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Restraint and Critical Incident Reduction Following Introduction of the Neurosequential Model of Therapeutics (NMT)

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ABSTRACT

Children with developmental trauma are at risk for severe and complex behavioral problems, often requiring long-term residential and day treatment. The Neurosequential Model of Therapeutics (NMT) is a developmentally sensitive approach to clinical work with a capacity-building component focusing on attachment, the impact of maltreatment and trauma, and emerging concepts in developmental psychology, neuroscience and traumatology. Research has demonstrated its effectiveness with trauma-exposed populations. NMT training may help providers working with trauma-exposed youth prevent critical incidents and reduce restraints. Restraint and critical incident data were obtained from 10 organizations providing residential and/or day-treatment services following exposure to, or certification in, the NMT. Data from the Pre-NMT Introduction period through to the Maintenance phase of NMT Certification were used to examine changes in restraints and critical incidents across phases of NMT exposure/certification. Multilevel logistic regression models suggested that NMT exposure and/or certification was associated with significant reductions in restraints and critical incidents. Reductions were sustained throughout the Maintenance phase. Estimates of potential staff hour and financial savings associated with these reductions are discussed. Implementation of the NMT in residential and day-treatment settings may result in staff, behavioral health provider, and organization-level changes that reduce critical incidents and restraint use.

KEYWORDS

child trauma; intervention; restraint; Neurosequential Model of Therapeutics; maltreatment

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Children and adolescents with histories of exposure to developmental adversity and traumatic events are at risk for a variety of emotional, social, cognitive, and behavioral health problems (Perry, 2006). The oftentimes explosive, aggressive, and "out of control" behaviors they can exhibit put them at risk of placement in day treatment, residential treatment, and inpatient psychiatric settings (Ford, Fraleigh, & Connor, 2010; Keeshin et al., 2014). Within these settings, their explosive behaviors can be particularly destructive as they undermine milieu and create a sense of un-ease and threat that impairs the learning, therapeutic and working environments (LeBel, Huckshorn, & Caldwell, 2010). The child's capacity to learn as well as child and staff safety can be threatened due to these behaviors, which are often labeled "critical incidents." Restraints and other types of holds are used when client or staff safety is perceived to be at risk. The threshold for restraint is lowered when staff becomes overwhelmed or frightened by client behaviors. Yet, restraints are unsafe and costly. Thus, restraint and critical incident reduction has been a focus of practice for the Substance Abuse and Mental Health Services Administration (SAMHSA) since 2005 (Curie, 2005; SAMHSA, 2011).

Restraints and critical incidents are a significant problem in child and adolescent inpatient (De Hert, Dirix, Demunter, & Correll, 2011), residential, and day-treatment facilities (LeBel et al., 2010; Pollastri, Lieberman, Boldt, & Ablon, 2016) and are becoming a concern in schools (LeBel, Nunno, Mohr, & O'Halloran, 2012). Researchers have identified reasons why restraints and critical incidents are common in these settings, and point to child and adolescent characteristics, as well as facility practices (Green-Hennessy & Hennessy, 2015; Zimmerman & West, 1997; dosReis et al., 2010; Keeshin et al., 2014). Many organizations use behaviorally motivated "point-and-level" systems that can be provocative and punitive––thus inadvertently increasing children's high-risk behaviors (Mohr, Martin, Olson, Pimariega, & Branca, 2009).

In response to these concerns, significant efforts have been made to reduce restraints and critical incidents (National Technical Assistance Center, 2006). Reviews of restraint and seclusion reduction strategies (LeBel et al., 2010; Scalan, 2010) have concluded that strong leadership coupled with staff training and preventive interventions results in the most promising outcomes. Some restraint interventions have been based in clinical theory specific to restraint reduction (VanLoan, Gage, & Cullen, 2015; Rich, 2008) while other interventions, like collaborative problem solving (CPS), achieve restraint reduction without directly focusing on it (Pollastri et al., 2016; Holmes, Stokes, & Gathright, 2014; Martin, Krieg, Esposito, Stubbe, & Cardona, 2008). Martin et al. (2008) and Pollastri et al. (2016) hypothesized that the implementation of CPS resulted in restraint reduction due to the intervention's focus on prevention of behavior problems and aggression, as

well as alternatives to traditional behavior-then-consequence behavior management strategies. Thus, the integration of novel clinical approaches that address core deficits in the clinical population and provide staff with new ways of thinking about and responding to patient behaviors may have a simultaneous impact on restraints and other critical incidents.

Practitioners concerned with the impact of trauma on the developing child have begun focusing on how to improve therapeutic programming and child outcomes by becoming more trauma-informed. Many "trauma-informed" and relationally based approaches, such as CPS, focus on addressing the core deficits of youth and providing staff with new ways of understanding and responding to dysregulated youth. Because childhood adversities are associated with almost 50% of childhood-onset mental disorders (Green et al., 2010), and perhaps even higher numbers of severe disorders requiring long-term residential or day-treatment intervention, the utility of trauma-focused programs in behavioral health residential settings is being increasingly explored.

Holmes et al. (2014) evaluated the use of CPS with traumatized youth in a hospital setting, noting that staff interactions with children improved when staff, including nursing and support staff, began "viewing the child's behavior through the lens of lagging skills" (p. 60). Trauma-informed approaches that focus on reducing the use of strategies that are potentially re-traumatizing for youth (holds, seclusions, restraints) and increasing "responsive and non-coercive" staff practices (Bryson, Gauvin, Jamieson, Rathgeber, Faulkner-Gibson, Bell, Davidson, Russel & Burke, 2017) have also been successful in reducing restraint use in many residential treatment programs (Farragher, 2002; Greenwald et al., 2012; LeBel et al., 2010), though not in all (Boel-Studt, 2017). Institutional trauma-focused programs, such as the Sanctuary (Bloom, 2017), TARGET (Ford, 2015), or Trauma Systems Therapy (Brown, McCauley, Navalta, & Saxe, 2013) models, rely heavily on staff training and providing staff with better ways of responding to youth risk behaviors, such as focusing on child regulation and identification and prevention of behavioral triggers. The success of these programs offers support to the notion that restraint and critical incident rates may be lowered by helping staff understand developmental trauma and teaching them new ways to engage and interact with children with histories of developmental trauma.

The Neurosequential Model of Therapeutics (NMT), designated an "emerging practice" by the National Quality Improvement Center for Adoption & Guardian Support and Preservation (QIC-AG.org), is a developmentally sensitive approach to clinical work with a significant capacity-building component focusing on attachment, the impact of abuse, neglect and trauma, and emerging concepts in developmental psychology, neuroscience and traumatology. A certification process has been developed for individual clinicians and organizations/sites to learn and implement this approach (see Method).

NMT Certification systematically teaches the three major components of this approach: (1) capacity building and mastery of core concepts; (2) an assessment process to determine (a) the timing and nature of developmental adversities and resilience-related factors, (b) current functioning in multiple domains (e.g., sensory integration, self-regulation, relational, cognitive), and (c) current relational milieu (i.e., connection to family, community, culture); and 3) the selection and sequencing of specific educational, therapeutic and enrichment interventions. NMT Certification supports providers in thinking critically about which therapies (including discreet evidence-based treatments like Parent–Child Interaction Therapy, Child Parent Psychotherapy and Trauma-Focused Cognitive Behavioral Therapy) may be most effective at which point during treatment, thereby improving outcomes and perhaps reducing the length and acuity of clinical services (Brandt, Diel, Feder, Lillas, 2012).

The core concepts that underlie this clinical approach were outlined in Perry, Pollard, Blakely, William, and Vigilante (1995), and have evolved with clinical experience and ongoing research in neuroscience, developmental neurobiology, and traumatology (Perry, 2001, 2009: Perry & Dobson, 2013; Perry, Hambrick, & Perry, 2016). Extensive clinical experience (2000 + clinicians in more than 100 child welfare, mental health, and early childhood programs in more than 20 countries, serving over 250,000 clients) and emerging research suggest that the NMT can be effective in clinical settings. In outpatient settings, NMT-guided intervention has been associated with improvements on the Battelle Developmental Inventory in young children with fetal alcohol spectrum disorders and histories of maltreatment (Zarneger, Hambrick, Perry, Azen, & Peterson, 2016). A preadolescent residential and day-treatment program serving a population with histories of developmental trauma and severe psychiatric comorbidities (major depression, bipolar) found significant reductions in the total score of the Child and Adolescent Functional Assessment Scale when delivering NMT-guided intervention (Wang, Wilkes, Perry, & McMaster, 2015). Similarly, in a large residential treatment center for predominately trauma-exposed youth, larger drops in CAFAS scores were demonstrated following NMT Certification than prior to NMT use (Grove, 2012). NMT-guided intervention has also been associated with improvements in children's social and emotional skills in the context of a therapeutic preschool (Barfield, Dobson, Gaskill, & Perry, 2014), and with improvements in emotion regulation in a sample of trauma-exposed children receiving NMT-guided sensorimotor intervention (Hansen & Lusk, 2012). Finally, young children exposed to domestic violence demonstrated superior improvement in NMT-informed groups in comparison to psychoeducational play therapy groups (Clark & Palinkas, 2014).

A core element of the capacity-building component of the NMT is to help clinicians and staff better understand the emotional, social, and behavioral

"sensitivity" that is common in developmental trauma. Understanding how the resulting reactivity and dysregulation can lead to a host of symptoms and problems begins (in the language of the "trauma-informed" movement) to shift the adult's understanding from "what is wrong with you" to "what happened to you." This shift in understanding helps avoid co-dysregulating interactions between the adult and child, and often leads to better opportunities for using regulatory strategies that can avoid escalation. It has been written that "Success [in reducing restraints] begins with a change in culture, from one of power to one of empowerment, from coercion to caring, and from hopelessness to hope," (p. 1139, Curie, 2005). Thus, it was expected that the introduction of the NMT could reduce critical incidents and restraints in residential and day-treatment settings where the primary population was children and youth with histories of developmental trauma exhibiting significant symptoms of sensitization and dysregulation.

Method

Participants

Ten organizations from three countries (United States, Canada, and Scotland) provided data on restraints and, when available (six sites), critical incidents in their residential and day-treatment programs prior to and following the introduction to and/or certification in the NMT. These 10 sites independently reported improved restraint and/or critical incident outcomes directly to the CTA at in-person meetings (e.g., Kibble) or in reports to funders (e.g., Hull Services, SaintA's). All 10 sites agreed to share their de-identified quality improvement program data with CTA. Institutional Board Review (IRB) was sought at the corresponding author's institution, and the project was classified as Not Human Subjects Research.

Each of the 10 organizations varied in their specific program elements and clinical mission, and had a somewhat different method for recording and defining "restraint" and "critical incident." Four sites had significant changes in their definition and tracking of critical incidents over the time periods of NMT implementation, so analysis was deferred. However, the outcomes presented from each site were from their residential and/or day-treatment psychiatric facilities, which treated children and youth with significant behavioral/emotional problems. The vast majority of these children and youth had well-documented histories of developmental trauma and attachment disruptions. The range of specific problems was considerable and included hypervigilance, sleep problems, profound impulsivity, dissociation, aggression, delinquency (including property destruction and harm to animals), relational and social skill issues, sexual acting out, attachment issues, and threats of self- or other-harm. Developmental delays in multiple domains (social, cognitive, and emotional) were common. Specific psychiatric diagnoses included ADHD, PTSD, anxiety disorders, depression,

substance abuse issues, Fetal Alcohol Spectrum Disorder, Oppositional Defiant Disorder, Conduct Disorder, Bipolar Disorder, psychotic disorder NOS (R/O schizophrenia), and Autism Spectrum Disorder. Average staff-to-child ratios across sites ranged from 1:3 to 1:8, with higher ratios representing day-treatment settings. Detailed program descriptions and definitions of how each site defined restraints and critical incidents can be obtained from the corresponding author. We provide one detailed site description here to help "bring to life" the typical site and client population:

Hull services, Calgary, Alberta

The Preadolescent Treatment Program (PTP) is a residential program that provides treatment to children between the ages of 5 to 13. The typical average daily census during the 72 months of this report was 12, with a typical 1:3 female/male ratio. The average placement duration is 12–15 months. Clients have generally had multiple placements in kinship, foster care, or group care prior to their admission to PTP, and are involved with Child and Family Services (most commonly Temporary Guardianship or Permanent Guardianship Orders). The program supports children with extreme maladaptive behaviors including aggression, property destruction, peer issues, sexual acting out, poor social skills, attachment issues, threats of self-harm and, in general, unsafe behaviors. These behaviors are frequently symptoms resulting from developmental trauma, which could include a chaotic, unpredictable environment, or exposure to physical abuse and/or neglect (95% of the clients have histories with documented trauma and adversity). The staff to child ratio is 1:4 in the mornings (during school) and 1:3 in the afternoons and evenings. *Hull Services Definition of Physical Restraints*: "Restricting the movement of a person served by physically holding them in a fixed position or while moving them from one location to another."

NMT Certification process

NMT Certification is a manualized multistage process that includes multimedia and print content, case-based webinars focusing on clinical consultation and implementation, and various web-based interactive learning forum to teach clinicians both the core concepts and how to use the NMT Clinical Practice Tools, a set of web-based metrics to help in assessment and treatment planning. This process is intentionally flexible in its timing and process (but not in required content or certification requirements) to meet the varying needs and resources of the program or organization. In the present report, due to this flexibility, each site had a somewhat different pattern and duration of NMT exposure. Despite differences in the length of time each site spent in each phase, the core content and key principles of the NMT were

consistent throughout the duration of this report. Indeed, fidelity to the training elements (e.g., completion of reading/webinar assignments, completion of necessary number of assessment reports) is monitored and sites and individuals are not certified unless components are complete. Fidelity is also evaluated by a bi-annual Fidelity exercise in which all NMT Clinical Practice tool users must evaluate and score a common "case" example. These scores then result in a clinician being rated "high" "acceptable" or "low" fidelity, and provide feedback for continued improvement.

The standard process of exposure to and certification in the NMT can be divided into five time periods. Minimal or no direct exposure to the core concepts of the NMT is considered "baseline" (Pre-NMT). Once a senior clinical leader or program staff is exposed to the NMT by either direct, in-person training, multimedia exposure using CTA's materials or participation in any of the NMT Case-based webinar series, the next phase, Introduction to NMT, begins (Intro NMT). It is during this phase that an organization will learn more about the benefits and limitations of the NMT approach and review the potential value of formal NMT Certification for their organization and clients. In some cases, an organization will learn how the NMT is being implemented by colleagues or other sites and make the choice to become certified without spending time in the Intro-NMT phase. The third phase is the actual beginning of formal NMT Certification. Phase I (Cert 1) is a 150-hr long manualized curriculum which most organizations complete over a 12 to 14-month period. After Phase I certification, organizations may select a group of senior clinicians to become internal NMT Trainers; at this point the site enters Phase II (Cert 2). This phase is also approximately 150 hours and Trainers typically take another 12 to 14 months to complete. At this point, the organization enters Maintenance (Maint), the fifth phase. Each site completes a "sustainability" plan which outlines their internal processes for ongoing support and training in the NMT. The site's internal NMT Trainers will continue to build capacity within the organization and, in some cases, facilitate a Phase I certification process for new or previously non-certified clinicians within their organization. Throughout the NMT Certification process a major emphasis is on "capacity building" for clinical and frontline staff; key areas covered include basics of neurodevelopment, impact of abuse and neglect on the developing child, attachment and bonding, basics of self-regulation, several regulatory strategies and practices, secondary trauma, self-care and interpersonal communication skills (more detailed descriptions of the NMT Certification modules can be obtained from the corresponding author).

In the present report, some sites had a long Intro-NMT phase, while others went immediately from baseline (Pre-NMT) to the third phase, Phase I of the NMT Certification process (Cert 1). Eight of the participating sites formally enrolled in and completed the entire NMT Site Certification process; the other two were exposed to the NMT by either individual NMT Certification of key clinical leaders (Warwick) or through an intensive on-site exposure (4 days of

onsite training to all clinical staff) to the NMT concepts (Kibble) but had not yet enrolled in NMT Certification.

Data analysis

All sites provided restraint data corresponding to each of the NMT implementation phases that they engaged in. Two sites had not proceeded to formal certification following the Intro-NMT phase (Teambuilders moved locations but ultimately became NMT certified; Kibble elected to become NMT certified after this report was prepared). Two other sites did not have an Intro-NMT phase; their first exposure to NMT principles began with formal certification. Six sites provided critical incident data corresponding to each of the NMT implementation phases that they engaged in. Data sent from each site were expressed in different ways, ranging from number of restraints or critical incidents per time period (week or month) to restraint or critical incident rate (incident/time period/client), due to differences in tracking restraints and critical incidents across sites. The raw data provided from each site were used to evaluate the number of restraints per implantation phase, and average census data were used to estimate the number of bed days in each phase. The dependent variable was therefore expressed as the number of restraints or critical incidents for the number of bed days in each phase by site.

We estimated the effects of implementing NMT in two multilevel logistic regression models. We fit one model of restraints (10 sites) and one model of critical incidents (6 sites), and in both cases we estimated random effects for site and implementation phase. Regarding the estimates for implementation phases, these models permitted comparison of quantities of interest in the form of comparing effects from their marginal posterior distributions and comparing predicted values for each site. For the former, we estimated contrasts as the difference between the Pre-NMT phase deflection (i.e., the deviation from the global intercept) and that of each subsequent phase for each of the 8,000 draws (2,000 samples from each of four chains) from the posterior (Kruschke, 2011). For the latter, given the fitted model, we predicted the number of events expected to occur in 10,000 bed days for each site, again permitting direct comparison across phases while also providing information about variation in the baseline expectation across sites. The models were estimated using the RStanArm library in R (Stan Development Team, 2017), which interfaces to the Stan modeling language (Carpenter et al., 2017). Our models used the default priors for intercepts and covariance matrices.

Estimated cost savings were calculated using estimates from Lebel and Goldstein (2005) and reported by SAMSHA (2011). This estimate suggests that the average restraint in an inpatient facility costs approximately $350

due to requiring approximately 12 person hours (Lebel & Goldstein, 2005; The Business Case for Preventing and Reducing Restraint and Seclusion Use, 2011). While this cost estimate pertains to inpatient facilities, which may have higher staff/youth ratio requirements and overhead costs, this $350/restraint estimate does not account for costs that may co-occur with restraints no matter the setting, such as staff turnover or lost staff time due to injuries sustained during restraints (Henderson, Siddons, Wasser, Gunn, & Spisszak, 2005). Given the potential for both over and underestimation, and the low staff-to-client ratios in the current sample, the Lebel and Goldstein (2005) estimate was determined to be the best heuristic for estimating cost benefits related to restraint reduction. This estimate has also been used for descriptive purposes in other studies evaluating potential cost benefits of restraint reduction in residential settings (e.g., Pollastri et al., 2016). For calculating cost, the absolute number of restraints per NMT Certification phase at each site was either provided or calculated based upon the restraint rates provided by the sites and the census at the site during the various NMT phases.

Results

Table 1 summarizes the time each site spent in each NMT Certification phase (the number of months each site was involved in NMT Certification ranged from 5 to 84), average patient census per site (ranging from 6 to 265), average patient length of stay (ranging from 4 to 26 months), and number of clients served by each site (ranging from 24 to 784) during their NMT Certification process. Two sites fast-tracked the certification process by skipping the Intro-NMT phase and going straight to NMT Phase 1. This was allowed because those sites were certain that they wanted to receive NMT Certification even

Table 1. Time spent in NMT Certification phases and average census data.

Site	Site name	Pre-NMT	Intro NMT	NMT Phase I	NMT Phase II	Maint	Total months	Avg census	Avg length stay	Total clients
		(M)	(M)	(M)	(M)	(M)	(M)		(M)	
1	NFI	48	24	24	24	36	156	6	10	79
2	TVN	12	5	15	11	7	50	16	4	229
3	Canyon Oaks	29	8	13	18	16	84	21	14	126
4	Cal Farley's	25		11	12	29	77	265	26	784
5	Saint A's	32	19	13	20	24	108	40	7	617
6	Hull	11	9	12	12	18	62	12	14	62
7	AYN	30	17	19	18	36	120	58	10	696
8	Teambuilders	12		5			17	8	8	24
9	Warwick	4	6				10	28	6	47
10	Kibble	12	12				24	40	12	80
Combined							71	49	11	2744

Note. NMT = Neurosequential Model of Therapeutics. M = Months. NFI = Northeastern Family Institute. TVN = The Village Network. AYN = Alexander Youth Network.

though none of the staff had any prior NMT exposure. Two other sites were introduced to the NMT through their clinical leaders' involvement in NMT Certification (the NMT has both individual clinician and site certification processes), but the organizations did not engage in the formal site certification process. One site completed NMT Phase I but was unable to remain open due to funding cuts (they later moved and were certified). Data were collected from 2009 to 2015.

Estimated reductions in restraints and critical incidents

The multilevel logistic models suggested significant reductions in restraints and critical incidents as a function of NMT implementation. Notable improvements from the Pre-NMT baseline were evident at the Intro-NMT phase in both models, and the estimates for all subsequent phases remained significantly below that of the Pre-NMT phase.

For each implementation phase after Pre-NMT, we compared the estimate in that phase to the Pre-NMT estimate for each sample drawn from the posterior. In the multilevel model setting, the random effects estimates are represented as deflections from the global intercept on the log-odds scale. In Figure 1, we plot the distribution of these differences for the restraints model. A vertical dotted line at zero is marked to indicate where the distribution might overlap significantly if there were no effect associated with the implementation phase. The mean of the distribution of differences between Intro NMT and Pre-NMT (top panel) is −0.420, implying that the odds of a restraint in Intro NMT are approximately 0.657 those of a restraint Pre-NMT. The distribution of differences at NMT Phase I is centered roughly at −0.923, corresponding to an odds ratio of 0.397. The estimates suggest a slight regression in restraints during NMT Phase II and Maintenance, but the estimates are still below the Pre-NMT phase.

To communicate the implications of the models more concretely, we used the posterior samples to make predictions about the number of restraints to expect per 10,000 bed days under counterfactual situations corresponding to each site and phase combination. The distributions of the predicted restraints are provided in Figure 2. Two features of these distributions are apparent. First, the pattern across implementation phases for each site is consistent with expectations in light of Figure 1. Second, there are notable differences in the baseline expectations for restraints across sites. For example, the restraint rates at Warwick were greater than those of Hull, and this translated into a greater number of expected restraints per 10,000 bed days at Warwick.

We repeated the above procedure for the model of critical incidents and observed a similar pattern of estimated reductions resulting from NMT implementation. In Figure 3, the estimates for each implementation phase are compared to the Pre-NMT phase. Again, there is a modest estimated reduction in

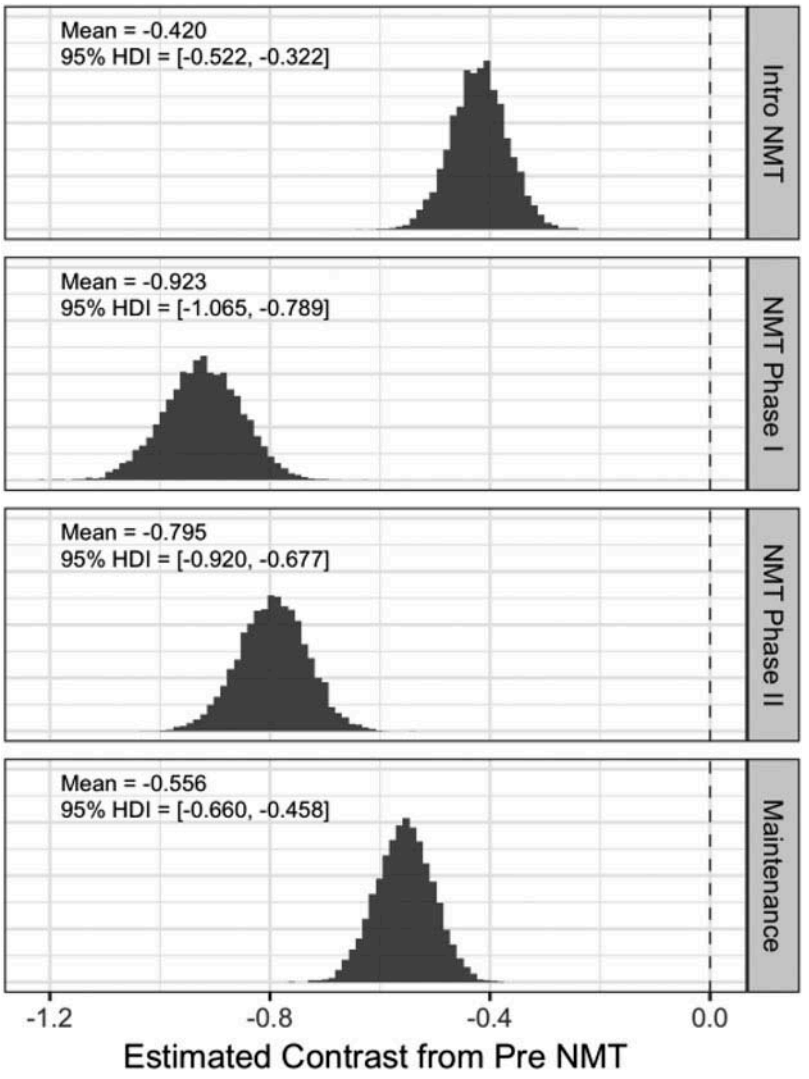

Figure 1. Estimated effect of NMT on restraints. *Note*. NMT = Neurosequential Model of Therapeutics. Distribution of contrasts between the Pre-NMT implementation phase and all subsequent NMT phases, derived from random effects estimates for phases from the multilevel logistic regression model of restraints. Panels are annotated with the mean and 95% highest density interval (HDI) for each distribution.

critical incidents associated with Intro NMT, where a drop in the log-odds of 0.289 is observed. In subsequent phases, the estimated improvements are more pronounced and demonstrate less variability, with estimated reductions of just over 0.6 in the log-odds of a critical incident for NMT Phase I and Maintenance and just under 0.5 in the log-odds of an incident in NMT Phase II.

These estimates are likewise used to produce distributions of predicted values for critical incidents per 10,000 bed days across the six sites represented in the model, shown in Figure 4. As with the restraints model, we

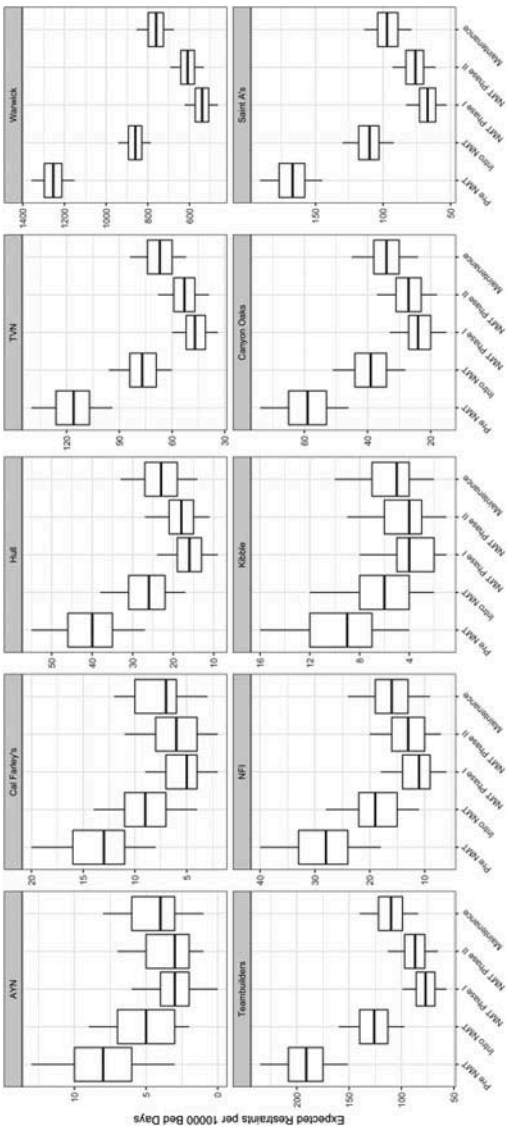

Figure 2. Estimated restraints per 10,000 Bed days. *Note.* NMT = Neurosequential Model of Therapeutics. NFI = Northeastern Family Institute. TVN = The Village Network. AYN = Alexander Youth Network. Posterior predictions across implementation phases for each site in the study from the multilevel logistic regression model of restraints. Boxes provide the interquartile range and whiskers span the 90% uncertainty interval.

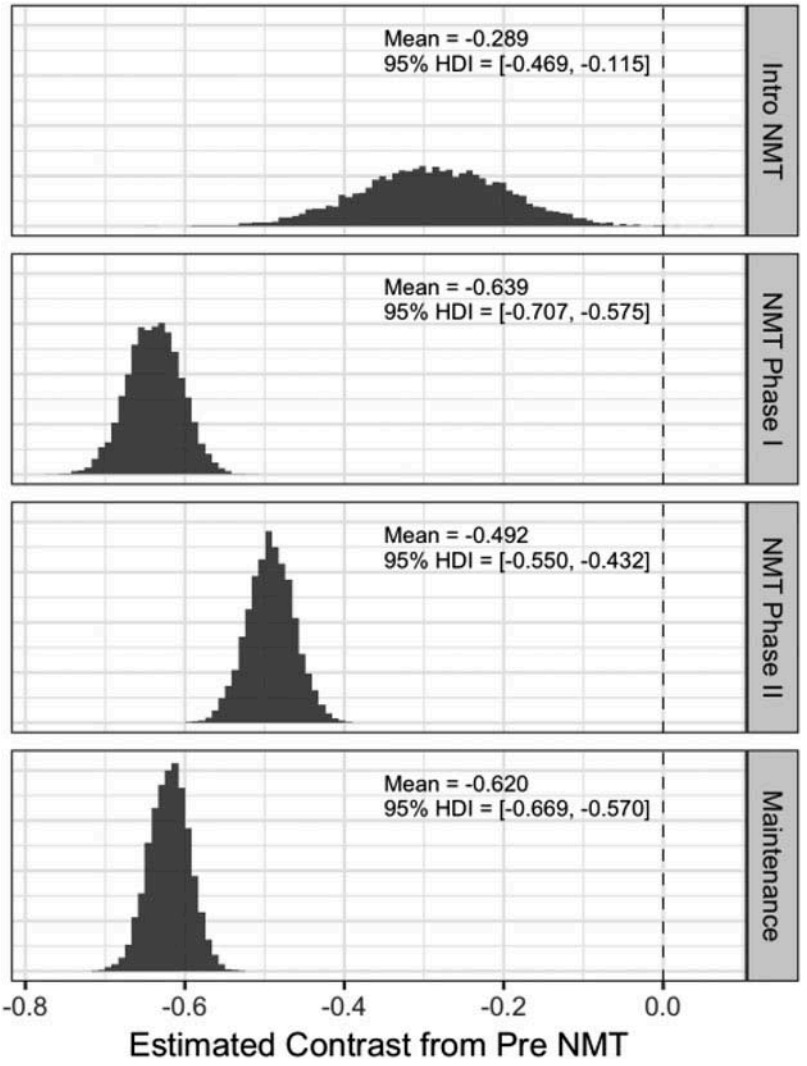

Figure 3. Estimated effect of NMT on critical incidents. *Note*. NMT = Neurosequential Model of Therapeutics. NFI = Northeastern Family Institute. TVN = The Village Network. AYN = Alexander Youth Network. Distribution of contrasts between the Pre-NMT implementation phase and all subsequent NMT phases, derived from random effects estimates for phases from the multilevel logistic regression model of critical incidents. Panels are annotated with the mean and 95% highest density interval (HDI) for each distribution.

observe a similar pattern in the reduction of critical incidents across phases within sites, but again there is considerable variation in the baseline expectation for a critical incident between sites.

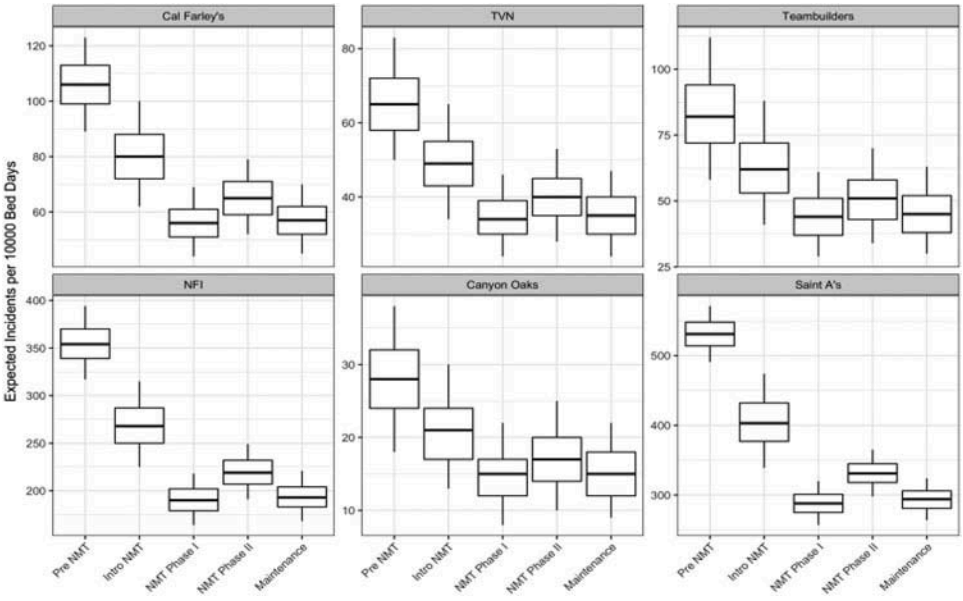

Figure 4. Estimated critical incidents per 10,000 Bed days. *Note*. NMT = Neurosequential Model of Therapeutics. NFI = Northeastern Family Institute. TVN = The Village Network. AYN = Alexander Youth Network. Posterior predictions across implementation phases for each site in the study from the multilevel logistic regression model of critical incidents. Boxes provide the interquartile range and whiskers span the 90% uncertainty interval.

Estimated economic savings across the NMT Certification process

Estimated economic benefits of the observed reductions in restraint were calculated (Table 2). If, as estimated by Lebel and Goldstein (2005) and reported by SAMHSA (2011), an average restraint in a typical inpatient facility costs approximately $350 due to consuming 12 person-hours, then the estimated 4,394 restraints avoided during the review period of this report saved the institutions an estimated collective $1,538,027, and allowed the re-direction of over 50,000 person hours (Lebel & Goldstein, 2005; The Business Case for Preventing and Reducing Restraint and Seclusion Use, 2011). These overall savings were observed despite the fact restraints increased at one site during the Intro-NMT phase. In addition, the two sites that did not become NMT Certified evidenced savings following the Intro-NMT phase alone. Nine of the 10 sites demonstrated cost savings at each time point. The other site (SaintA's) evidenced savings at all time points except Intro NMT and then Maint. However, gains made at other time points made up for those losses.

Table 2. Estimated economic savings associated with restraint reductions.

		Pre-NMT		Pre-NMT		Intro NMT			Cert 1			Cert 2			Maint		
	Site name	Restraint Rate	M	Monthly Cost	% Pre-NMT	M	Period Savings	% Pre-NMT	M	Period Savings	% Pre-NMT	M	Period Savings	% Pre-NMT	M	Period Savings	Total Savings
1	NFI	100	48	380	11.54	24	8025.6	0	24	9120	0	24	9120	0	36	13680	39945.6
2	TVN	100	12	5810	71.66	5	5229	29.43	15	61005	1.02	11	63270.9	15.22	7	34569.5	164074.4
3	Canyon Oaks	100	29	1400	25.2	8	8384	59.32	13	7410	10.73	18	22503.6	4.04	16	21494.4	59792
4	Cal Farley's	100	25	3896				44.64	11	24427.92	51.42	12	23376	49.14	29	58751.68	106555.6
5	Saint A's	100	32	5096	118.7	19	−18396.56	48.45	13	33124	79.6	20	122304	103.8	24	−6115.2	130916.2
6	Hull	100	11	642	58.85	11	2824.8	33.84	9	3755.7	11.43	12	6856.56	45.88	18	75576.24	89013.3
7	AYN	100	30	16662	62.9	17	104804	24.8	19	237433.5	38.39	18	185947.9	45.7	36	238266.6	766452
8	Teambuilders	100	12	1663				23.57	5	7234.05							7234.05
9	Warwick	100	4	45383	44.57	6	152486.9										152486.9
10	Kibble	100	12	2333	22.5	12	21556.92										21556.92
Total	% Pre-NMT	100		8326.5	51.9		284914.6	33		383510.2	27.53		433379	37.58		436223.2	1538027

Note. NMT = Neurosequential Model of Therapeutics. NFI = Northeastern Family Institute. TVN = The Village Network. AYN = Alexander Youth Network. Pre-NMT, Intro NMT, Cert 1, Cert 2, and Maint = the stages of NMT Certification. Economic savings estimates based on Lebel & Goldstein's (2005) estimate of the costs of restraints. All rates were converted such that "Pre-NMT" baseline = 100 and all other values as the % of "Pre-NMT" baseline. All statistical analyses (except the Total analysis) were conducted on raw, pre-converted data.

Discussion

The reduction of restraints and critical incidents is an ongoing federal initiative due to concerns with cost, safety, and patient wellbeing (The Business Case for Preventing and Reducing Restraint and Seclusion Use, 2011). Some site-wide implementation of clinical strategies that are not directly focused on reducing restraints have been associated with restraint reduction, particularly trauma-focused clinical approaches focused on reducing the use of strategies that are potentially re-traumatizing for youth (holds, seclusions, restraints) and increasing "responsive and non-coercive" staff practices (Bryson et al., 2017; Farragher, 2002; Greenwald et al., 2012; LeBel et al., 2010). The NMT is an approach to clinical problem solving that evolved from work with children with histories of developmental trauma, but has been useful in a wide range of early childhood, child, youth, and adult populations impacted by various developmental insults (e.g., FASD) and not just maltreatment. This study investigated whether introducing the NMT to residential and/or day-treatment sites predominately serving trauma-exposed children would result in a reduction of restraints and critical incidents.

The introduction to and/or certification in the NMT coincided with significant reductions in restraints across 10 residential and/or day-treatment psychiatric treatment facilities for children and adolescents and in critical incidents in the six (of the 10) sites that submitted critical incident data appropriate for analysis. Multilevel logistic regressions were used to estimate phase and site effects. Results indicated that decreases from Pre-NMT levels were noticeable by the Intro-NMT Phase, and markedly stronger by NMT Certification Phase 1. Given the length of time that sites were engaged in the NMT Certification process, significant reductions in critical incidents and restraints were maintained for an average of 75 months, or just over 6 years. Visible, yet non-significant upticks in restraints and critical incidents were noted during the NMT Maintenance phase. This could have been due to drift from fidelity to the NMT model. It may also reflect a need for the method of NMT implementation to adapt over time as organizations change (Chambers, Glasgow, & Strange, 2013). Although data on staff turnover were not systematically collected across sites, the authors' knowledge about the implementation process at the sites in this study offer some insights worth noting. At SaintA's and Hull, two sites with noticeable upticks in restraints during the maintenance phase, there was 100% turnover of NMT-trained frontline staff. At several sites without this uptick (TVN, NFI, San Mateo, & AYN), turnover in frontline staff was less than 30%. In response to these findings, the CTA altered the requirements for the Maintenance "sustainability" component, requiring more stringent adherence to the basic elements of the capacity-building process (e.g., number of case-based

webinars attended). It is notable that these sites (SaintA's and Hull) now informally report further improvements in restraint and critical incidence rates.

Lebel and Goldstein noted that each restraint may require twelve staff hours, and thus may cost around $350 (Lebel & Goldstein, 2005). Although their cost estimate was obtained in an inpatient facility, which may have higher staff/youth ratio requirements and overhead costs, their $350/restraint estimate does not account for costs that may co-occur with restraints such as staff turnover or injuries (Henderson et al., 2005). Given the potential for both over and underestimation, and relatively low staff-to-child ratios in the sites in the current study, the Lebel and Goldstein (2005) estimate was used as a rough estimate of potential cost benefits related to restraint reduction across the 10 sites in this study. Lebel and Goldstein (2005) noted that implementation of restraint-reduction protocols in one adolescent inpatient facility over approximately 3 years resulted in cost savings of 92%, or well over one million dollars. In the current study, over one million dollars may also have been saved over the six-year period across these 10 sites by redirecting over 50,000 person hours. Beyond cost, elimination of restraints likely improves client outcomes and staff working conditions (Mohr et al., 2009). Indeed, in a study in a residential and day hospital setting evaluating Lebel and Goldstein's (2005) hypothesis that reducing restraints may contribute to improved outcomes in youth by reallocating staff time to therapeutic endeavors, child outcomes on the Child and Adolescent Functioning Scale increased as restraints decreased (Pollastri et al., 2016).

There are several characteristics of the NMT that may have promoted the observed reductions in restraints and critical incidents. Training in NMT emphasizes aspects of relational "contagion" that will dramatically influence interpersonal interactions with dysregulated children and youth in both positive and negative ways. An understanding of proxemics, for example, can minimize escalating interactions between staff and a dysregulated child (Perry et al., 2016). The core concepts related to NMT emphasize the importance of "state-dependent" functioning; and help staff realize that there are times when verbal interactions and commands will be ineffective and escalating while other more regulatory interactions can de-escalate and minimize conflict. A focus on creating proactive regulating interactions and environments helps staff move away from managing each behavior reactively. Such individual changes in staff practices parallel organizational shifts in policies and program elements related to the NMT. This may have resulted in improved conditions for both the children and the staff in the current study.

Limitations

This study was conducted in real-world settings, demonstrating the feasibility of implementing the NMT and observing change in important indicators

throughout a standardized NMT Certification process. There were no "control" sites included in this study, limiting the conclusion that the NMT alone caused the observed reductions. Although the 10 sites were highly diverse, they were a convenience sample, as data were collected from sites that had independently presented their quality assurance data to NMT developers. There were limitations in the analysis as well. The data were provided in variable format given differences in each site's internal quality assurance data collection processes. Practically speaking, this required estimating restraint and critical incident rates based on average census data aggregated over the entire time period in each phase for each site, instead of having precise data for bed days and events in each phase. Thus, we acknowledge some measurement error in the dependent variables. In addition, we lack consistent information at the child level across sites, so we are unable to control for child attributes that may be associated the probability of restraint or critical incident. We present our results considering these shortcomings, but we are encouraged by the magnitude and direction of the findings associated with NMT implementation, and we look forward to future work on this question with more granular data.

Finally, other potentially relevant data were not collected or analyzed, such as systematic measures of site-wide NMT fidelity, or the use of other restraint-reduction practices such as CPS (several sites had participated in various restraint-reduction initiatives prior to starting the NMT, but none were actively involved in a specific restraint-reduction programs during the period of NMT Certification). Although fidelity to the NMT Clinical Practice Tools is assessed, because not all sites in the study were undergoing formal certification and thus using the clinical practice tools, this measure of fidelity did not fit with the current analysis. An ongoing challenge for the implementation of a clinically focused, system-wide approach such as the NMT is the inability to insure completely consistent timelines of NMT training and implementation across sites. As the NMT evolves, the coevolution of a more "research" focused variant of NMT Certification and implementation process for appropriate candidate organizations will help address some of the shortcomings of the current study.

Conclusions

Reducing restraints in child-serving institutions is essential to improving child care and is a federal priority. Clinical frameworks that clinically empower staff and promote proactive instead of reactive behavior management strategies are useful in reducing restraints and other critical incidents. Thus, clinical intervention strategies for children histories of trauma are relevant to a focus on restraint reduction. The NMT is an approach to clinical problem solving that has demonstrated effectiveness in working with traumatized and maltreated children and youth. The NMT has an extensive capacity-building component where providers learn about trauma-related behaviors and developmentally sensitive

ways to address them. Applying NMT principles may result in provider and organization-level changes that reduce critical incidents and the use of restraints on children with histories of developmental trauma.

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Previous Presentations

None

Conflicts of Interest

None

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