BMJ Open

Utility of a Paediatric Trigger Tool in a Norwegian department of paediatric and adolescent medicine

Anne Lee Solevåg,[1] Britt Nakstad[1,2]

To cite: Solevåg AL, Nakstad B. Utility of a Paediatric Trigger Tool in a Norwegian department of paediatric and adolescent medicine. *BMJ Open* 2014;**4**: e005011. doi:10.1136/bmjopen-2014-005011

▸ Prepublication history for this paper is available online. To view these files please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2014-005011).

Received 6 February 2014
Revised 10 April 2014
Accepted 11 April 2014

[1]Department of Paediatric and Adolescent Medicine, Akershus University Hospital, Lørenskog, Norway
[2]Institute of Clinical Medicine, University of Oslo, Oslo, Norway

Correspondence to
Dr Anne Lee Solevåg;
a.l.solevag@medisin.uio.no

ABSTRACT

Objectives: The British National Health Service (NHS) Paediatric Trigger Tool (PTT) was made based on various trigger tools developed for use in adults. The PTT has not previously been developed or used in Nordic units. We aimed to compare harm identified through PTT screening with voluntary incidence reports in our department. A secondary aim was to assess utility of the different triggers, including predictive value for identifying harm. We hypothesised that the NHS PTT would need adjustments for the setting in which it is used.

Setting: A Norwegian level II department of paediatric and adolescent medicine.

Participants: A convenience sample of 761 acute medical and surgical patient contacts March–May 2011. Median age (IQR) for the trigger positive patients was 2.5 (1.0–8.0) years; range 0–18 years.

Primary and secondary outcome measures: Incidence, type and severity of harm identified with the PTT compared with the department's voluntary incidence reports. The type and rate of identified triggers and positive predictive value for harm.

Results: The PTT revealed a harm rate of 5% for medical patients, as compared to 0.5% in the incidence reports the same months. PTT screening revealed other types of harm than those reported by healthcare personnel themselves. We identified only 20 of the 39 NHS PTT triggers. The most frequent trigger was readmission within 30 days. Hypoxia, which was the second most frequent trigger, did not predict any patient harm.

Conclusions: This study showed that the NHS PTT identifies more and other types of harm than voluntary incidence reports. The presence of adult-oriented triggers, triggers that were not identified at all, as well as triggers with a low predictive value for harm may indicate the need for modification of the PTT to different settings. More studies are needed before a final decision is made to exclude triggers from the screening.

Strengths and limitations of this study

- There is a limited understanding of how structured patient safety work in paediatrics can be performed.
- We investigated the utility of The British National Health Service Paediatric Trigger Tool (PTT) in a level II paediatric unit and found that the tool should probably be modified to different settings.
- Previous to this study, only one major PTT has been published in peer-review journal format and none have been applied in outpatient settings.
- This review is based on a significant amount of patient data. However, the single-centre character and the short study period call for additional studies, preferentially multicenter studies.

INTRODUCTION

By identifying recurring medical errors focused efforts can be made to improve patient safety.[1 2] However, medical errors do not always lead to harm to the patient. Patient harm can be caused by medical error, but can also occur as a result of a diagnostic or treatment procedure in the absence of a medical error.[3]

The so-called 'trigger tools' focus on patient harm, not errors, and can in combination with more traditional incident reporting in healthcare help departments and hospitals focus their improvement work to reduce the overall rate of patient harm.[4] The global trigger tool (GTT) is a retrospective method for detecting iatrogenic harm[5] and has been used as a benchmarking system and means for monitoring change over time. A trigger has been defined as data present in the patient's record that can directly or indirectly, by providing a clue for further investigation, represent an adverse event that caused patient harm.[6 7] The GTT has become a widely used tool in patient safety work. However, the understanding of healthcare-associated harm in children is limited as compared to adults and only recently a comprehensive paediatric trigger tool (PTT) has been developed.[8]

The National Health Service (NHS) PTT was made based on various trigger tools for

use in adults with the support of clinicians in nine UK hospitals, and was meant to be useful for district general hospitals, acute teaching hospitals and specialist paediatric centres.[4] However, there is a need for determining utility of such instruments derived from adult care in different institutions and patient groups. The items comprising the PTT should be piloted in different settings in order to remove unnecessary or adult-oriented triggers and/or add more relevant triggers.[7]

Hence, we aimed to examine the utility of the NHS PTT in a large Nordic department of paediatrics and if needed adjust the tool for use in our patients.

Our primary focus was to examine if or to what extent the PTT detected patient harm in medical and surgical patients in our department and compare these results with voluntary incidence reports. A secondary aim was to assess the utility of the different triggers, including predictive value of individual triggers for identifying harm.

METHODS

The study was approved as part of quality improvement activities by the institutional review board at Akershus University Hospital (AHUS).

Setting

AHUS is located outside the Norwegian capital Oslo. The hospital is the single largest acute hospital in Norway and offers a full range of medical services except cardiac surgery and neurosurgery, as well as treatment of severe traumatic injuries. AHUS does not have a paediatric intensive care unit (PICU), but transfers children below the age of 3 years in need for intensive care to a nearby university hospital. Critically ill children between 3 and 18 years are treated in the intensive care unit (ICU) for adults in AHUS. The hospital introduced early warning scoring systems after this study. Routine GTT screening has been performed since 2007.

The Department of Paediatric and Adolescent Medicine is a 37-bed level II unit. Children and adolescents between 0 and 18 years of age referred by general physicians for acute specialist care are examined in the children's emergency department (ED) and about 50% are admitted. Registration of patient harm in our unit is exclusively based on voluntary reporting through an electronic incidence reporting system called Extend Quality System (EQS).

PTT screening

We did a manual review of unplanned patient visits to the children's ED using the NHS PTT User guide.[4] For convenience, we included the visits that were documented for the purpose of evaluating the introduction of a paediatric early warning score in our department over a 3-month period.[9] These visits represented 95% of all contacts in the children's ED in the study months. Paediatric (medical), as well orthopaedic, general surgical; and ear, nose and throat (ENT) patients below the age of 18 years were included and the results were recorded in Excel spreadsheets (Microsoft Excel 2008 for Mac (Redmond, Washington, USA)).

The PTT screening was performed by the primary investigator (ALS) who is a consultant paediatrician in the department. As AHUS is the first hospital in Norway to screen for paediatric triggers, there are no courses or formal training in the PTT available in Norway. Hence, to get a general idea about the concept of trigger tools, ALS attended a full-day course in the GTT organised by The Norwegian Knowledge Centre for the Health Services. In addition, she received instructions from the GTT team at AHUS based on their review methodology and PTT screening of 10 patient records was performed in collaboration with a representative from the GTT team.

The PTT consists of 39 items described in box 1. The patient records were reviewed in the following order: diagnoses and treatment procedures, discharge summaries, medication charts, laboratory results, operation notes, nurse notes, physician notes and admission note. As only half of the acute referrals result in an admission, our practice differs from most medical departments for adults where a larger proportion of acutely referred patients are being admitted. The PTT user guide dictates a minimum length of stay of 8 h.[4] However, as we argue that our threshold for admitting patients from the children's ED is high with often only slight differences in disease severity and complexity between those who are admitted and those who are not, we also included acute outpatient visits in our screening. In our unit fluid replacement therapy has been an area of improvement. In an attempt to increase detection rates for harm caused by intravenous fluid therapy, we chose to register all patient contacts with the diagnoses hypokalaemia/hyperkalaemia and/or hyponatremia/hypernatremia as trigger positive regardless of the definitions used in the PTT user guide for these triggers (box 1). Otherwise, we strictly followed the definitions and guidelines outlined in the user guide.

The PTT uses an adapted version of the National Coordinating Council for Medication Error Reporting and Prevention (NCC MERP) 'Index for Categorising Errors'.[10] The rationale for this is that the NHS focuses on adverse events that cause actual patient harm and not medical errors that have a potential for patient harm. Therefore, only the NCC MERP categories E through I are included: temporary harm to the patient and required intervention (category E), temporary harm to the patient and required initial or prolonged hospitalisation (category F), permanent patient harm (category G), intervention required to sustain life (category H) and patient death (category I).

Harm identified through PTT screening was compared to harm identified through voluntary incidence reports in the department.

Voluntary incidence reporting

ALS read and classified patient-related incidents regarding paediatric (medical) patients reported in the EQS in March until May 2011. The rate of harm reported in

Box 1 The PTT items as depicted in the NHS PTT user guide[4]

Item

General care
- PG1 Early warning score
- PG2 Tissue damage or pressure ulcer
- PG3 Readmission within 30 days
- PG4 Unplanned admission
- PG5 Abnormal cranial imaging
- PG6 Respiratory or cardiac arrest/crash calls
- PG7 Diagnostic imaging for embolus/thrombus +/−confirmation
- PG8 Complication of procedure or treatment
- PG9 Transfer to higher level of care
- PG10 Hypoxia O_2 saturation <85%
- PG11 Cancelled elective procedure/delayed discharge

Surgical care
- PS1 Return to theatre
- PS2 Change in planned procedure
- PS3 Surgical site infection or hospital acquired urinary tract infection
- PS4 Removal/injury/repair of organ

Intensive care
- IP1 Readmission to intensive care or high-dependency care

Medication
- PM1 Vitamin K (except for routine dose in neonates)
- PM2 Naloxone
- PM3 Flumazenil (Romazicon)
- PM4 Glucagon or glucose ≥ 10%
- PM5 Chlorphenamine or antihistamine
- PM6 Antiemetics
- PM7 IV Bolus ≥10 mL/kg colloid or crystalloid given
- PM8 Abrupt medication stop

Lab test
- PL15 Thrombocytopenia (platelets <100)
- PL1 High INR >5 or aPTT >100
- PL2 Transfusion
- PL3 Abrupt drop in Hb or Hct (>25%)

Biochemistry
- PL4 Rising urea or creatinine (>2× baseline)
- PL5/PL6 Electrolyte abnormalities (Na^+ <130 or >150, K^+ <3.0 or >6.0)
- PL7 Hypoglycaemia (<3 mmol/L)
- PL8 Hyperglycaemia (>12 mmol/L)
- PL9 Drug level out of range

Microbiology
- PL10 MRSA bacteraemia
- PL11 *Clostridium difficile*
- PL12 VRE
- PL13 Nosocomial pneumonia
- PL14 Positive blood culture

Other
- PO1 Other event

Hb, haemoglobin; HCT, haematocrit; INR, international normalised ratio; MRSA, methicillin-resistant Staphylococcus aureus; VRE, vanc resistant enterococcus.

incidence reports during these 3 months was low. Therefore, all reports in an extended period of time, 2010–2012, were included. Patient harm identified in the incidence reports was classified from E through I for comparison to the findings from the PTT screening.

Statistical analyses

Data were analysed using PASW Statistics V.18.0 software (SPSS Inc, Chicago, Illinois, USA). Comparisons between groups were made using the χ^2 test for categorical variables and Mann–Whitney U test for continuous variables. p Values <0.05 were considered significant. Positive predictive value (PPV) with 95% CI for triggers was calculated and we calculated number of harm events per 1000 patient days and 100 patient contacts.

RESULTS

From 15 March until 31 May 2011 761 patient records, representing 2268 patient days were screened for triggers. Median age (IQR) in years was 3.5 (1.2–11.0) for all patients and 2.5 (1.0–8.0) for the trigger-positive patients. Male-to-female ratio was 352:409 and 113:129 for all patients and the trigger-positive patients, respectively.

We identified 48 incidents of harm, representing 21 harm events per 1000 patient days and 6 harm events per 100 consultations. The distribution of the 48 patients with identified harm according to status as admitted or outpatient, as well as their distribution across specialties are presented in table 1. A total of 60.4% of the harm events were in the paediatric (medical) patients, whereas 22.9% occurred in ENT patients, 10.4% in orthopaedic and 6.3% in general surgical patients.

Harm was detected in 5% of all paediatric contacts with a slightly higher rate of 7% in paediatric admissions. The incidence of harm in all contacts including surgical and ENT patients and in admissions only regardless of specialty was similar, 6.3% and 8.3%, respectively.

All, but two identified harm events were categorised as harm category F, 'Temporary harm to the patient and required initial or prolonged hospitalisation'. Examples of harm were postoperative pericarditis, ileus after gastrostomy, candida stomatitis after treatment with antibiotics, infection in percutaneous endoscopic gastrostomy, bleeding following placement of nasogastric feeding tube (harm category E) and nosocomial infection (gastroenteritis, pneumonia) for the paediatric patients. In orthopaedic patients osteomyelitis after pinning of Bennett's fracture was found and in general surgical patients haematoma after hernia operation (outpatient: harm category E) was found. In the ENT patients bleeding, infection and/or dehydration following adenotonsillectomy were recurring harms.

Voluntary incidence reports

About two-thirds of the incidents reported were minor incidents like delay in medication administration not leading to patient harm.

Table 1 Distribution of trigger-positive admissions and outpatient contacts across specialties

	Paediatric		Orthopaedic		General surgical		Ear, nose and throat	
	Admitted	Outpatient	Admitted	Outpatient	Admitted	Outpatient	Admitted	Outpatient
Total, n (%)	356 (47)	228 (30)	70 (9)	13 (2)	41 (5)	22 (3)	27 (3.5)	4 (0.5)
Trigger positive, n (%)	148 (61)	59 (24.5)	8 (3.5)	3 (1)	10 (4)	2 (1)	11 (4.5)	1 (0.5)
Harm, n	26	3	3	2	1	2	11	0

Patient harm as defined by the PTT user guide was found in 51/160 (30.9%) of the incidence reports 2010–2012. Thirty-seven harm events were classified as harm category E, eight category F, three category G, one category H and two category I. This equals 51/5854 (total number of patients admitted acutely with medical diagnoses 2010–2012)=0.9%. Only three of these incidents were reported in the PTT study months giving a voluntary-reported harm rate of 3/584 (number of paediatric patients in the PTT screening)=0.5% in March–May 2011.

Patient harm reported through the incidence reporting system included unexpected patient death; fall injury; pain and swelling from subcutaneous peripheral venous catheter; complications to procedure; anaphylactic drug reactions; and prolonged hospitalisation due to errors in medication and fluid administration.

Triggers

We identified one or more of 20 of the 39 NHS triggers in 242 (31.8%) of all patient contacts. In 71.5% of the trigger-positive contacts only one trigger was found. The highest number of triggers found in a patient contact was 4. The mean rate of triggers per patient was 1.4.

The most frequently found trigger was readmission within 30 days. Common reasons for unplanned readmission were surgical site infection, recurrent (respiratory tract) infections, postoperative bleeding and seizures. We found the second most common trigger in our screening to be hypoxia, but no patient harm was associated with this specific trigger.

Of the 242 trigger-positive contacts, 177 (73.1%) were admissions and 65 (26.9%) acute outpatient visits. Table 1 shows how trigger-positive admissions and outpatient contacts were distributed across specialties.

The PPV of one or more triggers for identifying harm was 19.8%. When calculations were made for admissions (n=761) and outpatient care (n=242) separately, PPV was 23.2% and 10.8%, respectively (p=0.03). When we looked at the PPV of individual triggers, PPV varied from 0 in the case of hypoxia, thrombocytopenia and electrolyte abnormalities to 100% in the case of surgical site infection and nosocomial pneumonia (table 2).

Table 3 shows rate of trigger-positive contacts, rate of harm and PPV of triggers across specialties.

DISCUSSION

This is the first report about use of a PTT in a European unit. Despite the fact that only half of the NHS paediatric triggers were found in the patient records screened in this study, we identified a 10 times higher harm rate using the PTT than what was reported in the department's voluntary incidence reports in the same period. Patient harm identified through incidence report analysis and PTT screening was different in number and character in our unit.

Our paediatric centre is the largest acute paediatric unit in Norway, but we do not have a PICU in our hospital. Therefore, we do not treat the most severely ill children, and we rarely use potent anaesthesia medications. This may be one of the reasons why half of the NHS triggers were not found in our review, reflecting that some diagnoses and interventions with a high incidence of complications are not present in the children and adolescents in our unit.

In the recently published Canadian Paediatric Adverse Events Study, the incidence, type and severity of harm among children admitted to academic paediatric centres were compared with those admitted to community hospitals in Canada.[8] In that study, significantly more patient records from academic paediatric centres (38.8%) than from community hospitals (21.6%) were trigger positive.[8] We found triggers in 31.8% of our patients. The overall rate of harm in the Canadian study was 9.2% with significantly more harm in academic paediatric centres (11.2%) than in community hospitals (3.3%). We found a total rate of harm in admitted children of 8.3%. These results might reflect that, although being an academic teaching unit, our centre probably has a patient population with disease severity and complexity somewhere in between the two compared unit levels in the Canadian study.

Kirkendall *et al*[7] found 37 harm events per 100 patients and 76 harm events per 1000 patient days, a significantly higher rate than in our patients. One of the reasons for this may be that the study was conducted in a large US tertiary centre where 32.5% of the patients went to the operating room during their hospital stay and 13.3% were admitted to an ICU during part of or whole stay.

We found a PPV of one or more triggers of 19.8% when both acute outpatient contacts and admissions were included and a higher PPV when only admissions were analysed. Lemon and Stockwell[6] found a PPV of 34%. One of the possible reasons for this difference is that Lemon and Stockwell only screened for 11 triggers while we identified 20 different triggers, of which some had an individual PPV of 0. Another important

Table 2 The triggers we identified in our study are presented with PPV with 95% CI for identifying harm

Item	PPV (CI)%
General care	
PG1 Early warning score	
PG2 Tissue damage or pressure ulcer	
PG3 Readmission within 30 days	24/175=14 (9 to 20)
PG4 Unplanned admission	
PG5 Abnormal cranial imaging	
PG6 Respiratory or cardiac arrest/crash calls	0/1=0 (0 to 95)
PG7 Diagnostic imaging for embolus/thrombus +/− confirmation	1/2=50 (3 to 97)
PG8 Complication of procedure or treatment	17/23=74 (51 to 89)
PG9 Transfer to higher level of care	3/22=14 (4 to 36)
PG10 Hypoxia O_2 saturation <85%	0/25=0 (0 to 17)
PG11 Cancelled elective procedure/delayed discharge	1/1=100 (5 to 100)
Surgical care	
PS1 Return to theatre	1/1=100 (5 to 100)
PS2 Change in planned procedure	
PS3 Surgical site infection or hospital acquired urinary tract infection	6/6=100 (52 to 100)
PS4 Removal/injury/repair of organ	
Intensive care	
IP1 Readmission to intensive care or high-dependency care	
Medication	
PM1 Vitamin K (except for routine dose in neonates)	
PM2 Naloxone	
PM3 Flumazenil (romazicon)	
PM4 Glucagon or glucose ≥10%	
PM5 Chlorphenamine or antihistamine	0/1=0 (0 to 95)
PM6 Antiemetics	
PM7 IV Bolus ≥10 mL/kg colloid or crystalloid given	3/19=16 (4 to 40)
PM8 Abrupt medication stop	
Lab test	
PL15 Thrombocytopenia (platelets <100)	0/7=0 (0 to 44)
PL1 High INR >5 or a PTT >100	
PL2 Transfusion	2/8=25 (4 to 64)
PL3 Abrupt drop in Hb or Hct (>25%)	2/8=25 (4 to 64)
Biochemistry	
PL4 Rising urea or creatinine (>2× baseline)	0/1=0 (0 to 95)
PL5/PL6 Electrolyte abnormalities (Na^+ <130 or >150, K^+ <3.0 or >6.0)	0/12=0 (0 to 30)
PL7 Hypoglycaemia (<3 mmol/L)	3/8=38 (10 to 74)
PL8 Hyperglycaemia (>12 mmol/L)	0/1=0 (0 to 95)
PL9 Drug level out of range	
Microbiology	
PL10 MRSA bacteraemia	
PL11 *Clostridium difficile*	
PL12 VRE	
PL13 Nosocomial pneumonia	2/2=100 (20 to 100)
PL14 Positive blood culture	1/1=100 (5 to 100)
Other	
PO1 Other event	

The numerator represents number of harm events and the denominator how many times each individual trigger was found in all patient contacts (n=761).
Hb, haemoglobin; HCT, haematocrit; INR, international normalised ratio; MRSA, methicillin-resistant Staphylococcus aureus; PPV, positive predictive value; VRE, vanc resistant enterococcus.

difference is that Lemon and Stockwell reported results from a 4-year period whereas we only screened for a 3-month period, which limits generalisability.

Like Kirkendall *et al*,[7] we found that some modules, in particular the laboratory module, contained adult-oriented triggers such as high INR and diagnostic imaging for embolus that were not identified in our chart review. Removal of unnecessary triggers would reduce the overall number of triggers that reviewers must consider. Hypoxia, electrolyte abnormalities and thrombocytopenia had a PPV of 0 and may not be worthwhile screening for in our patient population.

Table 3 Rate of trigger-positive contacts, rate of harm and PPV of positive triggers across specialties

Specialty	Rate of trigger-positive contacts	Rate of harm	PPV (%)
Paediatric	207/584 (35.4%)	29/584 (5.0%)	14
Orthopaedic surgery	11/83 (13.3%)	5/83 (6.0%)	45.5
General surgery	12/63 (19.0%)	3/63 (4.8%)	25
Ear, nose and throat	12/31 (38.7%)	11/31 (35.5%)	91.7
Total	242/761 (31.8%)	48/761 (6.3%)	19.8

However, bearing in mind the short study period of 3 months, further studies, ideally multicenter studies are needed before abolishment of some triggers.

To the best of our knowledge, we are the first group to report the use of a PTT for unplanned outpatient visits. Some trigger tools exist for outpatient care,[11 12] however they are not suitable for children and adolescents. As harm was detected in 7/267 (2.6%) of acute outpatient visits, we believe that identification of these events is important in a unit like ours where the number of acute outpatient visits is substantial.

Regardless, there seems to be a higher PPV of triggers in surgical patients, but the rate of harm was comparable across medical and surgical patients (5–6%), excluding ENT patients with a 35% total harm rate.

Needless to say, the extent to which trigger tools detect harm as intended depends to a large extent on routines for documentation. Like Kirkendall *et al*,[7] we noticed that frequently occurring complications like those due to peripheral venous catheters, for example, phlebitis, subcutaneous oedema, tissue necrosis and infection, are infrequently documented in the records of the patients in our unit. The same applies to the incidence reporting system that contains information about only a small fraction of these types of patient harm. Hence, certain types of patient harm that are frequently occurring and should be targeted by interventions are not detected in their full extent neither with the PTT nor through voluntary incidence reporting.

Limitations of the study

The PTT screening and incident report analyses were performed by only one investigator and the inter-rater agreement could not be assessed in this study. The judgement whether harm was present and how severe was left to one person, with no one to validate the findings. To the best of our knowledge, the PTT is not established in any Norwegian paediatric unit, and we did not succeed in finding a person with time and experience to validate the findings. For the same reason, this was a relatively small single-centre study and the study period was short. Some of the triggers that were not identified during the three study months could possibly have been detected if we had screened for a longer period. We screened unplanned outpatient contacts and we included all sodium and potassium levels out of range. This represents deviations from the PTT user guide and could potentially have biased our results. However, as the outpatient contacts and admissions are to a large extent reported separately, and as the sodium and potassium trigger did not predict harm in any of our patients, we believe that these factors did not influence the main conclusions of the study. Generalisability of our results may be limited to settings with similar organisation of specialist healthcare including referral practices. However, it is important that utility studies performed in various patient groups be published in order for clinicians to judge applicability of the results to their practice.

CONCLUSION

Using the NHS PTT we found a rate of trigger-positive contacts and a rate of harm comparable to an extensive Canadian review. The PTT enabled us to detect more and different types of harm among our children and adolescents than what we detect by our routine system for reporting patient harm.

The presence of adult-oriented triggers, triggers that were not identified at all, as well as triggers with a low predictive value for harm, indicate a need for modification of trigger tools to the setting in which they are intended to be used. The NHS PTT, with certain modifications can, as a supplement to voluntary incidence reporting, be used to calculate the rate of harm and identify areas of care where most harm events are occurring. Hence, it may inform priorities for action and track improvements over time.

Acknowledgements The authors wish to thank Gunnvor Flaa Marum in the AHUS GTT team for assisting in the PTT screening.

Contributors ALS was the lead author for this paper and involved in all stages including design of the research, acquisition of the data, analysis and interpretation of the data and statistical analysis. BN contributed to drafting of the manuscript, critical revision of the manuscript and supervision.

Funding This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None.

Ethics approval The institutional review board at Akershus University Hospital.

Provenance and peer review Not commissioned; internally peer reviewed.

Data sharing statement No additional data are available.

REFERENCES

1. Kohn LT, Corrigan J, Donaldson MS. *To err is human: building a safer health system*. Washington, DC: National Academy Press, 2000:287
2. Leape LL, Woods DD, Hatlie MJ, *et al*. Promoting patient safety by preventing medical error. *JAMA* 1998;280:1444–7.
3. Layde PM, Cortes LM, Teret SP, *et al*. Patient safety efforts should focus on medical injuries. *JAMA* 2002;287:1993–7.

4. NHS Institute for Innovation and Improvement. *The paediatric trigger tool user guide*. Coventry: NHS Institute for Innovation and Improvement, 2010.
5. Griffin FRR. *IHI global trigger tool for measuring adverse events*. Cambridge, MA: IHI Innovation Series White Paper, 2009.
6. Lemon V, Stockwell DC. Automated detection of adverse events in children. *Pediatr Clin North Am* 2012;59:1269–78.
7. Kirkendall ES, Kloppenborg E, Papp J, *et al*. Measuring adverse events and levels of harm in pediatric inpatients with the Global Trigger Tool. *Pediatrics* 2012;130:e1206–14.
8. Matlow AG, Baker GR, Flintoft V, *et al*. Adverse events among children in Canadian hospitals: the Canadian Paediatric Adverse Events Study. *CMAJ* 2012;184:E709–18.
9. Solevag AL, Eggen EH, Schroder J, *et al*. Use of a modified pediatric early warning score in a department of pediatric and adolescent medicine. *PLoS ONE* 2013;8:e72534.
10. National Coordinating Council for Medication Error Reporting and Prevention (NCC MERP) (1996, revised 2001) National Coordinating Council for Medication Error Reporting and Prevention (NCC MERP) Taxonomy of Medication Errors. http://www.NCCMERP.org
11. Gandhi TK, Seger AC, Overhage JM, *et al*. Outpatient adverse drug events identified by screening electronic health records. *J Patient Saf* 2010;6:91–6.
12. NHS Institute for Healthcare Improvement. *IHI outpatient adverse event trigger tool*. In: Institute for Healthcare Improvement, ed. Cambridge, 2011.