

Best practices for the pregnant neurosurgical resident: balancing safety and education

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Establishment of a diverse neurosurgical workforce includes increasing the recruitment of women in neurosurgery. The impact of pregnancy on the training and career trajectory of female neurosurgeons poses a barrier to recruitment and retention of women in neurosurgery. A recent Women in Neurosurgery survey evaluated female neurosurgeons' perception and experience regarding childbearing of female neurosurgeons and identified several recommendations regarding family leave policies. Additionally, pregnancy may carry higher risk in surgical fields, yet little guidance exists to aid both the pregnant resident and her training program in optimizing the safety of the training environment with specific considerations to risks inherent in neurosurgical training. This review of current literature aims to address best practices that can be adopted by pregnant neurosurgery residents and their training programs to improve the well-being of these residents while considering the impact on their education and the educational environment for their colleagues.

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WOMEN comprise over 50% of matriculating students at allopathic and osteopathic medical schools and 20.5% of current neurosurgical residents.¹⁻³ This marks an increase in female neurosurgery residents from 12.7% in 2009 and 17.6% in 2019.⁴ The Women in Neurosurgery Women and Pregnancy Task Force recently reported the results of a 28-question survey evaluating perception and experience regarding childbearing among female neurosurgeons. The survey identified numerous perceived barriers to pregnancy, as well as a preponderance of negative individual pregnancy experiences of women in neurosurgery.⁵ Not surprisingly, other surgical and nonsurgical specialties report similar concerns.⁶⁻⁹ Despite the evidence that pregnancy or consideration of pregnancy affects both residents and their training programs, the medical field has been slow to adapt.

As our specialty moves to improve diversity, including attracting women to the field of neurosurgery, and as policies supporting parental leave are written into training and board certification requirements, it becomes imperative for us to consider the additional barriers to childbearing inherent in residency training. Generic “wellness pro-

grams” are often focused on the mental and physical well-being of the neurosurgery resident in general.¹⁰ However, pregnant neurosurgery residents represent a population with specific physical and emotional stressors.¹⁰ Female physicians already demonstrate a high rate of high-risk pregnancies (26.3% vs 16.3% of the general population).¹¹ Additionally, evidence shows higher medical complication rates in pregnant surgeons, including higher rates of pregnancy loss (42%, nearly twice the rate of the general population), a higher need for assisted reproductive technology, more frequent nonelective cesarean deliveries, and increased rates of postpartum depression, which was independently associated with having had a major pregnancy complication.^{11,12}

In this review, we hope to address not only perceptions and reported barriers, but also physiological changes occurring during pregnancy that may place the pregnant neurosurgical resident at increased risk for maternal or fetal complications. We provide interventions for each of the three trimesters and the “fourth trimester” postpartum that can be carried forward by the pregnant resident, as well as best practices for residency programs, with specific

ABBREVIATIONS ABMS = American Board of Medical Specialties; ABNS = American Board of Neurological Surgery; ACGME = Accreditation Council for Graduate Medical Education; MMA = methyl methacrylate.

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consideration of situations unique to neurosurgical training. With these proposed accommodations, we consider the health and education of pregnant neurosurgery residents as well as the impact upon other trainees.

First Trimester

It is important to state that many pregnant residents prefer not to disclose they are pregnant in the first trimester, when miscarriage is still a significant risk. The need to arrange for accommodations to address the risks of the first trimester must be balanced with this desire for privacy. Thus, the subsequent recommendations are intended for the pregnant resident to consider as they decide when and whether to share information with their program.

First-trimester symptoms include predominantly fatigue and nausea, the latter potentially causing hypoglycemia and dehydration. This fatigue may be particularly disruptive in neurosurgical residency, during which long hours are common. It is important for the pregnant resident to adjust expectations of the need to rest. This may include identifying times of the day during which they are most energized to optimize productivity, taking naps during the day, or outsourcing or shifting home responsibilities to a partner or service.¹³

Nausea is common in pregnancy; nearly 70%–85% of women have nausea and up to 50% emesis. Comfort aids such as ginger, acupressure bands, or over-the-counter or prescription medications may be beneficial to treat nausea.¹³ Nausea may also require the pregnant resident to eat smaller meals or snack frequently, and drink smaller amounts, separate from eating. This frequency may be difficult for a neurosurgery resident who is scrubbed into a long surgery or attending to countless consults, particularly if they have opted to not publicize their pregnancy.

Programs should aim to create a safe environment for all residents to step away from duties when they feel ill and/or at periodic intervals, such as during a long surgical case, without undue inquiry, to create opportunity for pregnant residents to respond to their bodies without unnecessary attention or judgment. While the allowance to address bodily needs represents a basic human courtesy, public acknowledgment of these allowances and encouragement of this normalization by faculty members may decrease the specific stigmatization of nausea in women of reproductive age.

Radiation

Exposure to radiation during neurosurgical training poses a significant potential threat to residents who are pregnant or planning to become pregnant. Thus, policies that consider any childbearing-age female as potentially pregnant may improve the safety for all operating room personnel. The use of intraoperative fluoroscopy can be quite extensive in spine, endovascular, pain, and functional procedures. The United States Nuclear Regulation Commission advises that radiation to a fetus be restricted to less than 500 mrem over the course of the pregnancy, and the National Council on Radiation Protection and Measurements recommends a maximum of 50 mrem per month during gestation.^{14,15} Surgeries relying heavily

on intraoperative fluoroscopy can expose the operator to 5–50 mrem per case.¹⁵ While a cumulative radiation dose of less than 0.05 Gy (50 mSv, 5000 mrem) is thought to be safe for a fetus, the effects of higher doses (0.05–0.1 Gy) are unclear.¹⁴ The timing during gestation is critical. The fetus is most susceptible to the effects of radiation during the first trimester, particularly during the first 2 weeks of gestation, when a radiation dose of 0.05–0.1 Gy (up to 75 fluoroscopy uses) can result in miscarriage.^{14,16,17} This is especially alarming when considering that many women at this stage are unaware of or unlikely to reveal their pregnancy to others. In addition, growth restriction and congenital anomalies have been reported for exposure to a radiation dose of 0.2–0.25 Gy between 2 and 8 weeks of gestation, and an increased risk of childhood cancer has been found with an exposure of at least 0.01–0.02 Gy.¹⁶

To reduce the risk of radiation exposure to pregnant residents, efforts can be made by training programs to provide resources for all trainees. This should include detailed radiation safety training for all residents, radiation dosimetry badges with instructions on tracking radiation exposure, circumferential lead aprons with thyroid shields in good condition (standard aprons of 0.5-mm thickness attenuate 99% of radiation; 0.25-mm-thick aprons reduce exposure by 90%; thyroid shields lower exposure by a factor of 2.5).^{15,17} The National Council on Radiation Protection and Measurements also recommends reducing radiation exposure by having all members of the team stand more than 2 m (6.6 ft) away from the x-ray source during radiography for a fourfold reduction in exposure.¹⁵ Standing behind a radiation wall even with a lead apron, collimating radiographic images, taking low-dose images when possible, reducing the number of radiographs obtained, and providing maternity lead aprons (with 1-mm thickness over the area of the uterus) are all further steps that can be routinely implemented across programs. Incorporating universal precautions such as these into all training programs for all residents may also help female residents feel safer and less anxious overall regarding the issue of pregnancy. This may reduce the associated stress, fear, and perceived stigmatization that pregnant residents can experience and remove some of the burden from the resident to disseminate news of the pregnancy to colleagues prematurely.

Teratogens

Pregnant neurosurgeons are at risk of exposure to several potential teratogens, including anesthetic gases, methyl methacrylate (MMA), formaldehyde, antineoplastic agents, surgical scrub, and laser/electrosurgical plume. MMA, commonly used as cement for fixation in spine surgery and craniofacial reconstruction, has been linked to an increased risk of growth restriction, skeletal malformations, and increased fetal resorption in animal studies.^{15,18} The United States Environmental Protection Agency recommends exposure to a time-weighted average of no more than 100 ppm of MMA over an 8-hour workday.¹⁹ Pregnant surgeons should wear personal protective equipment such as gloves, face shield or goggles, and an air-purifying respirator when using these materials.

Exposure to anesthetic gases also poses a risk to preg-

nant neurosurgeons, as such agents can have an aberrant effect on the dividing cells critical to fetal development. The literature shows a direct exposure link of new anesthetic gases to genotoxicity, early pregnancy loss, and low birth weight.²⁰ However, this has not been demonstrated at doses used for general anesthesia, which is reassuring. The limit regulated by the Occupational Safety and Health Administration for nitrous oxide is a time-weighted average of 25 ppm over the period of anesthetic administration, and the limit for halogenated agents is 2 ppm averaged over a 1-hour period.¹⁹ Indeed, surgical facilities must be designed and maintained adequately to facilitate low exposures, as inadequate scavenging systems that leak anesthetic gases through breathing circuit connections or tubing can be a risk to pregnant operating room personnel.

Povidone-iodine-based surgical hand antisepsis also poses a risk to pregnant neurosurgeons. Although the long-term data on iodine exposure are limited, pregnant individuals exposed to povidone-iodine during delivery have shown a statistically significant rise in maternal urine iodine secretion and elevated thyroid-stimulating hormone levels in cord blood and breast milk, which could result in transient hypothyroidism in the exposed fetus.²¹ Alternative scrubs are recommended, including alcohol-based hand rubs and chlorhexidine-based products. These, although percutaneously absorbed, result in rapid metabolism, leading to untraceable serum levels.

Surgical smoke generated from the vaporization of tissue by electrocautery, lasers, and ultrasonic scalpel dissection can release aerosolized bacteria, viral DNA, viable cancer cells, and carcinogenic and mutagenic chemical pollutants into the surgical environment.¹¹ Moreover, 77% of these ultrafine particles can pass through standard surgical masks, deposit in the respiratory tract, and penetrate alveoli. Surgical smoke can increase the risk of preterm delivery, growth restriction, spontaneous abortion, stillbirth, and CNS/neural tube defects.¹¹ In an effort to reduce surgical smoke exposure, the Centers for Disease Control and Prevention and Occupational Safety and Health Administration recommend the use of local exhaust ventilation systems with a minimum capture velocity of 100 ft/sec and encourage the use of effective air-purifying respirators.¹⁹

Miscarriage

Miscarriage can be a devastating event, complicated when the pregnancy was not made public. While leave following miscarriage has been adopted in countries such as New Zealand and the United Kingdom, no clear US policy exists. Consideration of leave following miscarriage as bereavement or encouraging medical leave may allow the resident to grieve this loss appropriately.²²

Second Trimester

The second trimester of pregnancy is often a pregnant person's favored trimester, but it is not without complications and discomforts. Normal physiological changes and rapid growth of the uterus alter gastrointestinal, urinary, and cardiac systems and impact gait and mobility, increasing the risk of falls, sciatica, and low-back pain.

Changes to the gastrointestinal tract first noted in the second trimester include lower esophageal sphincter incontinence, reflux, low gastric pH, changes in gallbladder motility, increased constipation, and distortion of gastric anatomy due to the enlarging uterus. Gastroesophageal reflux is reported in 40%–85% of pregnancies.²³ Decreased gallbladder motility increases the formation of bile stones. Constipation, defined by the Rome criteria, occurs in almost half of all pregnancies, increasing the rate of hemorrhoidal disease when combined with prolonged standing. Frequent small meals and adequate hydration in addition to medicinal aids can mediate these physiological changes. Dilation of the ureters and the renal pelvis occurs in up to 80% of pregnant patients, creating a reservoir for infection.²⁴ The enlarging uterus displaces and flattens the bladder, decreasing capacity. Urinary frequency, urgency, and incontinence begin necessitating the need for frequent breaks.

Most cardiovascular changes reach their peak in the second trimester. Maternal systemic vascular resistance declines and cardiac output continues to rise, inducing physiological hypotension exacerbated during prolonged periods of standing. Hydration and lower-extremity compression can help to maintain venous return and decrease rates of syncope. Musculoskeletal complaints including low-back pain and sciatica can be mediated by ergonomics like positioning and comfort devices including gel mats and stools.

While physiological changes still occur in the second trimester, this trimester is notably the most favored trimester for more normal activities. In programs with limited flexibility to simply allow residents to take fewer calls without “making up” those missed calls, this may be a resident's preferred opportunity and would potentially allow for reduced workloads later in pregnancy, while lowering the risk of disruption of the call schedule in the event of preterm labor.

Third Trimester

The third trimester presents many physical challenges, given the rapid growth of the fetus and maternal musculoskeletal changes. These include increased weight gain, pronounced lordosis often causing low-back pain, edema causing numbness or weakness from nerve compression, and difficulty sleeping.^{13,25} Pregnancy belts that support the low back, regular exercise, and frequent breaks with stretching when feasible mediate back pain.²⁶ Compression stockings may decrease lower-extremity edema and improve cardiac return, potentially improving stamina during a long surgical case and reducing varicose vein development.

Preterm contractions may complicate a pregnant surgeon's third trimester, exacerbated by dehydration. Persistent contractions prior to 37 weeks require an evaluation to rule out preterm labor. While some studies have shown higher preterm labor and delivery rates in orthopedic surgeons working more than 60 hours per week, other studies have demonstrated no difference in preterm spontaneous labor among physicians in procedural versus nonprocedural specialties.^{27,28} Additionally, another survey dem-

onstrated a preterm labor rate of approximately 6.2%.²⁹ Given these limited data, it may not be necessary for surgeons and trainees to decrease surgical load if they feel physically able to continue their prepregnancy workload. It may be prudent to have a backup schedule in place starting at 36 weeks in the event the surgeon delivers before the estimated due date.

As many as 34% of pregnant patients experience carpal tunnel symptoms from increasing edema, often becoming worse after 32 weeks.²⁶ These symptoms can be particularly troublesome for the pregnant surgeon who may not wish to decrease her surgical volume, especially when case volume is linked to training advancement. Switching to larger gloves may reduce compression of the median nerve. Frequent stretching and wrist exercises may improve symptoms, along with wrist splints, heating pads, and limiting repetitive movements, when possible.

Hypertensive diseases of pregnancy impact 2%–8% of pregnancies and are typically diagnosed in the third trimester.³⁰ It is crucial to have routine prenatal visits during the end of pregnancy, generally, in a low-risk pregnancy, every 2 weeks after 28 weeks' gestation, and then weekly for the last month. The increased frequency in prenatal visits helps to identify worsening blood pressures before additional sequelae develop. Signs and symptoms of preeclampsia with severe features include headache, scotoma, and right upper-quadrant pain and should be discussed with a physician immediately if symptoms do not improve with normal treatments such as hydration and acetaminophen.

Postpartum (the fourth trimester)

Among neurosurgeons delivering their first child during training or in practice, the Women in Neurosurgery survey demonstrated that 42.6% only took 4–8 weeks of leave, while 25.9% took 8–12 weeks.⁵ Challenges to implementing family leave policies was noted as a particular barrier to childbirth by female neurosurgeons both planning and not planning to have children.⁵ Some concerns regarding the impact of parental leave on board eligibility have been mitigated by policies adopted by the American Board of Neurological Surgery (ABNS). In 2021, the American Board of Medical Specialties (ABMS) adopted a mandatory allowable 6-week parental, caregiver, or medical leave for all training programs of 2 or more years' duration without exhausting other time away or extending the duration of training.³¹ The ABNS has a similar policy permitting flexibility in training requirements to allow trainees to take time for family or medical reasons, provided that the trainee still meets a minimum of 54 months of core training.³² This ABNS allowance requires attestation from the program director that the resident was able to meet the educational goals of the program within the 84-month requirement, often accounted for by a reduction in their 30-month elective time.³² This is consistent with the general move toward consideration of competency-based education, allowing graduates who have not met the time-based requirements to matriculate with demonstration of necessary competencies. While having a child during a research or elective year may be the least disruptive

to education, many factors impact a resident's decision and timing around pregnancy.

Flexibility at the individual program level can allow a resident to take maximum allowable leave while still meeting the 54-month requirement. This could include restructuring the resident's rotation schedule to make up missed clinical time during their research time. Residency programs differ in the rotation schedules during junior and senior residency, so the flexibility to alter rotations may also depend on the time during training in which a resident has children. That notwithstanding, the creation of department-specific leave policies should account for the rotation schedule, allocated research time, specific duties of junior versus senior residents, and program structure, to allow for the least amount of disruption to all trainees. In addition, planning with regard for not only the pregnant resident but also their colleagues sets a precedent that everyone's educational experience is being considered in these situations, potentially reducing conflict among trainees. This may include strategies such as hiring additional personnel (e.g., advanced practice providers) or allowing moonlighting, to not overburden the other residents beyond allowable call schedules.

The financial effects of taking unpaid time off, added to the financial burden of having a child, including childcare, poses another barrier. Parallel to the ABMS changes, as well as the movement toward more progressive, flexible, and supportive parental leave policies for residents, the Accreditation Council for Graduate Medical Education (ACGME) adopted changes to their Institutional Requirements. These include requirements for a sponsoring institution to incorporate policy for leaves of absence, including a minimum of 6 weeks of medical leave with the equivalent of 100% of their salary for the first 6 weeks, a minimum of 1 week of additional paid time, and the continuity of full health and disability benefits for residents/fellows and their eligible dependents.³³ While this unfunded mandate will initially place some stress on sponsoring institutions, the requirement for full salary support during 6 weeks of parental leave will have a beneficial impact on residents who otherwise may have had financial impediments to taking parental leave. Additionally, many short-term disability plans allow for a portion of salary to be paid for longer leave periods, so programs should ensure resident awareness of these opportunities. It is critical to understand that maternity leave is a significant time of bonding between parent and child that is filled with care obligations and sleep disruptions. Extension of family leave beyond the initial ACGME/ABMS mandatory leave allowance should take this into consideration and should not be contingent upon required productivity, such as other scholarly activity, which may not be realistic.

Finally, it is crucial to destigmatize parental leave as solely serving childbearing residents. Although paternity leave is not as prevalent, research demonstrates that paternity leave is vital to father-child bonding, and lack of adequate paternal leave policies may further perpetuate existing inequalities.^{34,35} Programs should aim to have a standard parental leave policy and encourage its use equally among all residents as needed. Such a policy can and should also consider specific needs for residents who had

TABLE 1. Recommendations to mitigate risk in pregnancy by trimester

Resident	Residency Program
First trimester	
<ul style="list-style-type: none"> • Ensure appropriate rest—outsource home responsibilities • Identify the most energized times of the day to maximize efficiency • Comfort aids may assist with nausea (ginger teas, ginger chews, acupressure bands) • Increase frequency of smaller meals or snacks and hydration • Add pregnancy lead apron to procedures with radiation exposure • Avoid povidone-iodine–based surgical scrub agents 	<ul style="list-style-type: none"> • Create an environment that prioritizes all resident well-being—allow attention to bodily requirements • Provide appropriate radiation safety equipment, e.g., badges, circumferential lead aprons, thyroid shields, radiation walls • Allow pregnant residents to recuse themselves from cases with MMA • Provide alternatives to povidone-iodine scrub • Ensure adequate ventilation for surgical smoke • Consider bereavement leave policies following miscarriage
Second trimester	
<ul style="list-style-type: none"> • Eat frequent small meals and stay hydrated • Take frequent breaks in long cases to prevent urinary tract infections • Wear compression stockings 	<ul style="list-style-type: none"> • The second trimester may be the optimal time for night shifts or call shifts rather than the first trimester (with nausea) or third trimester, in which discomfort can be severe • Provide appropriate mat cushioning in the operating room and stools for resident comfort while operating
Third trimester	
<ul style="list-style-type: none"> • Pregnancy belts for low-back support help with back pain • Compression stockings may help with leg edema and varicose vein prevention • Increase glove size as necessary to reduce carpal tunnel syndrome • Wrist splints when not scrubbed may reduce carpal tunnel syndrome • Be aware of signs of preeclampsia 	<ul style="list-style-type: none"> • Departments should have plans in place to limit strenuous rotations or night float; early provision of cross-coverage or a backup schedule will reduce the burden in the case of preterm labor • Consider options to reduce workload toward the end of pregnancy to reduce the potential impact on the schedule
Postpartum (fourth trimester)	
<ul style="list-style-type: none"> • Know the leave policies of your institution • Remember the importance of parental leave for bonding and expect sleep disruptions; do not plan for significant productivity during this time • Plan ahead for lactation needs; know locations available for pumping and milk storage 	<ul style="list-style-type: none"> • Create and disseminate parental leave policies and educate residents on these policies • Ensure appropriate cross-coverage is available during parental leave, including the potential need for hiring additional staff such as advanced practice providers • Ensure the availability of appropriate and sanitary lactation rooms (bathrooms and other areas where food preparation should not occur are not appropriate lactation accommodations)

preterm births who may have obligations both during perinatal inpatient admission of their child and after homegoing. Improving the understanding that these opportunities are available to residents whose spouses have had children may decrease the largely unilateral stigma associated with maternity leave and improve equity within the program. Additional programmatic interventions may include consideration of compensation or future schedule accommodation for those residents who may have increased clinical or call responsibilities resulting from a coresident's leave of absence. While childcare following a resident's return to work has been identified in surveys as a significant barrier, a thorough review of childcare policies at both an institutional and societal level is beyond the scope of this paper and warrants larger societal considerations.

Breastfeeding

Many surgical specialties have noted that a lack of formal lactation policies creates practical challenges for residents in the postpartum period.^{5–7,9} As previously noted in the discussion of first-trimester interventions, the creation of policies that allow residents to attend to their health and

wellness should include policies supportive of lactation and milk expression at intervals appropriate to maintain milk supply for mothers who are breastfeeding. This includes appropriate and clean lactation rooms as well as a location for milk storage.

A summary of interventions is noted in Table 1.

Discussion

As the number of women applying to medical school and matriculating into neurosurgery has increased, it is paramount that we continue to evolve our specialty to adapt to this growing diversity. Worldwide, women neurosurgeons report worse career fulfillment and are less likely than their male colleagues to be married or have children.³⁶ The last point is likely multifactorial, stemming from a combination of the long duration of training, higher risk of pregnancy complications in older mothers, and increasing infertility with advancing age as many women may have chosen to defer pregnancy during training.^{37,38} Unbalanced attrition in neurosurgical residency programs as described by Agarwal et al. remains a concern, with women having higher attrition rates (18.5% compared with 10.35%

TABLE 2. Requirements and policies pertaining to parental leave

American Board of Medical Specialties
<ul style="list-style-type: none"> • Member boards must clearly state the training requirements for board eligibility. • Member boards must incorporate time away for parental, caregiver, and medical leave in addition to vacation. • Member board requirements must allow for a minimum of 6 weeks of time away from training at least once during training for parental, caregiver, or medical leave without exhausting all other time away or extending training. • Member boards must allow all new parents (birthing, nonbirthing, adoptive, foster, and surrogate) to take parental leave. • Member boards may establish guidelines to determine how requirements for graduation will be met while accommodating leave. • Member boards may limit the amount of time a candidate may take in any given year. • Member boards must make testing accommodations for candidates who extend training.
American Board of Neurological Surgery
<ul style="list-style-type: none"> • Programs must follow the human resource policies of their institution regarding parental leave. • The program director is responsible for ensuring that residents who receive <84 total months of training have received the full range of neurosurgical education. • The resident must complete a minimum of 54 months of core neurosurgical training. • Any resident completing <84 months of training must have a letter submitted to the ABNS from their program director indicating the approval of leave and that the resident received full training.
Accreditation Council for Graduate Medical Education Institutional Requirements*
<ul style="list-style-type: none"> • Sponsoring institutions must provide residents with a minimum of 6 weeks of approved medical, parental, and caregiver leave at least once and at any time during an ACGME-accredited program. • Sponsoring institutions must provide residents with 100% of their salary during the first 6 weeks of this leave. • Sponsoring institutions must provide residents with 1 week of paid time off reserved for use outside of the 6 weeks of approved leave. • Sponsoring institutions must ensure the continuation of health and disability benefits for residents and their eligible dependents during any approved leave of absence. • Sponsoring institutions must ensure that residency programs provide information to the resident on the impact to their board eligibility of any leave of absence.
Family and Medical Leave Act
<ul style="list-style-type: none"> • Eligible employees of covered employers are entitled to 12 workweeks of leave in a 12-month period for the birth of a child, care of a newborn child, or adoption of a child. • This is unpaid, job-protected leave with continuation of group health insurance.

* Committee on Advanced Specialty Training (CAST) programs have specific requirements for their programs and are not governed by ACGME requirements.

of men) and being more likely than men to switch specialties (only 18.19% of women who left transferred to another program compared with 42.35% of men).³⁹ In addition to higher residency attrition rates, women are at higher risk than their male counterparts of not becoming board certified.⁴⁰

Numerous policies at the professional level have been put into place (Table 2), demonstrating an increasing awareness of the need for resident physicians to maintain personal well-being during training. With an increasing focus on physician and resident wellness, it is imperative for us as a specialty to evaluate those factors that disproportionately impact childbearing residents, causing professional dissatisfaction, including the perceived stigma of pregnancy, lack of formal institutional maternity leave policies, lack of mentorship on integration of career and motherhood, and having to change fellowship plans.⁸ We can use these results from other surgical specialties to encourage improved policies for childbearing residents in neurosurgery. In fact, negative perceptions regarding pregnancy during training are not unique to neurosurgery and exist worldwide among both residents and residency program directors.^{41–43} Barriers to addressing these concerns fall into several categories: stigma associated with pregnancy and the impact on colleagues, lack of policy and

financial support regarding parental leave, and postpartum challenges including lactation and childcare needs.

One noted concern in multiple other specialty surveys was the impact of parental leave on on-time completion of residency, particularly for those residents interested in pursuing fellowship training where delayed graduation may affect their matriculation into a fellowship program.^{6,7} Specific to meeting educational requirements and graduating on time, the ABMS allowance of 6 weeks of parental leave is regardless of the duration of training, so this one-size-fits-all policy is equally applied to both 3-year and 7-year residencies.³¹ Fortunately, ABNS requirements for board eligibility include 30 months of elective time, which allows additional flexibility for those residents who may have more than one child during their training.³² Wide early-residency dissemination of these requirements, as well as the adoption of best practice guidelines for parental leave, may allow residents to be better informed so that they can plan their family in a manner that is least disruptive to their education and board eligibility.

While we intended to primarily address accommodations for childbearing residents who pursue pregnancy during training, medical leave policies should additionally accommodate other pregnancy-related needs, including the consideration of egg preservation and fertility treat-

ments. Comprehensive policies should also consider partner presence at prenatal appointments for neurosurgical residents whose partners are expecting.

Conclusions

Pregnancy remains a singular issue that differentiates our childbearing colleagues from their counterparts, with far-reaching impacts ranging from increased medical risks to decreased career satisfaction, higher attrition rates, and negative impact on career advancement. Surveys in numerous specialties all have similar overarching themes. With an understanding that pregnant surgeons are at higher risk of medical complications of pregnancy, our response as physicians should be to investigate means through which we can reduce these risks.¹² Additionally, as many residents perceive a stigma associated with requesting accommodations during pregnancy, we must not place responsibility solely on the pregnant resident, but rather aim to create a more supportive and inclusive environment that prioritizes the health, well-being, and education of all residents.⁵⁻⁸ Collaborative efforts among neurosurgery programs, potentially at the national organization level, should share best practices in policy development, which may help to unify efforts across our specialty, including the evaluation of policies in the global neurosurgical community that may vary from domestic policies.

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Author Contributions

Conception and design: Tomei, Hodges, Sweet. Drafting the article: all authors. Critically revising the article: all authors. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Tomei. Administrative/technical/material support: Tomei.

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