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FROM THE FIELD

Interventions to Increase Multivitamin Use Among Women in the Interconception Period: An IMPLICIT Network Study

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Abstract

Introduction Each year, 3% of infants in the Unites States (US) are born with congenital anomalies, including 3000 with neural tube defects. Multivitamins (MVIs) including folic acid reduce the incidence of these birth defects. Most women do not take recommended levels of folic acid prior to conception or during the interconception period.

Methods The Interventions to Minimize Preterm and Low Birth Weight Infants through Continuous Improvement Techniques (IMPLICIT) ICC model was implemented to screen mothers who attend well child visits (WCVs) for their children aged 0–24 months. Mothers were queried for maternal behavioral risks known to affect pregnancy including multivitamin use and use of family planning methods to enhance birth spacing. When appropriate, interventions targeted at those at risk behaviors are offered. A mixed effects logistic regression model was used to calculate the odds ratio (OR) of behavior change in MVI use among mothers who reported not using MVIs.

Results 37.7% of mothers reported not using MVIs at WCVs. 64.0% of mothers received an intervention to improve MVI use in this model. Mothers who received an intervention were more likely to report taking an MVI at the subsequent WCV if they received advice to take MVIs (OR 1.64) or directly received MVI samples (OR 3.09).

Conclusions Dedicated maternal counseling during pediatric WCVs is an opportunity to influence behavioral change in women at risk of becoming pregnant. Direct provision of MVIs increases the odds that women will report taking them at a higher rate than provider advice or no counseling at all.

Keywords Multivitamin · Folic acid · Congenital anomalies · Neural tube defects · Interconception care · Preconception

Significance Statement

What is Already Known About This Subject?

Current clinical guidelines strongly recommend folate supplementation for women prior to conception. Public health approaches including fortification of foods such as flour, grain and cereal have addressed but have not eliminated the need for specific folate supplementation.

What Does This Study Add?

Clinical systems aimed at improving the rates of supplementation in this population of women have not been widely explored and best practices have not been determined. Our article demonstrates the effectiveness of an innovative approach to improving folate supplementation in women prior to conception.

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Introduction

It is estimated that each year in the United States (U.S.), up to 3000 infants are born with neural tube defects (Williams et al. 2015) and approximately 3% of infants born have a serious congenital malformation (Wilson et al. 2007; CDC 2008). The two most common types of neural tube defects are spina bifida and anencephaly which can both contribute to malformations that result in significant disability or death (Viswanathan et al. 2017). Data from 2009 to 2011 confirms that the combined prevalence of these two conditions was 6.5 cases per 10,000 live births (Williams et al. 2015).

Adequate nutrition is protective against neural tube defects and other congenital anomalies. However, data from the National Health and Nutrition Examination Survey (NHANES) from 2003 to 2006 revealed that among non-pregnant U.S women age 15–44 years of age, less than 25% consume adequate folic acid (≥ 400 µg/day) (Tinker et al. 2010). Supplemental nutrition including intake of multivitamins (MVIs) with 400 mcg of folic acid (FA) reduces the rate of neural tube defects and other congenital anomalies (Czeizel and Bánhidy 2011; Wolff et al. 2009; De-Regil et al. 2010).

Since 1998, enriched cereal grain products in the United States have been fortified with 140 µg of folic acid per 100 g. Despite mandated fortification, the number of babies born annually with neural tube defects only declined by a third compared to pre-fortification levels (Williams et al. 2015). In addition, multivitamin use compared with folic acid alone has also demonstrated reductions in birth malformations including cardiovascular defects, limb defects and cleft palate among others (Wilson et al. 2007). In 2017, the US Preventive Services Task Force reaffirmed its recommendation that all women who are planning or capable of pregnancy take a daily supplement containing 400–800 µg of folic acid (Bibbins-Domingo et al. 2017).

Many factors affect the use of nutritional supplementation in reproductive age women including patient beliefs, pregnancy planning and access to care. One critical factor is that nearly 50% of pregnancies in the U.S. are unintended (Finer and Zolna 2016; Biermann et al. 2006). The rate of unintended pregnancy is even higher in certain populations including teen mothers. Furthermore, a 2014 report found that 29% of mothers had a short interpregnancy interval (Thoma et al. 2016). Unintended pregnancies along with short interpregnancy intervals are associated with low birth weight and premature birth (Dunlop et al. 2007). In addition, many women of reproductive age do not receive preventive health services. Only 3 in 10 of women received preconception counseling prior to their pregnancy and only 4 in 10 of women take folic acid prior to becoming pregnant (Pazol et al. 2017; Robbins et al. 2014). Similar proportions of women do not take multivitamins or folic acid in the interconception period defined as the time from the birth of one child to conception in a subsequent pregnancy (Srinivasan et al. 2018). In addition, 41% of women believe that MVIs are not needed (Bixenstine et al. 2015).

The Interventions to Minimize Preterm and Low Birth Weight Infants through Continuous Improvement Techniques (IMPLICIT) Network, a quality improvement collaborative focused on improving the health of women and their birth outcomes was developed in 2004. Since 2012, the Network has focused on developing, implementing and evaluating an interconception care (IMPLICIT ICC) model to address specific maternal risk factors for poor subsequent birth outcomes. A full description of the model and a preliminary feasibility study of the IMPLICIT ICC model has been previously published (Srinivasan et al. 2018).

The IMPLICIT ICC model includes screening mothers who attend well child visits of children aged 0–24 months for health behaviors including smoking, depression, multivitamin use and contraception. A survey of mothers in the network revealed that a majority of mothers (95%) report feeling comfortable receiving health advice from their child's health care provider (Rosener et al. 2016). Maternal presence at well child visits (WCVs) was also high (92.7%) suggesting this is a clinical opportunity to reach women at risk for specific health behaviors associated with poor pregnancy outcomes (Srinivasan).

Methods

The IMPLICIT Network collaborative includes family medicine and pediatric clinical sites where the IMPLICIT ICC model has been implemented. A total of 19 health centers implemented IMPLICIT ICC and have been sharing data with the Network. These sites are primarily family medicine clinical sites associated with family medicine residency programs. All participating sites secured Institutional Review Board (IRB) approval prior to project implementation.

At involved sites, mothers who attend WCVs were screened for adverse health behaviors known to affect subsequent pregnancies. These areas include (1) maternal depression screening, (2) tobacco use, (3) family planning and (4) multivitamin supplementation. Screening using the IMPLICIT ICC standardized questions and answer options is performed by a member of the clinical care team and the workflow is unique to each site. Mothers who screen at risk for any of these health behaviors are offered interventions. Those who report no MVI use are offered an intervention based on the clinical decision of the provider and the

workflow established at each site. Mothers are offered either counseling with a recommendation to start taking MVIs or are provided with a pharmacy prescription, a voucher for free MVIs to be filled at the pharmacy or a 90 day supply bottle of free MVIs at the WCV (Rosener et al. 2016).

The data including types of intervention offered were recorded and shared with the IMPLICIT Network through the Research Electronic Data Capture (REDCap) database from January 2015 to June 2018. De-identified data at each practice was either extracted from structured data fields in the electronic record or abstracted from paper charts and entered into the Network's data management system, REDCap, hosted at Lancaster General Hospital.

Analysis

We extracted data from the IMPLICIT Network database which contains a maternal demographics form as well as a repeating WCV form for each mom/child dyad. We removed WCVs where MVI status was not assessed from the analysis. We also excluded WCVs in which there was so subsequent follow up or in which the MVI intervention status was missing. We created a lagged MVI use variable to allow each recorded WCV MVI status to be compared to the MVI status and intervention (if applicable) from the previous WCV where MVI was assessed. Similarly, we created a lagged contraception status for the visit where MVI was assessed to allow stratification of MVI data by women most at risk for pregnancy. We calculated descriptive statistics with rates and cross-tabulations. Using a mixed effects logistic regression model we assessed the odds of MVI use given the MVI use reported at the previous visit contraception status at the previous visit and child's age at the time of visit; adjusted for the clustering of repeated measures within each mom/child dyad and within the IMPLICIT Network sites. Analyses were conducted using Stata version 15.1 (College Station, TX) and p values < 0.05 were considered significant.

Results

Overall, 11,521 mothers were screened at 36,398 WCVs with IMPLICIT ICC, including MVI use and family planning methods from January 2015 to June 2018. Mothers were present at 94.2% of WCVs. Screening rates for the risk areas assessed for all WCVs as a denominator were 69.7% for smoking; 73.9% for depression; 68.6% for contraception and 69.1% for MVI use. Screening rates for risk areas in WCVs with documented MVI status were 95.6% for smoking; 99.3% for depression and 95.8% for contraception.

The mean WCV per mom/child dyad was 3.2 (SD 2.4) in our data set and 2.6 (SD 1.9) in visits where MVI use was assessed. Mean number of months between all WCVs was 2.9 (SD 2.5) and the mean number of months between WCVs with documented MVI status was 3.2 (SD 2.8). Of the subset of mothers with available demographic information, 78.2% reported having Medicaid or Medical Assistance

Table 1 Maternal demographics (N = 11,521)

Demographic		All mom/child dyads		Final Dataset Mom/child dyads: MVI assessment with subsequent WCV with MVI assessment	
		Percent or mean (SD)	N	Percent or mean (SD)	N
n			11,521		5760
Insurance type	Medical assistance	78.2%	4014	78.3%	2272
	Private insurance	18.8%	967	18.9%	547
	Self-pay	2.9%	151	2.8%	82
Race	White	48.6%	2780	47.7%	1502
	Non-White	51.4%	2944	52.3%	1644
Ethnicity	Hispanic	23.1%	1203	26.2%	768
	Non-Hispanic	76.9%	3995	73.8%	2160
Maternal education	Less than high school	35.6%	1920	36.7%	1238
	High school or equivalent	35.1%	1893	34.6%	1168
	More than high school or equivalent	29.4%	1586	28.7%	970
Maternal age	Mean(SD)	26.2 (6.5)	6764	25.8 (6.8)	3727
Is mother a patient at this practice?	No	28.0%	1269	27.1%	699
	Yes	72.0%	3257	72.9%	1882

n values may not sum to the total mom/child dyads due to missing maternal demographics

insurance, 74.5% identified as Non-white or Hispanic and 70.7% had a high school education or less (Table 1).

After restricting the data set to only WCV with MVI assessed (excluded 11,231 WCV), WCV with a subsequent WCV (excluded 9,620 WCV) and eliminating WCV where the mother was not taking MVI and the MVI intervention status was missing (excluded 664 WCV), there were 14,883 WCV representing 5,760 mothers included in the analysis (Fig. 1).

Mothers reported not taking MVIs at 37.7% of visits and received an intervention at 64.0% of visits. The interventions were either advice to start taking MVI's (48.3%) or direct provision of MVIs (15.7%) during the visit (Fig. 2). For mothers not taking MVIs at an initial encounter, subsequent screening revealed that 22.1% of mothers started MVI with no intervention, 33.1% started MVI with advice only and 47.2% started MVI after it was directly provided to them (Fig. 2). In addition, mothers reported not using contraception at 29.3% of visits and 77.5% of those mothers received some form of intervention.

Compared with WCVs where mothers were not taking a MVI and received no intervention, mothers had higher odds of taking a MVI at the next visit if they received advice [OR 1.64, CI 1.41–1.90], had the MVI provided [OR 3.09, CI 2.55–3.74], or reported taking a MVI at the previous visit [OR 6.54, CI 5.71–7.48] (Fig. 3). Additionally, if the mother was pregnant, trying to conceive, or not on contraception she had higher odds of using MVI at the next visit [OR 1.28, CI 1.17–1.39] than mothers who were on contraception. However, the interaction between MVI use at the next visit and contraception status was not significant. For every 6-month increase in time from birth, the odds of maternal MVI use was 0.82 (CI 0.79–0.85) fold.

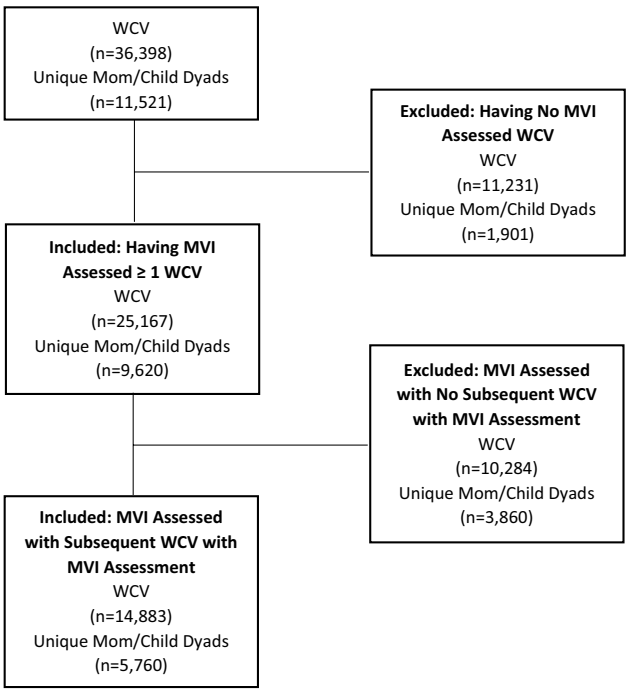

Fig. 1 Data exclusion flow chart

Discussion

Although many preconception guidelines exist, there are few studies which identify best practices and no consensus about the best way to deliver preconception care (Shannon et al. 2014). Several small studies have demonstrated that targeted interventions can influence behaviors such as preconception vitamin intake. A resource intense 6 session intervention trial in the Central Pennsylvania Women's Health Survey demonstrated significantly increased odds of taking a multivitamin with folic acid at 12 months follow up compared to controls (Weisman et al. 2011). A randomized trial performed at 4 pediatric practices demonstrated a sustained increase in MVI use among mothers presenting for WCVs with infants ≤ 12 months who received interconception resources and a brief educational intervention (Upadhya et al. 2019). Despite demonstrating feasibility, these studies argue for the need to identify effective behavior change interventions that can be delivered in longitudinal fashion.

The IMPLICIT Network is a large practice-based quality improvement collaborative with the capability of answering specific questions about factors associated with screening and intervention for known risk factors in future pregnancies. IMPLICIT ICC is an innovative model of care offered to women to promote screening and interventions for risk factors associated with poor birth outcomes. Because of the high rate of maternal presence at WCVs, there is significant opportunity to reach women who may be at risk for congenital anomaly or other poor pregnancy outcome. When risk factors such as lack of multivitamin use or lack of contraception use to enhance birth spacing were identified, an intervention was performed in the majority of cases including 64.0% of the time when mothers endorsed not using a MVI and 77.5% of the time that mothers reported not using contraception.

This analysis specifically targeted changes in behaviors in subsequent WCV's for mothers who were identified as having one of the risk factors named above. Our results suggest that the direct provision of MVIs is a more effective intervention than advising the use of MVIs alone. However, even a brief intervention such as advising MVI supplementation increased the odds that a mother would institute a behavioral change as measured at the subsequent visit.

One important finding of this analysis is that women who are at highest risk for becoming pregnant were noted to have higher odds of initiating MVI use by the subsequent well child visit. Although it cannot be determined why this is the

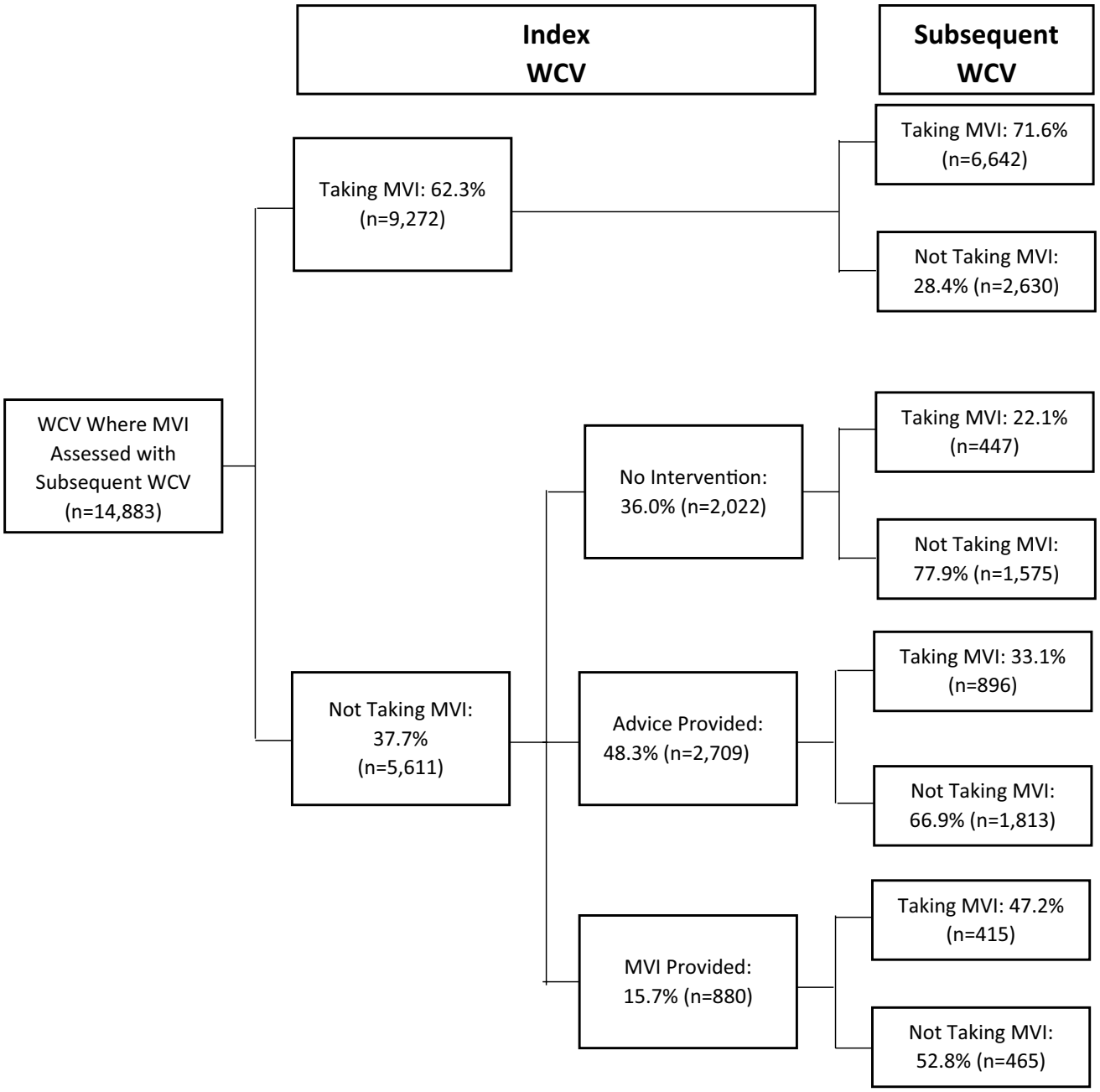

Fig. 2 Mothers MVI status at subsequent WCV

case, it does demonstrate the value of using the WCV as an opportunity to impact behavioral changes in women who are at risk of rapid repeat pregnancy. A possible explanation is that this group of mothers received more intensive counseling or assistance or were more receptive to the counseling they received. However, previous reports examining the connection between pregnancy intention and folic acid supplementation have yielded mixed results and future studies would be required to validate that assumption (Rosenberg et al. 2003; Chuang et al. 2010).

A linear relationship was observed with decreasing MVI use over time from 0 to 24 months. Study results show that reported MVI use decreased as the child got older and the odds of taking a MVI were lower for each 6-month time interval (Fig. 3). This finding might suggest that time from delivery is a marker for reduced likelihood to receive adequate vitamin supplementation (Nilsen et al. 2006). Therefore, a greater need for screening and intervention on MVI use exists at WCVs beyond 12 months when women may be more likely to become pregnant again.

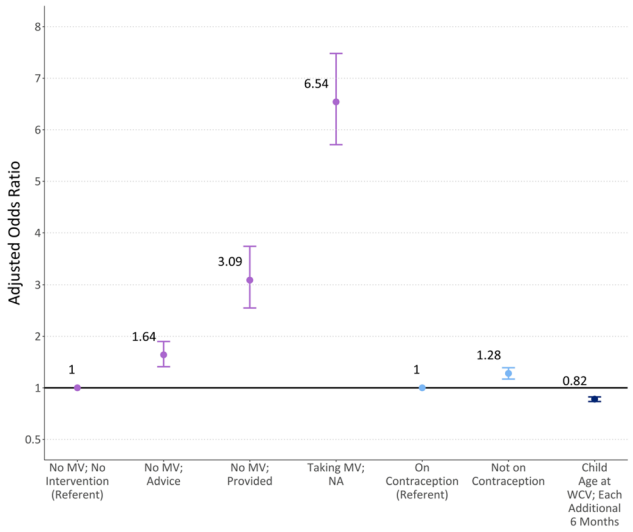

Fig. 3 Adjusted odds ratios of mother using MVI at the next WCV by intervention provided; adjusted for age of child at the WCV and clustering of observations within mothers within sites

Strengths and Limitations

A notable strength of this study is the large size of the database tracking over 11,000 mothers screened across 19 separate implementation sites. This large dataset analysis allows these results to be generalizable across many models of care in various primary care settings. Secondly, the data is derived from an established practice based quality improvement collaborative which has systems in place for regularly entering, sharing, reviewing and analyzing data. These features add to the fidelity of the data collected and the validity of the effects seen. Finally, it has been shown that parity is negatively associated with folic acid supplementation and our study demonstrated an effective model to target this population at increased risk (McNulty et al. 2011).

One limitation of the study is that strict standardized protocols do not exist for how interventions are performed at each of the network sites given the quality improvement basis for the project. In most cases, the provider selected whether and which type of intervention was performed and this self-reporting could reflect bias in reporting. However, even if the interventions were overstated, the presence or absence of maternal behaviors in subsequent visits are still likely to be accurately reflected. Moreover, allowing usual care patterns reflects "real world" practice rather than a protocol driven effort making the results more likely to be generalizable. As in all data driven by self-reporting, a possibility for reporting bias exists and there was no way to confirm that mothers were taking MVI's if they said they were. Our study did not include biomarkers to measure serum folate concentrations in mothers who have been exposed to the interconception care model. The data collection forms used at the time of this analysis did not distinguish the specific ways in which MVIs were provided limiting the ability to identify whether any one of those strategies was most effective. Finally, given birth defects are generally rare occurrences, this study was not powered to assess the linkage between increasing MVI use and birth defects.

Conclusions

The results of this study provide insight into the factors that may influence mothers to begin multivitamin and folic acid supplementation prior to becoming pregnant. Interventions on the part of the primary care provider to advise and arrange for MVI use during the first 24 months postpartum could increase the proportion of women using MVIs at the time of conception. Such a change would be valuable in the effort to reduce the number of children born with congenital anomalies including neural tube defects. Family medicine is a unique clinical specialty in which primary care physicians may simultaneously provide care to both children and their parents. For this reason, it may be positioned to more readily incorporate interconception care recommendations including folic acid supplementation prior to pregnancy. Future work should focus on comparing rates of MVI screening in family medicine vs. pediatric sites as well as developing processes for direct provision of MVIs.

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Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

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