CE 2.0 ANCC Contact Hours

Developing, Implementing, and Evaluating a Nurse-Driven Rapid Reversal Protocol for Patients With Traumatic Intracerebral Hemorrhage in the Presence of Preinjury Warfarin

Abigail R. Blackmore, RN, MSN ■ Lisa M. Caputo, MA ■ Pamela W. Bourg, RN, MS, FAEN ■ Charles W. Mains, MD

ABSTRACT

Warfarin-related traumatic intracerebral hemorrhage (ICH) is often fatal, yet timely evaluation and treatment can improve outcomes. Our study describes the process of developing and implementing a protocol to guide the care of patients with traumatic brain injury (TBI) on preinjury warfarin developed by nurses across several service lines at our Level I trauma center over a 6-month period. Further, we evaluated its efficacy by examining records of adult patients with TBI on preinjury warfarin admitted 1 year before and after protocol implementation. Efficacy was defined as activation rates, receipt and time to head computed tomography (CT) scan and international normalization ratio (INR), and receipt and time to fresh frozen plasma (FFP) administration in patients with ICH with an INR more than 1.5, as per protocol. A subset analysis examined patients with and without an ICH. Outcomes were compared using univariate analyses. One hundred seventy-eight patients were included in the study; 90 (50.6%) were admitted before and 88 (49.4%) after implementation. After implementation, there were improvements in activation rates (34.4% vs. 65.9%; $p < .001$), the frequency of head CT scans (55.6% vs. 83.0%; $p < .001$), time to INR (24.0 min vs. 15.0 min; $p < .05$), and, for patients with ICH with an INR 1.5 or more, decreased time to FFP (157.0 vs. 90.5; $p < .05$). In conclusion, our protocol led to a more efficient process of care for patients with TBI on warfarin. We believe the implementation process, managed by a dedicated group of nurses across several service lines, substantially contributed to the success of the protocol.

Key Words

Blood, Clinical protocols, Coagulation, Intracerebral hemorrhage (ICH), Nursing, TBI (traumatic brain injury), Trauma

Oral anticoagulants are commonly prescribed to protect against thrombotic diseases common to aging and chronic disease populations. Warfarin, the most widely prescribed anticoagulant, however, also increases the risk of intracerebral hemorrhage (ICH) development, hemorrhage expansion, prolonged bleeding, and mortality following traumatic brain injury (TBI) (Flibotte, Hagan, O'Donnell, Greenberg, & Rosand, 2004; Karni et al., 2001; Mina et al., 2002; Rosand, Eckman, Knudsen, Singer, & Greenberg, 2004). Timely identification of an ICH by head computed tomography (CT) scans and administration of reversal agents decreases ICH progression and reduces mortality (Goldstein et al., 2006; Ivascu et al., 2005), making rapid evaluation and treatment the cornerstone of care for such patients. A protocol to guide treatment of these high-risk patients was associated with reduced time to head CT scan and administration of reversal agent fresh frozen plasma (FFP), decreased hemorrhage progression, reduced mortality rates, and reduced time to operative intervention and international normalized ratio (INR) normalization (Bair et al., 2005; Ivascu et al., 2005; Kalina, Tinkoff, Gbadebo, Veneri, & Fulda, 2008). However, according to a recent survey of trauma centers, less than a third of hospitals had any protocols in place for warfarin reversal (Goldstein, Rosand, & Schwamm, 2008).

In 2013, a cohort of nurses from the trauma, emergency, and neuroscience departments at our Level I trauma center created and implemented a detailed, evidence-based protocol to improve the care of patients on preinjury warfarin presenting with a TBI. The purpose of our

Author Affiliations: Trauma Services Department (Mss Blackmore and Bourg and Dr Mains) and Trauma Research Department (Ms Caputo), St. Anthony Hospital, Lakewood, Colorado; and Trauma Research Department, Swedish Medical Center, Englewood, Colorado, and Trauma Research Department, Medical Center of Plano, Plano, Texas (Ms Caputo).

An abbreviated version of this research was presented at the 17th Annual Meeting of the Society of Trauma Nurses in New Orleans, LA, in April 2014 as a poster presentation.

All the authors state they have no financial or other conflicts of interest to disclose.

Correspondence: Pamela W. Bourg, RN, MS, FAEN, St. Anthony Hospital, 11600 W 2nd Pl, Lakewood, CO 80228 (PamelaBourg@Centura.org).

DOI: 10.1097/JTN.0000000000000201

study was threefold: we first describe the process undertaken by nurses to draft the protocol; second, we provide a roadmap of the implementation and outreach process; and, finally, we compare performance measures of activation rates, receipt and time to head CT scan and INR, and receipt and time to FFP before and after implementation of the protocol.

METHODS

Setting

The study was conducted at a community-based American College of Surgeons-verified Level I trauma center in the Denver metropolitan area. The hospital treats more than 13,000 trauma-related emergency department (ED) patients annually, of which approximately 2,400 patients are admitted. Located in a suburban area with a high population of elderly citizens, nearly 40% of our trauma patients are older than 65 years. The trauma center also serves as the tertiary receiving hospital in a private health care system of 14 Level I–V designated trauma centers located throughout the state of Colorado.

Protocol Development

Three potentially preventable deaths attributed to delays in reversing the INR in patients with warfarin-related traumatic ICH revealed the need for guidance to ensure these high-risk patients were rapidly evaluated, and those with an ICH received reversal therapy immediately. As nurses are often the first point of contact for patients and manage patient flow throughout the evaluation and treatment process, hospital leadership selected a nursing research group, composed of nurses from the trauma, emergency, and neuroscience departments, to draft, implement and evaluate an evidence-based protocol.

The nursing group's first step was to review relevant guidelines for warfarin reversal, which included the Eastern Association for the Surgery of Trauma (EAST) practice management guidelines. The EAST guidelines suggest patients of any age on anticoagulants receive an immediate brain CT scan (Barbosa et al., 2012; Calland et al., 2012). The EAST guidelines for care of mild traumatic injury suggest patients should have their INR determined upon admission, and patients with a normal head CT scan but supratherapeutic INR be admitted for a period of observation (Barbosa et al., 2012). Moreover, patients older than 65 years on preinjury anticoagulants with a posttraumatic hemorrhage should receive reversal agents to correct INR values within 2 hr of hospital admission (Calland et al., 2012). We secondly reviewed basic science reports and identified existing protocols. Specifically, we emulated the frequently-cited protocol from William Beaumont Hospital (Royal Oak, MI) as a model for our own protocol (Ivascu et al., 2005). Finally, we met with all participating departments to ensure each protocol step could easily be integrated into practice. With an emphasis on the importance of gathering input from all staff members, from nurses to physicians to administrators, we were able to make small improvements to the protocol while also achieving buy-in from the trauma services, neurosurgery, and emergency departments. Finally, our rapid reversal protocol was formally prepared and presented to the Trauma Multidisciplinary Committee in early 2013 and was implemented on April 1, 2013.

As demonstrated in Figure 1, the rapid reversal protocol guides the care of patients on preinjury warfarin with a confirmed or suspected TBI. The decision to enact the protocol is made by the triage nurse in the ED that processes the Emergency Medical Services (EMS) report; this can be done while the EMS crew is en route to the trauma center or when the EMS crew arrives in the ED. If the protocol is activated, a digital page is sent to physicians, physician assistants, and trauma program staff on duty, alerting them of the Level 2 activation, an activation level that necessitates the immediate arrival of an attending ED physician and nurse. A "coagulation alert" is also issued, alerting blood bank personnel to deliver two units of universal donor FFP to the patient's bedside in the ED. The protocol requires all patients on preinjury warfarin with a confirmed or suspected TBI to receive an immediate head CT scan, laboratory panel, and INR drawn, while accompanied by an ED nurse. The laboratory panel consists of complete blood count, basic metabolic panel, coagulation panel, and venous lactate values. During this initial assessment and evaluation, the nurse to patient ratio is 1:1. Radiological evidence of a hemorrhage necessitates trauma surgeon notification followed by administration of reversal agents and/or surgery, as determined by INR values and clinical presentation. Patients without evidence of a hemorrhage are treated for their injuries, with frequent neurological checks and potential trauma center admission, dependent upon neurological condition.

In contrast to the William Beaumont Hospital protocol, our protocol places an ED nurse in the center of the patient care, guiding the patient care throughout the process. Further, our protocol heavily relies on laboratory values, including INR values, and the need for immediate surgical intervention in addition to clinical presentation to determine further treatment steps.

Outcome Evaluation

We evaluated the efficacy of the protocol by examining the medical records of adult patients with TBI on preinjury warfarin admitted 1 year before (January 1, 2012, to December 31, 2012) and 1 year after (June 1, 2013, to June 1, 2014) implementation of the rapid reversal protocol. We excluded patients who were admitted during the 6-month rollout period (January 1, 2013, to May 31,

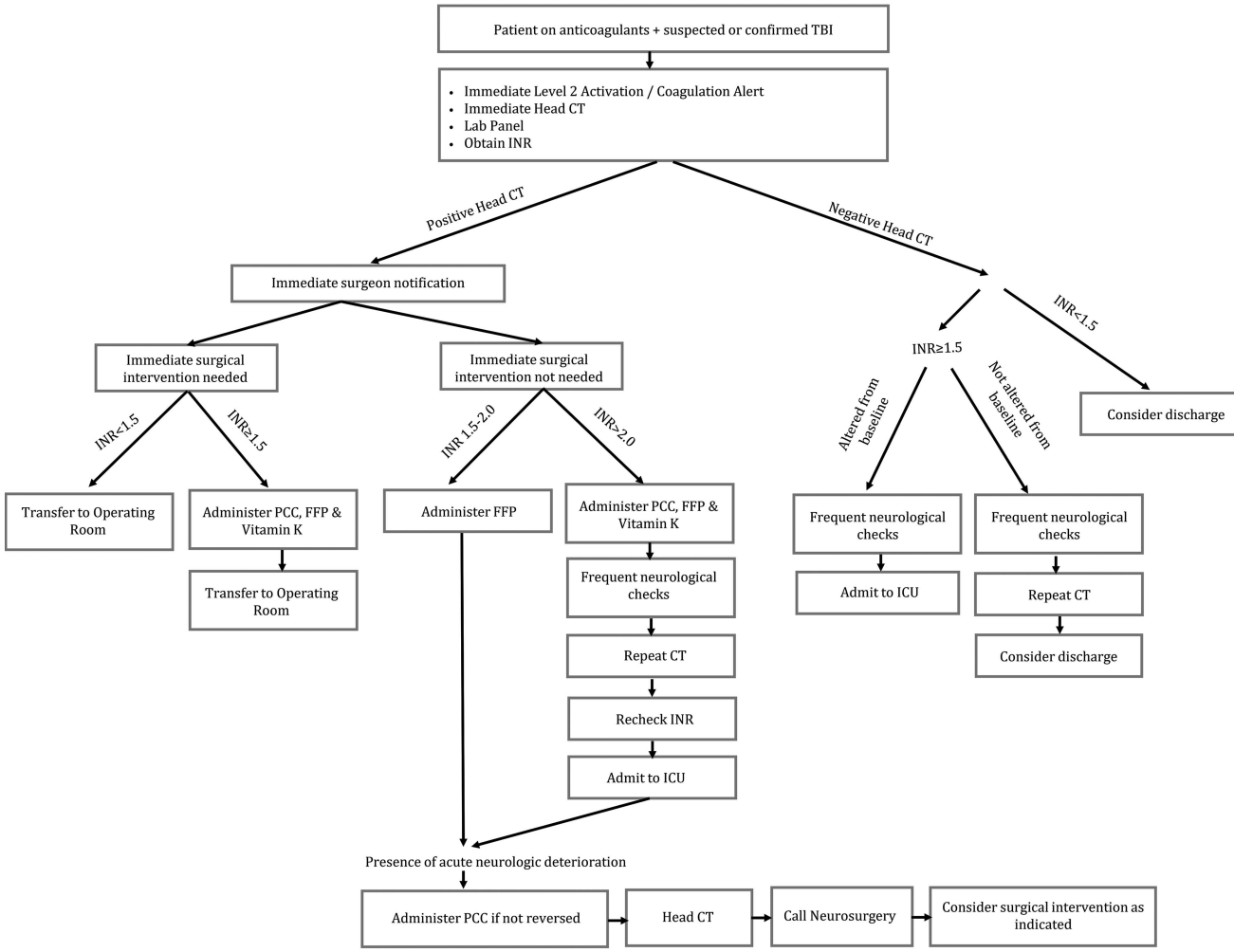

Figure 1. Rapid reversal protocol.

2013). Patients dead on arrival or younger than 18 years were also excluded from the analysis. Data were queried from the hospital's trauma registry (TraumaBase, Conifer, CO), in which dedicated trauma registrars prospectively abstract data on all trauma admissions.

Outcomes of interest included the activation rate, or the proportion of patients activated as at least a Level 2 activation, receipt of head CT scan and INR draw within 4 hr of admission, and time to head CT scan and INR. Time to INR represented the time the INR was drawn and sent to the laboratory. Additionally, we compared the receipt and time to reversal agent FFP before and after implementation for those patients with a confirmed ICH, verified by a positive head CT scan, with an INR 1.5 or more. Finally, we compared demographic and injury characteristics of age, mechanism, Glasgow Coma Scale (GCS), and transfer status between the pre- and postimplementation populations. In addition to examining the overall population, we conducted subset analyses of patients with and without ICH, as determined by head CT scans.

Chi-square tests were used to analyze activation rate and the receipt of a head CT scan and INR draw. The Kruskal–Wallis test was used to compare median times to head CT scan, INR, and administration of FFP. Mean values are presented for normally distributed data; median values are presented for nonnormally distributed data. A p value $\leq .05$ was used to indicate statistical significance. Analyses were performed using SPSS software (version 23, Chicago, IL).

RESULTS

Protocol Implementation

Our 6-month education period commenced by describing case exemplars that deteriorated because of an underappreciation of the elevated risk of hemorrhage progression for patients on preinjury anticoagulants, presented in parallel with our rapid reversal protocol. In-service didactic teaching was provided by the trauma program manager and director of trauma services to physicians, physician

assistants, and nurses in the trauma, emergency, and neuroscience departments. Further, in-person trainings on proper distribution methods and reporting techniques were provided to the blood bank and the laboratory services teams, respectively. Emphasis was placed on the shared responsibility and accountability of each department, and intercommunication between departments. To account for staff turnover, protocol education was conducted monthly for the first 6 months of implementation, and the information was also briefed to nurses prior to each shift for the first 3 weeks after implementation.

Compliance and outcomes were monitored and evaluated by the trauma program manager through the trauma quality improvement system. Individual cases and protocol feedback were also discussed in a multidisciplinary environment with trauma and neurosurgery groups during monthly TBI case conferences and routine quality improvement meetings. Health care providers who did not follow the protocol received a letter of notification and education by the trauma department, via the Performance Improvement and Patient Safety program.

Outcome Evaluation

One hundred seventy-eight patients with a suspected or confirmed TBI on preinjury warfarin were included in the study. More than three quarters (79%) of patients were admitted due to a fall. One hundred six patients (59.5%) had a positive head CT scan, indicating the presence of an ICH. Median length of stay in all patients was 3.0 days, and 11.8% expired in-hospital. Ninety patients (50.6%) were admitted before and 88 (49.4%) were admitted after protocol implementation. Age (74.5 vs. 77.5; $p = .2$), initial INR laboratory values (1.7 vs. 1.8; $p = .4$), and rates of patients transferred to our facility (41.1% vs. 31.8%; $p = .2$) were similar between the pre- and postprotocol implementation populations. Patients admitted after the protocol's implementation presented with higher initial GCS scores than patients admitted before implementation (12.8 vs. 14.2; $p < .05$).

Overall Population

As presented in Table 1, there was a significant improvement in activation rates (34.4% vs. 65.9%; $p < .001$) and receipt of head CT scans (55.6% vs. 83.0%; $p < .001$), as well as reduced time to INR (24.5 min vs. 15.0 min; $p < .05$) after protocol implementation. The rate of INR draws, however, did not significantly change between time periods (882 [60] min vs. 94.3 [66] min; $p = .2$). There was an increase in median time to head CT scans (37 [12.0–77.0] min vs. 43.5 [25.0–72.0]; $p = .1$); this finding was not statistically significant (Table 1).

Patients With a Positive Head CT Scan

Of the 106 patients with an ICH, evidenced by a positive head CT scan, indicators were similar to the overall population. Rates of activation (28.1% vs. 52.4%), receipt of head CT scan (45.3% vs. 73.8%), and median time to INR (26.0 min vs. 13.5 min; $p < .05$ for all) demonstrated significant improvements. Further, there was a statistically significant decrease in the median time to FFP after implementation (157.0 vs. 90.5; $p < .05$) in patients with an INR 1.5 or more. Conversely, there was no significant change in the receipt of FFP among patients with an INR 1.5 or more (71.8% vs. 83.3%; $p = .5$). In addition, there was no significant change in the rate of INR draws pre- and postimplementation (88.2% vs. 92.5% = 9%; $p = .5$). Time to initial head CT scan significantly increased after implementation (15.0 min vs. 26.0 min; $p = .02$).

Patients With a Negative Head CT Scan

Of the 72 patients without evidence of an ICH, we again found a significant increase in activation rates (50.5% vs. 78.3%; $p < .0001$) after protocol implementation. There were also trends toward improvements in the rate of head CT scans (80.8% vs. 91.3%; $p = .2$) and INR draws upon admission (88.2% vs. 95.3%; $p = .3$), and a moderate improvement in time to head CT scan (48.0 min vs. 45.0 min; $p = .5$), but these findings were not of statistical

TABLE 1 Comparison of Outcome Measures and In-hospital Outcomes in the Overall Patient Population, Pre- and Postprotocol Implementation

	Preimplementation ($n = 90$)	Postimplementation ($n = 88$)	p
Activation rate, % (n)	34.4 (31)	65.9 (58)	<.001
Receipt of head CT scan upon arrival, % (n)	55.6 (50)	83.0 (73)	<.001
INR draw upon arrival, % (n)	88.2 (60)	94.3 (66)	.2
Time to first head CT scan, minutes, median (IQR)	37 (12.0–77.0)	43.5 (25.0–72.0)	.1
Time to first INR, minutes, median (IQR)	24.5 (12.8–70.5)	15.0 (10.1–29.5)	.005

Note. CT = computed tomography; INR = international normalization ratio; IQR = interquartile range.

significance. Time to INR demonstrated a slight, insignificant increase in time, from 15.0 to 19.0 min ($p = .7$).

DISCUSSION

Patients with warfarin-related head injury face up to a fivefold increase in the risk of death compared with their non-anticoagulated counterparts (Mina et al., 2002). Between 1998 and 2004, warfarin prescriptions increased 45% in the United States alone (Wysowski, Nourjah, & Swartz, 2007), and prescriptions can be expected to grow substantially in parallel, with our aging and increasingly obese population (Finkelstein et al., 2012; Wang, McPherson, Marsh, Gortmaker, & Brown, 2011) likely to face increased risk of thrombotic diseases. Despite an increase in rates of anticoagulation-related ICH in the United States in recent years (Liotta & Prabhakaran, 2013), managing such patients remains a challenge. By implementing a protocol that emphasized rapid evaluation and treatment through clear, detailed requirements for evaluation including activation, a laboratory panel and INR draws, as well as providing a clear algorithm dependent on both INR values and clinical presentation, patients with TBI on warfarin were more likely to be activated, receive a head CT upon arrival, faced reduced time to INR and, for patients with an ICH and an INR 1.5 or more, decreased time to administration of FFP. It is possible the educational outreach component, which emphasized case exemplars, existing research, and achieving hospital-wide buy-in, in addition to the presence of the protocol, served as a catalyst for heightening awareness and diligence with these patients. In addition, the monitoring and regular reporting added pressure for providers, potentially further enforcing the protocol's requirements.

Thus, we attribute the success of our protocol to the dedicated nursing group that provided extensive time drafting the protocol through an evidence-based method, incorporating the feedback of several service lines, providing ongoing education, and endlessly monitoring compliance. Managing each of these moving components required leadership, communication, organization, and a high level of intrapersonal communication skills, a role nurses were uniquely capable of managing.

We did find an increase in the time to head CT scan in both the overall population and in patients with a positive head CT scan after protocol implementation. We assume this increase is due to the rapid reversal protocol's requirement for all patients on preinjury warfarin agents with a suspected head injury to receive a head CT scan, including patients not demonstrating any symptoms of an ICH, which may increase volume. These findings have spurred in-service education sessions to identify opportunities to improve these lagging times.

Our study is not without limitations. First, our study was set at a single institution, limiting our ability to generalize such results and recommendations to dissimilar trauma centers. We are in the process of adapting this protocol to meet the needs of lower level trauma centers within our family of facilities; measuring the protocol's effectiveness in different environments is an area for further evaluation. Second, as our protocol relies on INR values to guide treatment, this study is only applicable for patients on warfarin. We plan to develop, implement, and study an additional protocol to guide management of patients on additional anticoagulants in the future. In addition, given the retrospective nature of the study, we could not account for the reasons behind some time delays or some patients not being activated or receiving a head CT scan or INR draw. Further, we did not measure the receipt or time to vitamin K or prothrombin complex concentrate (PCC). Because the drugs are given at the same time as FFP, we felt FFP was an accurate measure for the receipt of the three drugs. In addition, vitamin K and PCC are not collected in our trauma registry, making retrospective collection of these data points difficult. Lastly, initial data collected by the Blood Bank and Trauma Program leadership have indicated there has been some wasting of FFP following implementation of the protocol. We are currently working to update our database to more accurately track this issue.

CONCLUSION

The described rapid reversal protocol, drafted and implemented by nurses, provides a synchronized guide to care for patients with TBI on preinjury warfarin. Implementation of the protocol resulted in an increase in activation rates, an increased rate of head CT scans, decreased time to INR, and a reduction in the time between arrival and FFP administration for patients with an INR 1.5 or more. We believe the implementation process, managed by a dedicated group of nurses working with multiple service lines and tirelessly monitoring, evaluating, and even adapting the protocol to ensure these high-risk trauma patients receive prompt care, greatly contributed to the success of the protocol as well. As the use of warfarin continues to parallel the rising age and obesity rates in the United States, we hope that our publication serves as a roadmap to assist other trauma centers develop and implement a protocol that centers on rapid evaluation and treatment for patients with TBI on preinjury warfarin.

KEY POINTS

- To develop and implement a protocol to guide the care of patients with warfarin-related traumatic ICH, a group of nurses led a process to identify patient management guidelines, existing protocols, and basic science reports. Implementation involved meeting with various service lines to gather input and obtain buy-in, and conducting

regular education sessions. The protocol development and implementation process took 6 months.

- Our protocol resulted in improvements in measured indicators. After implementation, we found increased activation rates, the frequency of head CT scans, and reduced time to INR draws. Further, time to reversal agent FFP decreased for patients with ICH with an INR 1.5 or more after the protocol was implemented.
- We attribute the success of the protocol to the dedicated group of nurses uniquely qualified to manage a variety of moving parts, including drafting the protocol, approaching various service lines for input, providing education, and managing the evaluation process.

REFERENCES

Bair, H., Ivascu, F., Janczyk, R., Nittis, T., Bendick, P., & Howells, G. (2005). Nurse driven protocol for head injured patients on warfarin. *Journal of Trauma Nursing*, *12*(4), 120–126.

Barbosa, R. R., Jawa, R., Watters, J. M., Knight, J. C., Kerwin, A. J., Winston E. S., … Eastern Association for the Surgery of Trauma. (2012). Evaluation and management of mild traumatic brain injury: an Eastern Association for the Surgery of Trauma practice management guideline. *The Journal of Trauma and Acute Care Surgery*, *73*(5 Suppl. 4), S307–S314.

Calland, J. F., Ingraham, A. M., Martin, N., Marshall, G. T., Schulman, C. I., Stapleton, T., … Eastern Association for the Surgery of Trauma. (2012). Evaluation and management of geriatric trauma: An Eastern Association for the Surgery of Trauma practice management guideline. *The Journal of Trauma and Acute Care Surgery*, *73*(5 Suppl. 4), S345–S350.

Finkelstein, EA., Khavjou, OA., Thompson, H., Trogdon, JG., Pan, L., Sherry, B., & Dietz, W. (2012). Obesity and severe obesity forecasts through 2030. *American Journal of Preventative Medicine*, *42*(6):563–570.

Flibotte, J. J., Hagan, N., O'Donnell, J., Greenberg, S. M., & Rosand, J. (2004). Warfarin, hematoma expansion, and outcome of intracerebral hemorrhage. *Neurology*, *63*(6), 1059–1064.

Goldstein, J. N., Rosand, J., & Schwamm, L. H. (2008). Warfarin reversal in anticoagulant-associated intracerebral hemorrhage. *Neurocritical Care*, *9*(2), 277–283.

Goldstein, J. N., Thomas, S. H., Frontiero, V., Joseph, A., Engel, C., Snider, R., … Rosand J. (2006). Timing of fresh frozen plasma administration and rapid correction of coagulopathy in warfarin-related intracerebral hemorrhage. *Stroke*, *37*(1), 151–155.

Ivascu, F. A., Howells, G. A., Junn, F. S., Bair, H. A., Bendick, P. J., & Janczyk, R. J. (2005). Rapid warfarin reversal in anticoagulated patients with traumatic intracranial hemorrhage reduces hemorrhage progression and mortality. *The Journal of Trauma*, *59*(5), 1131–1137; discussion 1137–1139.

Kalina, M., Tinkoff, G., Gbadebo, A., Veneri, P., & Fulda, G. (2008). A protocol for the rapid normalization of INR in trauma patients with intracranial hemorrhage on prescribed warfarin therapy. *The American Surgeon*, *74*(9), 858–861.

Karni, A., Holtzman, R., Bass, T., Zorman, G., Carter, L., Rodriguez, L., … Lottenberg L. (2001). Traumatic head injury in the anticoagulated elderly patient: A lethal combination. *The American Surgeon*, *67*(11), 1098–1100.

Liotta, E. M., Prabhakaran, S. (2013). Warfarin-associated intracerebral hemorrhage is increasing in prevalence in the United States. *Journal of Stroke and Cerebrovascular Diseases*, *22*(7), 1151–1155.

Mina, A. A., Knipfer, J. F., Park, D. Y., Bair, H. A., Howells, G. A., & Bendick, P. J. (2002). Intracranial complications of preinjury anticoagulation in trauma patients with head injury. *The Journal of Trauma*, *53*(4), 668–672.

Rosand, J., Eckman, MH., Knudsen, KA., Singer, DE., & Greenberg, SM. (2004). The effect of warfarin and intensity of anticoagulation on outcome of intracerebral hemorrhage. *Archives of Internal Medicine*, *164*(8), 880–884.

Wang, Y. C., McPherson, K., Marsh, T., Gortmaker, S. L., & Brown, M. (2011). Health and economic burden of the projected obesity trends in the USA and the UK. *Lancet*, *378*(9793), 815–825.

Wysowski, D. K., Nourjah, P., & Swartz, L. (2007). Bleeding complications with warfarin use: A prevalent adverse effect resulting in regulatory action. *Archives of Internal Medicine*, *167*(13), 1414–1419.