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# Detection of Potentially Avoidable Harm in Oncology From Patient Medical Records

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Disclosures provided by the authors are available with this article at jop.ascopubs.org.

**QUESTION ASKED:** Although medical record–based measurement of adverse events (AEs) associated with cancer care is desirable, condition-specific triggers in oncology care are needed. We sought to develop a screening tool to facilitate efficient detection of AEs across settings of cancer care via medical record review. We hope to use this tool to understand the frequency, spectrum, and preventability of AEs with the goal of helping improve the quality and safety of cancer care.

**SUMMARY ANSWER:** We developed a cancer-specific screening tool to help identify candidate preventable AEs that occur during cancer care from patients' medical records. Our oncology screening tool consists of 76 triggers—readily identifiable findings to screen for possible AEs that occur during cancer care (Table 1).

**METHODS:** We sought to develop a screening tool to facilitate the detection of AEs across settings of cancer care via medical record review. We obtained structured and unstructured input from clinical experts to develop our tool, using a modified Delphi process.

**BIAS, CONFOUNDING FACTOR(S), DRAWBACKS:** Our oncology tool requires further evaluation in order to understand its usefulness for population-based assessments of AEs in oncology and quality improvement.

**REAL-LIFE IMPLICATIONS:** Information obtained from structured record reviews using an oncology trigger tool could help to prioritize quality improvement activities, identify high-risk groups, and generate cancer-focused quality measures. Ultimately, the goals of this work are to prevent AEs and allow timely, automated identification of these events so that clinicians can intervene promptly to improve patient outcomes. JOP

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**Table 1. Memorial Sloan Kettering Cancer Center Oncology Trigger Tool**

| | Trigger |
|---|---|
| Laboratory | |
| L1 | Adrenal function studies* |
| L2 | Abnormal phosphate (> 5, < 1.5 mg/dL)* |
| L3 | Abnormal serum bicarbonate (< 18, > 36 mEq/L)* |
| L4 | Abnormal serum bilirubin (> 2 mg/dL)* |
| L5 | Abnormal serum calcium (> 12, < 7 mg/dL)* |
| L6 | Abnormal serum magnesium (> 4, < 1.5 mg/dL)* |
| L7 | Abnormal serum potassium (> 6, < 2.5 mEq/L)* |
| L8 | Abnormal serum sodium (> 150, < 130 mEq/L)* |
| L9 | Arterial blood gas (not in PACU/ICU)* |
| L10 | Bladder catheter and positive urine culture* |
| L11 | BNP (> 400 pg/mL)* |
| L12 | *Clostridium difficile* toxin positive* |
| L13 | Elevated AST (> 300 units/L) or ALT (> 300 units/L)* |
| L14 | Elevated blood glucose (> 250 mg/dL)* |
| L15 | Elevated creatinine > 1 mg/dL and 50% greater than baseline* |
| L16 | Elevated INR (> 8)* |
| L17 | Elevated lipase (> 160 U/L)* |
| L18 | Elevated serum uric acid (> 10 mg/dL)* |
| L19 | Elevated troponin (> 0.64 ng/mL)* |
| L20 | Elevated TSH (> 10 mcU/mL)* |
| L21 | Low fibrinogen (< 100 mg/dL)* |
| L22 | Neutropenic fever (except in patients with leukemia or bone marrow transplant)* |
| L23 | Platelet count < 20,000 (except in patients with leukemia or bone marrow transplant)* |
| L24 | Positive blood culture without contaminant (eg, *Staphylococcus epidermidis*)* |
| L25 | Tylenol blood level* |
| Orders | |
| R1 | Acute inpatient dialysis |
| R2 | Blood transfusion |
| R3 | Cardiac defibrillator |
| R4 | Chest x-ray in inpatient or urgent care center |
| R5 | Contact precautions/order for isolation |
| R6 | Fistulogram/sinogram |
| R7 | High-dose intravenous proton pump inhibitor (omeprazole, esomeprazole, and pantoprazole 80-mg bolus followed by 8 mg/h infusion) |
| R8 | ICU transfer from floor |
| R9 | Nasogastric tube (not in operating room) |
| R10 | Noncontrast chest CT scan after radiation to the chest |
| R11 | Percutaneous drain placement |
| R12 | Platelet transfusion (except in patients with leukemia or bone marrow transplant) |
| R13 | Positive bone imaging test (plain films, CT scans) |
| R14 | Positive lower-extremity ultrasound |
| R15 | Positive upper-extremity ultrasound |
| R16 | Rapid response team |
| R17 | Reintubation |

(continued in next column)

**Table 1. Memorial Sloan Kettering Cancer Center Oncology Trigger Tool (continued)**

| | Trigger |
|---|---|
| R18 | Steroid enema |
| R19 | Use of pressors |
| Consultations | |
| C1 | Inpatient cardiology consult* |
| C2 | Inpatient gastroenterology consult* |
| C3 | Inpatient or outpatient IR consult (excluding referral for port placement) |
| C4 | Inpatient surgery consult for nonsurgical patients* |
| C5 | Lymphedema consult* |
| C6 | Nephrology consult* |
| C7 | Neurology consult and noncontrast head CT scan* |
| C8 | Sitter and inpatient psychiatric consult* |
| General care | |
| G1 | Death in hospital |
| G2 | Extravasation |
| G3 | Fall |
| G4 | Hospital readmission/urgent care visit within 72 h of hospital discharge or ambulatory surgery |
| G5 | Low urine output (< 30 mL/h) |
| G6 | Pressure ulcer |
| G7 | Return to the operating room or IR within 30 days of surgery |
| Vital signs | |
| V1 | Blood pressure (> 200/100 mmHg) |
| V2 | Low oximetry results ($Sao_2$ < 88%) |
| V3 | Pain score (≥ 7) |
| V4 | Temperature (< 35°C perioperatively) |
| Medication related | |
| M1 | Epinephrine* |
| M2 | Flumazenil, glucagon, naloxone, protamine* |
| M3 | Initiation of therapeutic anticoagulation* |
| M4 | Intravascular thrombolytic therapy* |
| M5 | Kayexalate* |
| M6 | Methylnaltrexone* |
| M7 | Octreotide* |
| M8 | Oral anesthetics (eg, Magic Mouthwash, viscous lidocaine)* |
| M9 | Sodium thiosulfate, hyaluronidase, topical dimethylsulfoxide, dexrazoxane, phentolamine* |
| M10 | Total parenteral nutrition* |
| M11 | Use of intravenous glucose or dextrose* |
| M12 | Use of more than three doses of antiemetics within 24 h* |
| M13 | Vitamin K* |

Abbreviations: BNP, brain natriuretic peptide; CT, computed tomography; ICU, intensive care unit; INR, international normalized ratio; IR, interventional radiology; PACU, postanesthesia care unit; $Sao_2$, arterial oxygen saturation; TSH, thyroid-stimulating hormone.

*Triggers have been automated in the pilot study at Memorial Sloan Kettering Cancer Center.

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## Abstract

### Purpose

Widespread consensus exists about the importance of addressing patient safety issues in oncology, yet our understanding of the frequency, spectrum, and preventability of adverse events (AEs) across cancer care is limited.

### Methods

We developed a screening tool to detect AEs across cancer care settings through medical record review. Members of the study team reviewed the scientific literature and obtained structured input from an external multidisciplinary panel of clinicians by using a modified Delphi process.

### Results

The screening tool comprises 76 triggers—readily identifiable findings to screen for possible AEs that occur during cancer care. Categories of triggers are general care, vital signs, medication related, laboratory tests, other orders, and consultations.

### Conclusion

Although additional testing is required to assess its performance characteristics, this tool may offer an efficient mechanism for identifying possibly preventable AEs in oncology and serve as an instrument for quality improvement.

## INTRODUCTION

Widespread consensus exists about the importance of improving patient safety in oncology,[1-3] yet our current understanding of the frequency, spectrum, and preventability of adverse events (AEs) across cancer care is limited. This information is essential for improvement. AEs, which refer to unwanted outcomes associated with medical care rather than to the underlying disease or condition of a patient, can be harmful and costly for patients with cancer.[4,5] Examples of AEs are hospital-acquired infections, delirium, procedural complications, surgical infections, and falls. In this context, AEs are not limited to serious AEs, which generally refer to adverse drug reactions that occur during clinical trials.

Medical record review has been the primary approach to conducting population-level assessments of AEs in health care.[6-9] Given the quantity and complexity of information in patient records, screening tools are used to guide targeted reviews for AEs based on key triggers or easily identifiable flags.[10,11] The Institute for Healthcare Improvement developed the Global Trigger

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Tool (GTT) to measure AEs in the general inpatient setting.[10,12] Triggered cases are followed up with focused reviews to assess whether an AE occurred. Reviewers typically assess the likelihood that the AE could have been prevented or whether the harm associated with the AE could have been mitigated. Trigger tools have been developed successfully for population-level assessments in patient safety and quality improvement in several settings.[13-16]

Much of the work in measuring AEs has focused on general medical, surgical, and pediatric inpatient settings.[6-8,17] Because cancer care often is outpatient, these efforts may not capture important AEs. Conversely, the measurement of outpatient AEs alone can miss important AEs associated with surgery and inpatient care.[18-22] AEs may have various causes and expected frequencies by group that warrant cohort-specific benchmarking. Many existing quality measures exclude patients with cancer for these reasons.[19] Indeed, studies of traditional trigger tools have shown poor performance in oncology populations.[23,24] For example, an oncology module of the GTT detects oncology-specific inpatient AEs.[25] Two analyses raised concerns about its inability to capture several important AEs in cancer care, particularly those after surgery (complications of anesthesia or abscess), measurement error, and disagreement between reviewers in AE identification.[23,26]

Although medical record–based measurement of AEs associated with cancer care is desirable, condition-specific triggers in oncology care are needed. We developed a screening tool to facilitate efficient detection of AEs across settings of cancer care through medical record review. Ultimately, we hope to use it to generate population-level estimates of AEs, identify high-risk patients, and improve quality of cancer care.

## METHODS

We developed an oncology trigger tool through a multistep process (Figure 1). First, members of the study team compiled an organ system–based list of common AEs or severe AEs relevant to the treatment of patients with breast, colorectal, and lung cancers. The goal was to identify AEs that occur in any inpatient or outpatient setting during the course of cancer care. We initiated this process by identifying a wide range of clinically significant AEs within each organ system on the basis of our clinical knowledge and experience. We then added to and refined the initial list by reviewing AEs reported in clinical trials in patients with breast, colorectal, and lung cancers.[27-34] Finally, we consulted outside specialists, including anesthesiologists and hematologists, to capture additional specialty-specific AEs.

From the list of AEs, we generated a set of candidate triggers that might signal the occurrence of the corresponding AE. We included triggers that would be easily identifiable from medical record review and would be generalizable across institutions with different electronic medical records. We used our own clinical experience and reviewed existing triggers from previous tools to generate our list of triggers.

To narrow the list of triggers, we sought input from clinicians on the study team with expertise in medical oncology, surgery, patient safety, quality measurement, and research methods (C.A., A.S.E., S.N.W., A.K., D.C., D.P.). Study team members assigned each trigger a summary score from 1 to 3 based on ease of trigger detection in the medical record, likely frequency of trigger, severity of the associated AEs, and expected specificity of the trigger. As a group, the team members reviewed and discussed the scores that they individually assigned to each trigger. For redundant triggers, they determined the likely best options. From the discussion, they reached consensus on the triggers to be rated and assessed by an external multidisciplinary panel of clinicians. This panel included nine representatives from medical oncology, radiation oncology, surgery, inpatient and outpatient nursing, anesthesiology, general medicine, and emergency medicine. The clinicians had expertise in treating patients with breast, colorectal, and lung cancers.

To obtain input from the external panel in a structured way, we used a modified Delphi process.[13,35] For this process, panel members individually rated on a 5-point scale each trigger based on expected frequency, ease of trigger detection, and seriousness of the related AE. The panel also provided open-ended feedback about specific triggers and recommendations for additional triggers. The individual scores for each criterion were averaged and a summary score calculated for each trigger by multiplying the three averaged scores. The study team ranked the triggers by these scores and comments provided by the panel, and proposed whether to include the trigger in the list. The study team returned the proposed list to the panel for additional feedback. The study team reviewed the final comments and determined the triggers that would comprise the oncology trigger tool. The study was considered exempt research by the institutional review board of Memorial Sloan Kettering Cancer Center.

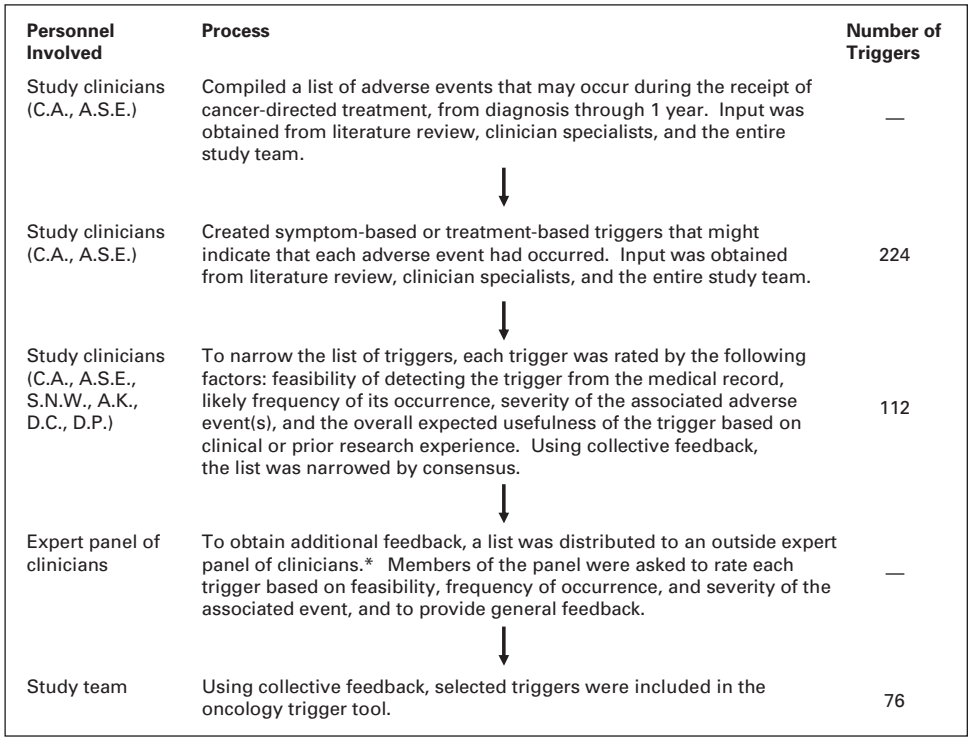


**FIG 1.** Diagram of the development of the oncology trigger tool. *The expert panel and outside specialists consisted of 12 clinicians who provided input either through structured ratings or general feedback. They represented several disciplines: medical oncology, radiation oncology, surgery, nursing, anesthesiology, hematology, general medicine, and emergency medicine.

## RESULTS

The oncology trigger tool comprises 76 triggers (Table 1). For ease, we categorized triggers as general care (eg, death in hospital), vital signs (eg, blood pressure > 200/100 mmHg), medication related (eg, epinephrine), laboratory tests (eg, *Clostridium difficile* toxin positivity), other orders (eg, reintubation), and consultations (eg, nephrology).

We encountered several challenges while developing and refining the set of relevant triggers. The first was to exclude AEs and triggers that result primarily from the disease process rather than from the care delivered. We also eliminated redundant triggers that are likely difficult to identify through record abstraction or that have low sensitivity or specificity for the associated AE. For example, we initially considered the use of patient restraints as a trigger for the AE inpatient delirium but ultimately selected the presence of an order for a sitter and inpatient psychiatric consult because this may be easier to identify. Similarly, we excluded ECG as a trigger for a variety of severe cardiac AEs, including myocardial infarction because it was nonspecific. Instead, we used the presence of elevated troponin levels. We explicitly included triggers for some expected treatment-related toxicities, such as neutropenia and uncontrolled pain because further study may characterize risk factors for these potentially preventable AEs. Finally, we eliminated a small number of AEs because we suspected that they would be rare (eg, air embolism, suicide), could not identify a trigger with sufficient sensitivity and specificity to flag its presence (eg, peripheral neuropathy), or would likely be captured through other methods (eg, retained foreign body during surgery).

## DISCUSSION

We created an oncology-specific AE trigger tool based on cancer-specific harm vulnerabilities by using a modified Delphi approach. The tool, which requires further evaluation, includes 76 triggers. In the process of creating the tool, we focused on cancer-specific harms, such as toxicities related to treatment, adverse drug events, diagnostic delays, and miscommunication with patients and among caregivers. This tool may offer a mechanism for identifying candidate preventable AEs in oncology. Some of the GTT triggers are not sufficiently specific for cancer care because laboratory abnormalities and expected toxicities are common. The current tool differs from the GTT in that it incorporates events that occur in ambulatory and inpatient settings, identifies cancer care–specific complications,

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| Orders | |
| R1 | Acute inpatient dialysis |
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| R4 | Chest x-ray in inpatient or urgent care center |
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| R7 | High-dose intravenous proton pump inhibitor (omeprazole, esomeprazole, and pantoprazole 80-mg bolus followed by 8 mg/h infusion) |
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| R13 | Positive bone imaging test (plain films, CT scans) |
| R14 | Positive lower-extremity ultrasound |
| R15 | Positive upper-extremity ultrasound |
| R16 | Rapid response team |
| R17 | Reintubation |
| R18 | Steroid enema |
| R19 | Use of pressors |
| Consultations | |
| C1 | Inpatient cardiology consult* |
| C2 | Inpatient gastroenterology consult* |
| C3 | Inpatient or outpatient IR consult (excluding referral for port placement) |
| C4 | Inpatient surgery consult for nonsurgical patients* |
| C5 | Lymphedema consult* |
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| C7 | Neurology consult and noncontrast head CT scan* |
| C8 | Sitter and inpatient psychiatric consult* |
| General care | |
| G1 | Death in hospital |
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| G4 | Hospital readmission/urgent care visit within 72 h of hospital discharge or ambulatory surgery |
| G5 | Low urine output (< 30 mL/h) |
| G6 | Pressure ulcer |
| G7 | Return to the operating room or IR within 30 days of surgery |
| Vital signs | |
| V1 | Blood pressure (> 200/100 mmHg) |
| V2 | Low oximetry results ($Sa_{O_2}$ < 88%) |
| V3 | Pain score (≥ 7) |
| V4 | Temperature (< 35°C perioperatively) |
| Medication related | |
| M1 | Epinephrine* |
| M2 | Flumazenil, glucagon, naloxone, protamine* |
| M3 | Initiation of therapeutic anticoagulation* |
| M4 | Intravascular thrombolytic therapy* |
| M5 | Kayexalate* |
| M6 | Methylnaltrexone* |
| M7 | Octreotide* |
| M8 | Oral anesthetics (eg, Magic Mouthwash, viscous lidocaine)* |
| M9 | Sodium thiosulfate, hyaluronidase, topical dimethylsulfoxide, dexrazoxane, phentolamine* |
| M10 | Total parenteral nutrition* |
| M11 | Use of intravenous glucose or dextrose* |
| M12 | Use of more than three doses of antiemetics within 24 h* |
| M13 | Vitamin K* |

(continued in next column)

**Table 1. Memorial Sloan Kettering Cancer Center Oncology Trigger Tool (continued)**

Abbreviations: BNP, brain natriuretic peptide; CT, computed tomography; ICU, intensive care unit; INR, international normalized ratio; IR, interventional radiology; PACU, postanesthesia care unit; $Sa_{O_2}$, arterial oxygen saturation; TSH, thyroid-stimulating hormone.

*Triggers have been automated in the pilot study at Memorial Sloan Kettering Cancer Center.

and includes triggers that do not need a detailed review of the clinical notes. This contribution addresses the paucity of tools available to detect the range of cancer care–related AEs through medical record abstraction and may advance the study of patient safety events in the oncology community.

Our objective was to generate and ultimately validate a comprehensive set of triggers that are objective, reproducible, and identifiable through automated chart abstraction techniques. By following the GTT methodology, we developed an oncology trigger tool to support this goal of improving our understanding of AEs in patients with cancer across the spectrum of care. Information obtained from structured record reviews can help to prioritize quality improvement activities and identify high-risk groups. Information obtained could also lead to cancer-focused quality measures.[19] Further evaluation of the performance of the tool will help us to understand its usefulness for population-based assessments of AEs in oncology and quality improvement. Ultimately, the goals of this work are to prevent AEs or allow timely identification of these events so that clinicians can intervene promptly to improve patient outcomes. JOP

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**Authors' Disclosures of Potential Conflicts of Interest**

Disclosures provided by the authors are available with this article at jop.ascopubs.org.

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## AUTHORS' DISCLOSURES OF POTENTIAL CONFLICTS OF INTEREST

### Detection of Potentially Avoidable Harm in Oncology From Patient Medical Records

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