, there was evidence of pre-operative tumour spillage into her abdomen. On pathology, the typical triphasic cells of Wilms tumour were present, but diffuse anaplasia was also present – rendering the pathology as 'high risk' or 'unfavourable'. Her treatment continued according to the SIOP-2001 protocol, consisting of etoposide, carboplatin, cyclophosphamide and doxorubicin. She also had abdominal and pulmonary radiotherapy to address the remaining microscopic tumour in her abdomen and her lung metastases, with a total dose of 15Gy to her lungs and 21Gy to her whole abdomen.[2]

After completing her therapy, she was found to be in remission. At the time of remission, she was 6 years old and starting first grade. She did well in first, second and third grades. Still, since moving to Canada 8 months ago, she is struggling in the fourth grade. At first, her teachers thought it might be that she is taking more time than anticipated to transition to the new school system; however, they have noticed Nora has difficulties with focusing on tasks at school. They know Nora had cancer – she tells all of her teachers because she is proud of her journey (and her scars to prove it!) They wonder if her issues with attention might have something to do with her past history of cancer. After meeting with the teachers on several occasions, Nora's parents brought this up with their community pediatrician. To help address some of these concerns, the pediatrician has referred Nora to the AfterCare Clinic at McMaster Children's Hospital.

You are a medical student doing an elective rotation in pediatric hematology/oncology. You are spending the afternoon in the AfterCare Clinic and your preceptor asks you to review the patient's chart before you accompany her into the room. She asks you what late effects of childhood cancer you might consider in this patient, given the story.

Dr. Marjerrison:

Now, before we discuss the details pertaining to Nora's case, let's work to understand the current landscape of childhood cancer in Canada.

Kristen:

If we were to ask most people, they probably would say that they know someone with cancer. Still, childhood cancer is relatively uncommon. In Canada, childhood cancer makes up less than 1% of all new cancer diagnoses.[3] Thirty-two percent of these cancers are leukemias, 19% are brain and CNS cancers, and 11% are lymphomas. Between 2009 and 2013, 4,715 new cases of childhood cancer among 0-14 year olds were diagnosed in Canada. This works out to be about 943 cases per year on average.[3]

When we think about cancer, we often think about mortality and morbidity and, unfortunately, one in every five children living with cancer in Canada does not survive.[4] The survival rates differ depending on age and type of cancer. In Ontario children age 0-14, the highest 5 year overall survival rate is among survivors of renal tumours,

retinoblastoma, germ cell tumours, acute lymphoblastic leukemia (ALL) and lymphomas.[5] Conversely, the lowest 5 year overall survival rates are among children with high grade astrocytomas, acute myeloid leukemia (AML), malignant bone tumours and soft tissue sarcomas.[5]

If 1/5 kids do not survive, there are 4/5 or 80% who do. In fact, there are approximately 30, 000 childhood cancer survivors living in Canada today.[4] This is largely due to advances in therapy and the incorporation of multimodal treatment modalities into well-researched, disease-specific, risk stratified treatment protocols. Very often, kids are receiving some combination of chemotherapy, radiation and/or surgery - because these are the mainstays of treatment. Still, we have to remember that these treatments in and of themselves can have side effects and this, coupled with the fact that these therapies are often given at a time when kids are actively growing and developing, can certainly magnify some of these effects. As such, many treatment effects persist and perhaps even evolve in adolescence and adulthood.

Dr. Marjerrison:

So, let's talk about late effects of childhood cancer! That is why we're here, aren't we?
Kristen:

Yes. Most childhood cancers are treated with multiple therapeutic modalities, including some combination of chemotherapy, radiation, surgical intervention or stem cell transplantation. Often, these treatments occur when children are undergoing considerable physical, psychological, social, cognitive and emotional development. For the purposes of this podcast, we will focus on the late effects of chemotherapy and radiation, as we feel this is most relevant to your learning.

It's helpful to adopt a systems-based approach when discussing these late effects. The systems we will discuss today include the central and peripheral nervous system, the endocrine system, the cardiovascular system, the respiratory system, the GI system, the renal and genitourinary systems, the reproductive system, the musculoskeletal system, the hematologic system and even systems pertaining to psychosocial health and development.[6] It's also important to consider *which* chemotherapeutic agents were used as the principal drugs of treatment and *which areas* were targeted by radiation therapy, as this information will help the clinician to hone in on the affected systems and develop a targeted approach to long-term monitoring of late effects. At this point, we'd like to refer you to a very helpful summary document developed by the BMJ entitled "Managing Long Term Side Effects of Chemotherapy"[7] as well as the *Pediatrics in Review* document "Late Effects in Survivors of Childhood Cancer."[6] These documents will serve as a helpful guides for you as we continue our discussion.

First, let's talk about how chemotherapy and radiation affects the nervous system!

Dr. Marjerrison:

Chemotherapy, namely methotrexate, can affect the central nervous system, especially when we give it via lumbar puncture for diseases like leukemia or in high doses, as we'd see in osteosarcoma. We might worry about cognitive dysfunction down the road and, for this, neurocognitive evaluation is important.[6] It's also important to do a screening neurological exam when seeing these kids in follow-up.[7]

Some chemotherapy drugs affect the peripheral nerves, causing peripheral neuropathy.[7] One such drug is vincristine, which our patient received. Some chemotherapy agents can also cause hearing loss, like cisplatin or carboplatin – which was also included in Nora's regimen.[7] For that reason, we always make sure the patient gets a baseline audiological assessment before treatment starts, during therapy and after treatment we repeat it if there are symptoms.[7]

Finally, high dose corticosteroids, like Prednisone, can cause cataracts. For this reason, children need an eye exam every year and should be referred to an ophthalmologist if they have symptoms.[7]

It should also be noted that radiation to the brain, head and neck can also affect the central nervous system similarly. [6]

Kristen:

Next, let's move on to the endocrine system.

When we think of the endocrine system and how it might be affected by radiation and chemotherapy, we have to think about the pituitary gland, the thyroid, the gonads and the bones. Let's start with the pituitary gland because we were just talking about the brain.

Dr. Marjerrison:

As you know, the pituitary gland is the gland that sits in the middle of the brain and is a vital part of many of our hormone loops. It responds to both negative and positive feedback and helps ensure our body has an optimal level of hormones for various functions. Radiotherapy, in particular, can affect the pituitary and, inherently, many of these hormone systems, causing patients to be diagnosed with endocrinopathies later in life. Radiation to the pituitary gland or to the thyroid can lead to hypothyroidism, thyroid nodules or even thyroid cancer.[6] For this reason, we recommend yearly assessment of the thyroid after radiotherapy for the rest of your life.[8]

When we think about the effects of cancer treatment on the endocrine system, we also need to think about the bones. The bones are important organs and bone health is

mediated by hormones which, again, can be affected by treatment. Corticosteroids, like prednisone or dexamethasone, are often given at high doses during chemotherapy and we know that steroids can cause issues with our bones, particularly osteopenia and osteoporosis. Patients should get a baseline bone density scan after treatment,[8] and they should be encouraged to ensure they have adequate dietary intake of calcium and vitamin D both during and after therapy. Also, different than in adults, children are still growing, and it's important to know that radiotherapy can stop the growth of bones – so we really try to do surgery instead of radiation for sarcomas in kids whenever possible.

Finally, radiation to the lower abdomen and pelvis, as well as certain chemotherapy drugs called "alkylating agents" can affect the reproductive system, contributing to infertility and abnormal pubertal development.[6] If the kids are post-pubertal at diagnosis, there may be an opportunity to sperm bank or save oocytes prior to these treatments to preserve fertility options. However, in many cases, therapy needs to be started urgently, and the children are still too young or unwell to undergo these procedures. It's important to have these discussions with families and patients before you begin treatment. That being said, these effects are dose-dependent, meaning the bigger dose you get the more likely fertility is to be affected. After treatment, it's really important to follow gonadal function, as impaired testosterone and estrogen synthesis can lead to an inability for children to enter puberty naturally. In the case of our patient Nora, she had both cyclophosphamide, an alkylator, as well as whole abdominal radiotherapy. Following her pubertal development will be important and even if she starts having periods, she's likely to have a reduced number of eggs, meaning she'll go into early menopause – so that will need to be followed closely.

Kristen:

Okay. Dr. Marjerrison. We've spoken about the brain, nerves and endocrine organs. What about the other organ systems involved? I've heard that the heart and lungs can be affected by childhood cancer treatments. Is this true? Can these young people get heart disease earlier?

Dr. Marjerrison:

Yes, they totally can. Thinking first about the heart, this is especially true with chemotherapy drugs called anthracyclines. Our patient Nora had doxorubicin, which is one of these drugs. These drugs, especially if given in bigger doses, can cause dilated cardiomyopathy leading to congestive heart failure and possibly even arrythmias. Furthermore, radiation to the heart, which happens when you give lung radiation for example, has been known to cause coronary artery disease and hypertension.[7] It's important that we counsel around smoking and the importance of a healthy lifestyle because the odds of developing these cardiac sequelae are exacerbated by other, more typical risk factors like smoking, dyslipidemia and diabetes.[7] Clinicians should consider

doing a blood pressure at every visit,[7] as well as an EKG at baseline and when clinically indicated.[8] We follow for the development of cardiomyopathy with echocardiograms, but because the risk is dose-dependent, the screening recommendations vary depending on your dose.[6]

Kristen:

Okay, so that's the heart. What about the lungs?

Dr. Marjerrison:

Yeah, the major thing we are concerned about with regard to the respiratory system is pulmonary fibrosis. Again, chest radiation is the biggest culprit for pulmonary fibrosis, along with some chemotherapy agents like bleomycin, commonly used in Hodgkin lymphoma.[7] Patients need a baseline chest x-ray and pulmonary function test after treatment, and then follow these as clinically indicated. Also, make sure you give these kids their vaccines, including influenza and pneumococcal vaccinations and recommend smoking cessation if they are smokers.[7]

Kristen:

Okay, so we've touched on the brain, heart, lungs and endocrine system, but there are TONS of organs in the abdomen. What about the renal, genitourinary and GI systems? Are there late effects for those systems as well?

Dr. Marjerrison:

Absolutely. Some chemotherapies can cause kidney problems. For instance, carboplatin and cisplatin can cause chronic kidney disease. We have to think about secondary renal tract cancers, especially if certain chemotherapy drugs – for example, cyclophosphamide -- are used to treat the patient and especially if they have had lower abdominal and pelvic radiation.[6,7] It's important to encourage patients to report any urinary symptoms. When the kids have gotten these therapies, clinicians should take a blood pressure at every visit, perform a urinalysis every year and, when they finish therapy, it is important to document baseline kidney function.[7]

With regard to the GI system, the late effects are primarily associated with radiation to the abdomen, and after major abdominal surgeries. For abdominal radiation, we can see bowel obstruction, fistulae, strictures and secondary malignancies. We can also see liver inflammation, fibrosis and cirrhosis. And remember when we spoke about neuropathy and chemotherapy? The same kind of thing can happen with the nerves that innervate the bowels. With neuropathy, the bowels can become slow, leading to constipation and abdominal pain – although this mostly resolves after the therapy has finished.

With high doses of abdominal radiation, we might consider the effects on the reticuloendothelial system. In fact, functional asplenia can occur at these doses. Our spleen is important because it helps protect us from infection but, with functional asplenia, the patient's spleen just isn't working properly. You have to take extra precautions with a patient who is known to have a functional asplenia when they have a fever,[6] because they can get sick very quickly (especially when they are exposed to encapsulated organisms such as haemophilus influenzae, streptococcus pneumonia or meningococcus).[8] For the patients at risk of functional asplenia, we need to ensure we do a really good physical exam at the time of illness to try to identify a source of infection and, when they are febrile, take blood cultures[8] because they may have bacteremia.

Kristen:

Okay, that makes sense. I've also read that chemotherapy and radiation have been associated with development of secondary cancers…

Dr. Marjerrison:

Yes, for sure. Tell me a little bit more about what you've read.

Kristen:

Well, I've read that patients who have been treated for childhood cancer can have recurrences of their old cancer after they have been in remission, or they can develop completely new cancers. Some common secondary cancers in this population include breast cancer after chest radiation[6], sarcomas after musculoskeletal radiation[6], skin cancers after any radiation that includes the skin, meningiomas of the brain after cranial radiation, and less commonly, acute myeloid leukemia after some chemotherapies, etoposide in particular.[6]

Dr. Marjerrison:

Exactly. As you describe Kristen, there's many second cancers associated with radiotherapy. Since kids have long lives ahead of them, we really only try to use radiotherapy when absolutely necessary for kids. With that said, it's important to know that all these risks are really dose-dependent, and we are getting much better at protecting breast tissue during radiation, and giving lower doses of etoposide for that reason. Like with Nora for example, when she had etoposide, her dose was much lower than a dose we might expect to cause secondary AML. Do you know how we would monitor for these secondary malignancies?

Kristen:

Well, you can't really go wrong with a good physical exam. For patients at risk of secondary leukemia, I would probably keep a close eye on their CBC and frequently ask them about any symptoms of fatigue, bleeding and easy bruising.[8] At the same time, you should examine the patient's skin for pallor, petechiae and purpura.[8] For things like skin cancers, patients should examine their own skin regularly, especially in areas where they have had radiation.[8]

For patients who had chest radiation, I read that they should do a self-examination every month and that a clinician should examine the breasts every year from puberty to age 25, after which the examination should happen every 6 months.[7] I wonder if you could tell me about the recommendations for cancer screening in these populations?

Dr. Marjerrison:

Sure! I'll chat about the cancer screening for breast, colorectal and cervical cancers because we have provincial screening programs for those types of cancer here in Ontario.

For breast cancer screening, the Children's Oncology Group recommends doing the clinical breast exam as you just mentioned.[8] The recommendation for self-screening is different from what the SOGC recommends for the general population, but that's because the risk is much higher – in the range of someone with a BRCA2 mutation – so if you remember your stats training, the number needed to treat is much lower, and that balances in favour of self-screening. They also recommend yearly mammograms and breast MRI beginning 8 years after radiation or at the age of 25, whichever occurs last.[8]

For colorectal screening, the Children's Oncology Group recommends patients who have had abdominal radiotherapy as part of their therapy get colonoscopy every 5 years beginning 5 years after radiation or at age 30, whichever occurs last.[8] They also recommend pap smears for cervical cancer beginning at age 21.[8]

Kristen:

Okay, thanks. That's super helpful.

While we have finished using our systems-based approach to the physiological late effects of childhood cancer treatment, I think it's important to briefly touch on the psychosocial effects of childhood cancer. Of course, this could be an entire podcast in and of itself!

Dr. Marjerrison:

Yes, absolutely it could.
Kristen:

It's no surprise that a childhood cancer diagnosis can be devastating for patients and their families, but so can the treatment process. In fact, in addition to physiological sequelae, survivors of childhood cancers can develop several psychosocial sequelae including post-traumatic stress disorder (PTSD), depression, difficulties with education, difficulties with relationships, issues with employment, social isolation, financial strain[7] and risky behaviours that might predispose a young person to illness or injury.[8] These patients might potentially develop issues pertaining to the psychosocial effects of chronic pain, fatigue and problems with sleeping.[8] Even those who seem to be coping well, often struggle with what we call 'survivor guilt'. For these reasons, the clinical interview during each follow-up encounter is very important such that clinicians can screen for these concerns. While many young people lead happy and healthy lives and won't have any of these long term sequelae, we ought to screen every childhood cancer survivor for psychosocial issues. Each survivor should undergo a yearly psychosocial assessment and be connected with support groups, psychologists and counsellors if they need it. These individuals might also benefit from a discussion surrounding use of antidepressant and anxiolytic medications if clinically indicated.[7] I'd be especially aware of those patients who have a personal or family history of anxiety, depression or mental illness.[8]

Dr. Marjerrison:

Okay, that was a lot of information so let's distill it down into several points that listeners can take away and apply to their clinical practice. Of course, you can always refer back to this podcast or any of the documents we mentioned in the beginning but we wanted you to have some simple, clinical pearls that cover the basic concepts.

Kristen:

Okay so, as a med student who is transitioning to residency, here's what I think is high yield for people like me:

1. Childhood cancer is relatively uncommon and, of all the childhood cancers, the most common is leukemia.

2. Most childhood cancers are treated with multiple modalities, meaning that treatment protocols often include some combination of chemotherapy, radiation, surgery or stem cell transplantation – although novel treatments, like immunotherapies are becoming much more prevalent.

3. Treatment for childhood cancer is led by a few multi-national research consortia, such as the COG in North America, and SIOP in Europe. A big part of the reason that over 80% of children with cancer survive is because of how quickly we can learn about the best treatments for children when we work together. Protocols developed by these groups are evidence-based and stratified by risk groups. There are many factors that determine if a child is high, intermediate or low risk

and these factors differ for each cancer diagnosis. Risk groups help us to decide which treatment kids get and what their prognosis is.

4. Chemotherapy and radiation have long term effects and we have to monitor for these late effects after kids are done treatment. It is important that they are not lost to follow up. They can have this follow up in the community or in a follow-up clinic at a tertiary care centre, provided that their clinicians feel comfortable monitoring and managing these late sequelae. Usually, kids go to what are called AfterCare clinics once the major risk for cancer relapse has passed, usually after 2 years post-treatment. How often they need to be seen, and where, depends on the intensity of their treatment and the likelihood of developing late effects – but initially, at least, they are seen yearly.

5. It's helpful at this point in your training to group the late effects by system and virtually all of the body's systems can be affected. Special attention should be paid to the nervous system, the cardiorespiratory systems and the endocrine system. Once you are further along in your training, you might find it helpful to group the late effects by chemotherapy drug or area of radiation. Remember that some effects can develop at the time of therapy and persist, but many others emerge with time, and need ongoing monitoring.

6. There are certain screening guidelines, depending on the therapeutic exposure the child had. If you want all the nitty-gritty details on these guidelines, there is a really comprehensive document by the Children's Oncology Group entitled, "*Long-Term Follow-Up Guidelines for Survivors of Childhood, Adolescent, and Young Adult Cancers.*" This document outlines all of the late effects that you might expect in patients who have had chemo, radiation, stem cell transplant or surgical interventions. You can always go back to these guidelines if you need to!

I feel like those are the important take-aways, would you agree Dr. Marjerrison?

Dr. Marjerrison:

Yes, absolutely I agree. Now, let's bring it back to the case.

Remember Nora? She had Wilms Tumour. She was treated with several chemotherapeutic agents as per protocol, including vincristine, dactinomycin, doxorubicin, cyclophosphamide, carboplatin and etoposide. She also received abdominal and chest radiation. With this information in mind, she'd be at risk of numerous late sequelae. What do you think some of those sequelae might be, Kristen?

Kristen:

Okay, because she had abdominal radiation and surgery, I'd be thinking about the organ systems in that area including the GI system, the genitourinary system and the

reproductive organs. Specifically, I'd worry about potential bowel obstruction or strictures, and secondary GI cancers in the abdomen. I'd warn patients what to watch out for and I would make a note that she would need colonoscopies when she's an adult.

I'd also be particularly concerned about Nora's renal function, as she had a nephrectomy and likely had a lot of radiation to her remaining kidney. I'd probably keep a close eye on her creatinine, urea and lytes and, at each visit, I would be sure to ask her about her voiding pattern. She'd probably be at risk of future renal tract malignancy and there might be scarring or damage to her bladder.

Because she received abdominal radiation, I would hope that Nora's care team had discussed fertility risks prior to commencing her treatment. Because Nora had both cyclophosphamide and pelvic radiation, I'd be really worried about her gonadal function. I imagine that she should be followed by an endocrinologist to ensure she enters puberty appropriately and eventually a fertility specialist to optimize her fertility, should she decide she wants to have children in the future. If she were able to conceive, she'd also be at risk during her pregnancy as her uterus would have been radiated and may not stretch to accommodate a baby well, so she should be followed by high-risk obstetrics I'd imagine.

With the chest radiation, I wonder if Nora would be at increased risk of developing pulmonary fibrosis or a secondary breast cancer. She would have to be screened for this. She would need a yearly respiratory physical exam and ongoing breast examinations as discussed previously.

Dr. Marjerrison:

Well done, and yes, she'd definitely be at risk of pulmonary fibrosis and breast cancer. What about the late effects of her chemo?

Kristen:

Well, Nora's chemo regimen included doxorubicin, which can be associated with dilated cardiomyopathy, so she'd need screening, including regular echocardiograms, with the frequency decided by her dose. She also had vincristine which can cause neuropathy around the time that it's given – so we should check in to see if she experienced that, and if so, if it's persisted. Because of the carboplatin, we should check her hearing and her renal function – which we should also keep an eye on because of her cyclophosphamide that can also affect her fertility. I don't think dactinomycin has many late effects we need to watch out for. And what about her etoposide – do we have to watch out for secondary AML?

Dr. Marjerrison:

As we were talking about before, most regimens use only low dose etoposide as hers did – so that risk is incredibly low. I'd include a CBC in her screening bloodwork but I wouldn't be too worried. You're right about the rest. Dactinomycin isn't associated with significant late effects. You were talking about pregnancy before, and the other thing to keep in mind about cardiac late effects is the additional strain that a pregnancy can put on her heart after doxorubicin – so another reason she'd need to be followed closely if she ever were to get pregnant.

Kristen:

Oh, that's important.

Of course, I'd also be thinking about the psychosocial effects we mentioned previously, especially given that Nora likely spent many formative years of her development in-hospital. We know, from the case, that Nora is struggling in school. She didn't get any cranial radiation or methotrexate, but it could be due to other physiological sequelae like ototoxicity. It could be that she has issues with hearing and that could be affecting her learning. I would want to do a really good assessment of her hearing and development. Then, if those are fine, she might still need neurocognitive testing, as she could still be affected by any of the learning issues that other kids face. Maybe some extra help at school and individualized planning to help her achieve her learning goals would be a good idea. The sooner we can intervene, the better!

Dr. Marjerrison:

Yes, all great thoughts! I'd also add that we might want to consider baseline bloodwork including liver function tests, liver enzymes and a CBC. We should think about following for diabetes because our patient's pancreas is nestled in the abdomen and they're at higher risk of developing diabetes, so start with a HbA1c and glucose testing at baseline and then as clinically indicated.

Do you have anything else you'd want to add or think about?

Kristen:

Once Nora is part of the AfterCare program at McMaster, what might her care look like from here on out? How do the AfterCare clinics work in the Ontario-based hospitals and are there similar services in other provinces?

Dr. Marjerrison:

Well, kids in Ontario are pretty lucky. The Pediatric Oncology Group of Ontario – or POGO as it's often known – helps coordinate cancer care for kids in the province. One

of the initiatives that they support are the AfterCare clinics. There are AfterCare clinics associated with each of the children's cancer hospitals in Ontario, which provide support to survivors of childhood cancer throughout their lifetimes. In some other provinces the oncology clinics do follow their patients for survivorship care, but often that stops at 18, when they are transitioned back to their family doctors. That's a bit tricky though, because as we've discussed, many of these late effects emerge with aging – and often not until cancer survivors are in their 30s to 40s, or even later. As for Nora, even though she didn't get her upfront treatment here, now that she's living in our region, especially because of all the risks we discussed, we'll plan to follow her on a yearly basis and provide support to her pediatrician and family doctor with regard to her health.

Kristen:

Okay, thanks Dr. Marjerrison! I think Nora's in the clinic room. Do you want me to go ahead and get started?

Dr. Marjerrison:

Sure, I'll meet you in there. You've got this!

Kristen:

Thanks! And, with that, we've reached the end of the podcast! Thanks for listening, folks. Don't forget to check out more podcasts at PedsCases.com. Happy learning!

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3. Canadian Cancer Society. Childhood cancer statistics. Toronto, Ontario: Canadian Cancer Society; 2019 [cited 2019 Sept 4]. Available from: https://www.cancer.ca/en/cancer-information/cancer-101/childhood-cancer-statistics/?region=on.

4. Kids Cancer Care Foundation of Alberta. Types of Childhood Cancers. Calgary, Alberta: Kids Cancer Care Foundation of Alberta; 2019 [cited 2019 Sept 4]. Available from: https://www.kidscancercare.ab.ca/childhood-cancer/all-childhood-cancers

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5. Pediatric Oncology Group of Ontario (POGO). POGO Surveillance Report. Toronto, Ontario: Pediatric Oncology Group of Ontario (POGO); 2019 [cited 2019 Sept 4]. Available from: https://www.pogo.ca/research-data/data-reports/2018-pogo-surveillance-report/

6. Meck MM, Leary M, Sills RH. Late effects in survivors of childhood cancer. Pediatrics in review. 2006 Jul 1;27(7):257.

7. Ahmad SS, Reinius MA, Hatcher HM, Ajithkumar TV. Anticancer chemotherapy in teenagers and young adults: managing long term side effects. Bmj. 2016 Sep 7;354:i4567.

8. Children's Oncology Group (COG). Long-term follow-up guidelines for survivors of childhood, adolescent, and young adult cancers. Version 5.0. http://www.survivorshipguidelines.org. 2018.

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