Wrong-site nerve blocks: 10 yr experience in a large multihospital health-care system†

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Editor’s key points

- The anaesthetic equivalent of wrong-site surgery is wrong-side regional block.
- Femoral nerve blocks are more likely to be placed on the incorrect side of injury/surgery.
- A specific regional block timeout policy is likely to mitigate the risk of wrong-site blocks.
- Open disclosure should follow a wrong-site block.

Introduction. Although wrong-site surgery has garnered extensive scrutiny, the incidence of wrong-site blocks remains unknown. Our study thus sought to quantify the incidence of wrong-site blocks and examine some of their associated risk factors in our multihospital health-care system.

Methods. Using quality-improvement and billing data, we quantified the total number of blocks and wrong-site blocks occurring between July 1, 2002 and June 30, 2012 within the University of Pittsburgh Medical Center Health System. The incidence of wrong-site block was determined by block type, hospital, and type of service involved in performing the block. The incidence of wrong-site block was compared with that of wrong-site surgery. Fisher’s exact tests were performed to determine associations between the incidence of wrong-site block and any of the aforementioned variables. A root-cause analysis was performed to determine the source of wrong-site blocks after the implementation of a timeout policy.

Results. Of the 85 915 patients receiving blocks, 70 441 received only unilateral blocks, yielding an overall incidence of wrong-site block of 1.28 (95% confidence interval 0.43–2.13) per 10 000 patients receiving unilateral blocks. The incidence of wrong-site block was highest with femoral blocks, and differed from the incidence of wrong-site surgery. All occurrences of wrong-site block after the implementation of the timeout policy involved policy violations.

Conclusions. Our study provides the first incidence data on wrong-site block in a large patient population and can help hospitals to develop policies based on these data. It is yet to be determined whether active intervention can eliminate this adverse event.

Keywords: medical errors; nerve block; quality assurance, health-care

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Since the release of the Institute of Medicine’s 1999 report ‘To Err is Human: Building a Safer Health System’, wrong-site procedures have garnered extensive scrutiny. Occurring at an unacceptable rate, these errors—which encompass procedures performed on the wrong side, wrong body part, or wrong patient—place tens of thousands of patients at risk from associated morbidity and mortality, at a total estimated cost in the tens of billions of dollars.†

While much of the attention surrounding wrong-site procedures has focused on wrong-site surgery, recent data suggest that wrong-site nerve blocks are even more common. In addition to potentially increasing the length and cost of hospital stay, wrong-site blocks put patients at risk unnecessarily for nerve block-related complications, which can have serious consequences.†

To date, several case reports have provided important information regarding individual instances of wrong-site block, but do not define the magnitude and scope of the problem. Our study was thus conducted to assess the incidence of wrong-site blocks in our large multihospital health-care system and review their associated risk factors. A preliminary account of our results is given in a published abstract.†

Methods

After obtaining Institutional Review Board approval (University of Pittsburgh Institutional Review Board, IRB Number: PRO10120146), investigators collected data from patients who underwent wrong-site peripheral nerve blocks under the care of the University of Pittsburgh Department of Anesthesiology. In the USA, wrong-site blocks are considered serious reportable events by the National Quality Forum.† Within the University of Pittsburgh Medical Center Health System (UPMCHS), all blocks are performed in the presence of a nurse

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trained to identify and report a wrong-site block properly; therefore, we were able to ensure that all wrong-site blocks occurring in our hospital system were recorded.

Except for children who were given nerve blocks under general anaesthesia, nerve blocks were performed in awake patients under mild sedation, with communication between the patient and block team remaining constant. Blocks were performed in the presence of an attending anaesthetist. All hospitals at UPMCHS have teaching responsibilities, so blocks were typically performed by either residents or fellows at different levels in training. As all of the wrong-site blocks were performed outside the operating room and identified before surgery, there were no wrong-site blocks that resulted in wrong-site surgeries.

Using quality-improvement and billing data, we established the total number of blocks and wrong-site blocks occurring throughout a 10 yr period between July 1, 2002 and June 30, 2012 [fiscal years (Fys) 2003–2012] within UPMCHS under the supervision of the University of Pittsburgh Physicians Department of Anesthesiology. Similar to a wrong-site surgery or procedure, a wrong-site block was defined as a block performed on the wrong side, wrong body part, or wrong patient. This definition encompassed any portion of the block procedure where the skin was broken at the incorrect site; therefore, the definition of wrong-site block included even those instances where practitioners were able to recognize their error after initial skin injection and take corrective action.

To date, all wrong-site blocks within our hospital system have occurred in the context of unilateral blocks, where blocks are performed on only one side of a patient. Specifically, every case of wrong-site block has involved a physician placing the block on the wrong side of a patient (e.g. administering a block on the left side of a patient when that individual was to undergo an operation on the right side). Hence, in addition to quantifying the incidence of wrong-site block for all blocks (unilateral and bilateral) performed at our institution, we calculated the incidence of wrong-site block specifically for unilateral blocks, because patients were found to be at risk for receiving wrong-site blocks only when they were undergoing procedures necessitating unilateral blocks. The number of unilateral blocks and the number of patients receiving unilateral blocks were determined from billing data.

The incidence of wrong-site block was specifically determined by year, block type, and hospital. Incidence was also determined by the type of service involved in performing the block, which was either a dedicated acute interventional perioperative pain service (AIPPS) tasked solely with perioperative nerve blocks and pain management or an integrated operating room (OR)/AIPPS responsible for these functions and for the administration of the intraoperative anaesthetic. For FY 2009–2012, the frequencies of wrong-site block and wrong-site surgery within the same facilities were compared. Incidence is expressed as the number of wrong-site blocks occurring per 10 000 patients. For the comparison among different block types, incidence is expressed as the number of wrong-site blocks occurring per 10 000 blocks.

Unilateral incidence was not calculated for the comparison between wrong-site block and wrong-site surgery because the cases of wrong-site surgery within our institution may have involved errors aside from laterality, such as wrong body part or wrong patient.

Before June 2010, each hospital had its own method of verifying interventional nerve blocks. After a wrong-site block that occurred during the administration of an interscalene block in June 2010, a mandatory ‘timeout’ policy was developed by the Department of Anesthesiology to establish a system-wide protocol for verifying block placement. During the timeout, the attending physician verifies that the correct site/side on a patient has been marked, immediately before block placement. Critically, the timeout takes place in the presence of the entire medical team involved in administering the block, after the patient has been properly positioned.

In the present study, to examine the relative efficacy of the timeout policy, the frequencies of wrong-site blocks occurring before and after the system-wide introduction of this policy in June 2010 were compared. Additionally, for wrong-site blocks occurring after introduction of the policy, root-cause analysis (RCA) was performed to determine ‘causation.’ This included a review of the relevant records and interview of all personnel present during the block.

Statistical analysis
Statistical analyses were performed using R version 3.0.1.10 Given the small number of outcome events, statistical associations could not be determined using multivariable analysis; therefore, any associations were based on univariate analysis. Fischer’s exact tests were performed to compare the frequency of wrong-site block with respect to the type of service involved in performing the block and the type of block performed. Additionally, Fisher’s exact test was used to compare the frequency of wrong-site block with that of wrong-site surgery. When applicable, to account for multiple comparisons, pairwise comparisons followed by a Bonferroni correction were performed. In the case of a Fisher’s exact test revealing an association between two variables, a logistic regression analysis to determine the nature or strength of that association could not be performed because of the small number of wrong-site blocks in the study. Hence, while it was possible to detect associations between variables, it was not possible to determine the nature or strength of those associations quantitatively.

Results
During the 10 yr study period, peripheral nerve blocks (unilateral and bilateral) were performed on 85 915 patients, nine of which were wrong-site blocks (Table 1). The overall incidence of wrong-site block per 10 000 patients was 1.05. The number of wrong-site blocks and incidence of these errors per 10 000 patients by year for FY 2003–2012 is represented in Figure 1, as is the total number of nerve blocks performed. Throughout this period, the total number of hospitals performing blocks increased from six to 13, and the annual number of patients receiving nerve blocks grew from 1596 to 18 178.
Of the 85,915 patients receiving blocks, 70,441 received only unilateral blocks, yielding an overall incidence of wrong-site block of 1.28 per 10,000 patients receiving unilateral blocks.

The number of patients receiving nerve blocks at each hospital ranged from a minimum of 157 to a maximum of 30,589 (Fig. 2A), with the incidence of wrong-site block at each hospital ranging from a low of zero to a high of 3.23 per 10,000 patients (Fig. 2a). For hospitals that had a dedicated AIPPS performing the blocks, the incidence of wrong-site block was 0.84 per 10,000 patients, compared with an incidence of 1.51 per 10,000 patients for hospitals that had an integrated OR/AIPPS (Fig. 2c). There was no significant difference, however, between the number of wrong-site blocks and the type of service involved in performing the block. Likewise, for patients receiving only unilateral blocks, there was no difference between these two variables (incidence for dedicated AIPPS = 1.14 vs integrated OR/AIPPS = 1.51 per 10,000 patients).

During the study period, the total number of unilateral and bilateral blocks performed was 134,721, yielding an incidence of wrong-site block of 0.99 per 10,000 unilateral blocks. For each type of procedure (general or unilateral only) and block (sciatic, paravertebral, miscellaneous, upper extremity, lumbar plexus, or femoral), the number of blocks and incidence of wrong-site block were quantified and are presented in Table 2. Femoral blocks had the highest incidence of wrong-site block for both procedure types.

For both the general (bilateral + unilateral) and unilateral comparisons, Fisher’s exact test revealed an association between the number of wrong-site blocks and the particular block type. Post hoc pairwise comparisons showed the association result from the comparison between femoral and paravertebral blocks in the general case (P = 0.003), but failed to reveal a significant association in the unilateral case. A separate Fisher’s test revealed that wrong-site blocks are more prevalent with femoral blocks than with all other block types combined (Fig. 3A and a) in both the general (femoral incidence = 2.55, other incidence = 0.27, P < 0.01) and unilateral comparisons (femoral incidence = 2.65, other incidence = 0.44, P < 0.05).

Between FY 2009 and FY 2012, the number and frequency of wrong-site blocks was compared with that of wrong-site surgeries (Fig. 4). During this 4yr period, a total of 59,671 patients received blocks with six documented wrong-site blocks (incidence of 1.01 per 10,000 patients), while a total of 580,557 surgical cases were performed with six documented wrong-site surgeries (incidence of 0.10 per 10,000 patients). For FY 2009–2012, there was an association between the number of wrong-site blocks and the type of procedure (either surgery or block) performed (P < 0.01). During this period, wrong-site block occurred 10 times as often as wrong-site surgery.

Before the introduction of the mandatory timeout policy in June 2010, 43,131 patients received unilateral and bilateral blocks with six documented wrong-site blocks (incidence of 1.39 per 10,000 patients), while after implementation of the policy, 42,784 patients received unilateral and bilateral blocks with three documented wrong-site blocks (incidence of 0.70 per 10,000 patients). There was no association, however, between the number of wrong-site blocks and the existence of the policy. Likewise, there was no association between the number of wrong-site blocks for patients receiving unilateral blocks and the presence of the policy.

### Root-cause analysis

For the period after the instatement of the mandatory timeout policy in June 2010, the RCA revealed that each of the three occurrences of wrong-site block was linked to major policy violations and/or deviated from standard practice at UPMCHS hospitals. In the first of these incidents, where a femoral nerve block was administered on the wrong leg of a patient in 2011, the attending physician who performed the block did not participate in the timeout, which runs contrary to the prescriptions of the policy. Instead, the timeout was performed by a nurse who was still in training. Additionally, during the block, the ultrasound machine was moved to the side of the patient that was scheduled to be blocked, when it is common practice for the machine to be placed on the opposite side.

The second incident occurred during the administration of a lumbar plexus block. In this instance, the personnel responsible for performing the timeout felt that they had been rushed through the process. Hence, when the block was performed, the correct location to be blocked was not marked on the patient, which constitutes a significant policy violation. Furthermore, the block was performed with the patient in the supine position, when the proper protocol for a lumbar plexus block calls for the patient be in the lateral position.

The third incident occurred during the administration of a femoral nerve block for a patient who received a femoral block after a sciatic block. Although in this instance the timeout had been conducted properly, the anaesthetist did not see the marking on the femoral site after the patient had

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**Table 1** Wrong-site block occurrence by hospital and block type within UPMCHS. AIPPS, acute interventional perioperative pain service; OR, operating room; UPMCHS, University of Pittsburgh Medical Center Health System. Hospital letters correspond to specific hospitals within UPMCHS.

<table>
<thead>
<tr>
<th>Year</th>
<th>Hospital</th>
<th>Service type</th>
<th>Block type</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>A</td>
<td>Dedicated AIPPS</td>
<td>Femoral</td>
</tr>
<tr>
<td>2006</td>
<td>A</td>
<td>Dedicated AIPPS</td>
<td>Femoral</td>
</tr>
<tr>
<td>2008</td>
<td>I</td>
<td>Integrated OR/AIPPS</td>
<td>Femoral</td>
</tr>
<tr>
<td>2009</td>
<td>J</td>
<td>Integrated OR/AIPPS</td>
<td>Femoral</td>
</tr>
<tr>
<td>2010</td>
<td>I</td>
<td>Integrated OR/AIPPS</td>
<td>Miscellaneous (cervical)</td>
</tr>
<tr>
<td>2010</td>
<td>B</td>
<td>Dedicated AIPPS</td>
<td>Upper extremity (interscalene)</td>
</tr>
<tr>
<td>2011</td>
<td>D</td>
<td>Dedicated AIPPS</td>
<td>Femoral</td>
</tr>
<tr>
<td>2011</td>
<td>A</td>
<td>Dedicated AIPPS</td>
<td>Lumbar plexus</td>
</tr>
<tr>
<td>2012</td>
<td>J</td>
<td>Integrated OR/AIPPS</td>
<td>Femoral</td>
</tr>
</tbody>
</table>
been repositioned, and so performed the block at the incorrect location.

**Discussion**

In analysing wrong-site blocks occurring throughout a 10 yr period in a large multihospital care system, our study is the first to report the frequency (as blocks per 10,000 patients and as blocks per 10,000 blocks) with which these errors occur. Hence, in addition to demonstrating how prevalent wrong-site blocks are in our health-care system, our study provides a comparator allowing for incidence comparisons across other institutions. Without any comparative data, it is difficult to determine whether the frequency of wrong-site block observed in our health-care system is similar to that observed in others.

Notably, all cases of wrong-site block in our study involved wrong-side blocks, occurring only when physicians scheduled to perform unilateral blocks on a patient administered them on the opposite side. The most appropriate figures for assessing the risk of wrong-site block therefore seem to be those quantifying the incidence of these errors using either the number of unilateral blocks or the number of patients receiving unilateral blocks as the denominator. The overall incidence of wrong-site block was 1.28 per 10,000 patients receiving unilateral blocks, compared with 1.05 per 10,000 patients receiving either unilateral or bilateral blocks.

Despite our large study cohort, our small sample size of wrong-site blocks may have limited our ability to detect significant differences in several of our comparisons examining wrong-site block risk factors. Furthermore, in the instances where we were able to determine statistical significance, we could only demonstrate that there were associations between particular variables, not the nature or strength of those associations. Additionally, the rarity of wrong-site blocks made it difficult to determine the efficacy of strategies designed to prevent these events; it was therefore not possible to distinguish whether preventative measures were decreasing the incidence of wrong-site blocks at our institution or if such a reduction was occurring by chance. Thus, our statistical

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**Fig 1** Number of wrong-site blocks (A), prevalence of wrong-site block per 10,000 patients (B), and number of patients receiving blocks (C) within the University of Pittsburgh Medical Center Health System (UPMCHS) between fiscal years (FYs) 2003 and 2012.
findings should be interpreted with caution, and future studies should be conducted to address the limitations of this study.

In our study, the frequency of wrong-site block varied depending on the type of block performed. In particular, two-thirds of wrong-site blocks occurred during the

![Graph A: Number of patients receiving blocks by hospital](image)

![Graph B: Number of wrong-site blocks prevalence by hospital](image)

![Graph C: Number of wrong-site blocks prevalence by service type](image)

**Fig 2** Number of blocks (a) and prevalence of wrong-site blocks per 10,000 patients (b) by hospital and type of service involved in administering the blocks within UPMCHS. The type of service involved in administering the blocks was either a dedicated acute interventional perioperative pain service (AIPPS) or an integrated AIPPS/operating room (OR) service. (c) The overall prevalence of wrong-site block for both the dedicated AIPPS and integrated OR/AIPPS. NS, not significant.

**Table 2** Number of blocks and prevalence (per 10,000 blocks) of wrong-site block by procedure and block type. WSB, wrong-site block. *Includes saphenous, cervical, and transverse abdominis planes

<table>
<thead>
<tr>
<th>Block type</th>
<th>No. of WSBs</th>
<th>No. of blocks (bilateral + unilateral)</th>
<th>WSB prevalence (bilateral + unilateral)</th>
<th>No. of blocks (unilateral only)</th>
<th>WSB prevalence (unilateral only)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sciatic</td>
<td>0</td>
<td>26 284</td>
<td>0</td>
<td>25 454</td>
<td>0</td>
</tr>
<tr>
<td>Paravertebral</td>
<td>0</td>
<td>44 788</td>
<td>0</td>
<td>3937</td>
<td>0</td>
</tr>
<tr>
<td>Upper extremity</td>
<td>1</td>
<td>23 698</td>
<td>0.42</td>
<td>23 698</td>
<td>0.42</td>
</tr>
<tr>
<td>Miscellaneous*</td>
<td>1</td>
<td>8458</td>
<td>1.18</td>
<td>7096</td>
<td>1.41</td>
</tr>
<tr>
<td>Lumbar plexus</td>
<td>1</td>
<td>7967</td>
<td>1.26</td>
<td>7720</td>
<td>1.30</td>
</tr>
<tr>
<td>Femoral</td>
<td>6</td>
<td>23 526</td>
<td>2.55</td>
<td>22 677</td>
<td>2.65</td>
</tr>
<tr>
<td>Overall</td>
<td>9</td>
<td>134 721</td>
<td>0.67</td>
<td>90 582</td>
<td>0.99</td>
</tr>
</tbody>
</table>
administration of a femoral nerve block, and wrong-site blocks occurred with the highest frequency at this site (in both the general and unilateral-only cases). This may stem, at least in part, from the fact that patients are positioned in a manner in which they have relatively little awareness of the blocking procedure during the administration of femoral blocks compared with their positioning during the placement of other block types. Given that patients already exhibit a general reluctance toward challenging a health-care team’s activities and often have a lack of understanding of the relationship between the block and site of surgery, placing them in an orientation where they cannot directly visualize the block placement, as is done during the administration of femoral blocks, may further deter them from identifying errors.

Furthermore, errors may be more likely to occur with femoral blocks because femoral and sciatic blocks are often placed together in a single-shot fashion and require that the patient be repositioned during the blocking procedure. Relative to other block procedures then, femoral and sciatic blocks may involve more confusion, increasing the chance of a wrong-site block. Lending support to this notion, findings from our RCA revealed that one of the two wrong-site femoral blocks occurring after June 2010 arose because of confusion during repositioning the patient. Additionally, in our practice, unilateral lower extremity blocks (femoral, sciatic and lumbar plexus) are performed far more often than unilateral upper extremity blocks (brachial plexus and axillary) and unilateral paravertebral blocks. This suggests that wrong-site blocks may be more likely to occur with block types that are administered more often than others.

Within our multihospital health-care system, two types of perioperative interventional nerve block services exist: (i) a solely AIPPS model, where the AIPPS member is dedicated exclusively to the perioperative nerve block and pain management; and (ii) an integrated OR/AIPPS model, where the anaesthetists are responsible for both the nerve block and intraoperative anaesthesia. Importantly, AIPPS has standard protocols and practices across hospitals, in addition to a commitment from the hospital to provide additional health-care support (such as nurses) to run the service. While our study did not reveal an association between the type of service involved in performing blocks and the number of wrong-site blocks, the incidence of wrong-site block was higher for the integrated OR/AIPPS group than for the dedicated AIPPS group. This may be because of the increased production pressure that members of an integrated OR/AIPPS face in having to perform both the nerve block and intraoperative anaesthesia, in addition to the consistency in service delivery and overall nerve block experience associated with a dedicated AIPPS team. Under the AIPPS model, the nurses that
participate in the performance of nerve blocks are provided by the hospital; therefore, this model has the advantage of having two independent teams working together to achieve the same goal.

Consistent with data collected by the Pennsylvania Patient Safety Authority, which continues to identify wrong-site block as the most common type of wrong-site procedure from case reports, our study found the incidence of wrong-site block to be 10-fold that of wrong-site surgery. While wrong-site surgery has received much regulatory attention, with resultant policies and protocols aimed at prevention, wrong-site block has received considerably less attention. Furthermore, the environment in which nerve blocks are performed—where each team member may have other obligations and there is inconsistency in who is available during the process—presents unique challenges for policies aimed at preventing wrong-site blocks.

In spite of these challenges, with the introduction of our system-wide timeout policy, there appears to be a trend towards a reduced incidence of wrong-site block. Supporting the efficacy of this policy, results from our RCA suggest that the wrong-site blocks occurring after the implementation of the policy could have been avoided had the relevant personnel adhered to the demands of the policy. Hopefully, as personnel gain more experience in performing the timeout policy correctly, and routine, periodic education continues to be provided, the incidence of wrong-site block will decrease even further. While team-based simulation may be useful to improve an understanding and compliance with the policy, the number and rotating nature of members of the team responsible for provision of the policy makes formal simulation impractical.

In all three of the cases that we analysed with our RCA, the wrong-site block was recognized before the patient left the block room, and the correct site was subsequently reblocked before surgery. In the case concerning the wrong-side lumbar plexus block, the error was identified before the injection of local anaesthetic, after skin incision. The nerve block was then performed on the correct side. Regarding both cases of wrong-side femoral blocks, the patients were reblocked on the correct side shortly after the error was discovered, while they were still in the holding area.

In every case of wrong-site block examined in our study (both before and after the implementation of the timeout policy), patients were made aware immediately upon discovery of the wrong-site block. Surgery and recovery in all of these patients were uneventful, and none of these cases was presumed to increase hospital stay or cost. Additionally, there was no legal action associated with any of these errors.

In summary, this study describes the incidence of wrong-site blocks throughout a 10 yr period within a large multihospital health-care system. A total of nine wrong-site blocks occurred, with an overall incidence of 1.28 per 10 000 patients receiving a unilateral block. While the small number of wrong-site blocks makes analysis of risk factors difficult, we investigated several factors at our hospital that may increase the likelihood of the occurrence of a wrong-site block. Future studies are needed to determine conclusively the circumstances that lead to these errors. Going forward, while it may be unreasonable to expect any policy to eliminate the risk of wrong-site block entirely, it is plausible that a standardized process could reduce its incidence considerably. Ultimately, findings from our study could inform policies seeking to reduce the incidence of such ‘never events’.

Authors’ contributions
M.E.H.: conception and design of the manuscript; acquisition, analysis, and interpretation of data; drafting the article; final approval of the version to be published. J.E.C.: conception and design of the manuscript; analysis and interpretation of data; final approval of the version to be published. J.R.L.: acquisition, analysis, and interpretation of data; drafting the article.

Declaration of interest
None declared.

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