

# NC-FASTER SYNDROME VALIDATION REPORT: Year 2 Update



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The Carolina Center for Health Informatics in the Department of Emergency Medicine at the University of North Carolina at Chapel Hill prepared the original Year 1 *NC-FASTER Syndrome Validation Report* in 2021 and this update for Year 2. Lead authors are listed below. For more information about NC DETECT, please visit our website (<http://ncdetect.org/>) or email us at [ncdetect@listserv.med.unc.edu](mailto:ncdetect@listserv.med.unc.edu).

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## Introduction

The North Carolina Disease Event Tracking and Epidemiologic Collection Tool (NC DETECT) is a grant-funded, population-based surveillance system that collects data for public health surveillance and early event detection. NC DETECT captures emergency department (ED) visit data, Carolinas Poison Center (CPC) data, emergency medical services (EMS) data, data from select urgent care centers, and data from inpatient and outpatient encounters in the NC Health Information Exchange (HIE). NC DETECT is managed by the Carolina Center for Health Informatics (CCHI) at the University of North Carolina at Chapel Hill under a contract with the North Carolina Division of Public Health (NC DPH) Communicable Disease Branch.<sup>1</sup> NC DETECT captures ED visit data from all 24/7, acute-care, civilian, hospital-affiliated EDs as mandated by NC General Statute § 130A-480.<sup>2</sup> Currently, there are 130 facilities sending ED visit data to NC DETECT (a full list of participating EDs is available at <http://ncdetect.org/participating-hospitals>).<sup>1</sup>

Since NC DETECT is primarily designed for acute event detection (e.g. infectious disease outbreaks, bioterrorism, etc.) and situational awareness, facilities are required to submit ED visit data to NC DETECT at least once daily. While many data elements are available in near real-time, data elements tied to hospital billing (such as diagnosis codes) may take up to a few weeks to enter the system. The near real-time data are available to authorized users through a secure web portal, and annual static data sets are made available to researchers approximately six months after the close of the calendar year, significantly faster than other statewide hospital and ED discharge and mortality datasets, through a Data Use Agreement.<sup>3</sup> NC DETECT collects a variety of ED visit data elements for research and surveillance purposes, including patient sex, patient age, patient county of residence, ED visit date and time, chief complaint, mode of transport, expected source of payment, ED discharge disposition, and diagnosis codes. Please visit <http://ncdetect.org/data-elements/> for a full list of data elements.<sup>1</sup>

In 2020, North Carolina (NC) received funding for the Firearm Injury Surveillance Through Emergency Rooms (FASTER) surveillance program. To achieve the proposed program objectives, the NC Injury and Violence Prevention Branch (IVPB) partnered with NC Division of Public Health's Epidemiology Section's Surveillance Systems Unit (SSU), the University of North Carolina (UNC) Injury Prevention Research Center (IPRC), and the CCHI. This partnership leverages the existing Syndromic Surveillance (SyS) work with ED visit data in NC to work towards the FASTER goals of increased timeliness of firearm injury reporting and dissemination of findings and insights derived from these data to key firearm injury prevention stakeholders.

The utility of data produced by NC-FASTER is dependent on the syndrome definition(s) used to identify firearm-related injuries, as well as the underlying data quality. NC has over 18 years of experience developing and evaluating syndrome definitions for use with SyS ED visit data. Syndrome definitions based on keywords from chief complaints (and triage notes, when available) and ICD-10-CM final diagnosis codes are routinely added to NC's in-house SyS system, NC DETECT, and shared publicly. NC DETECT currently provides access to over 240 active case definitions for ED visit data, including CDC case definitions for firearm-related injury.

We are currently assessing data quality with regards to quality of injury mechanism coding in NC DETECT ED visit data, focusing especially on facility trends related to firearm-related injury mechanism discharge diagnosis codes, while simultaneously evaluating the CDC all-intents firearm-related injury case definition in our data. The objective of this report is to

describe the latter effort and our preliminary syndrome validation findings from comparing information contained in free text fields with ICD-10-CM diagnosis codes provided for each visit. Findings detailed in this report will be used to make recommendations for ongoing improvement in FASTER syndrome definitions, for the benefit of NC-FASTER and all other endeavors using NC DETECT ED visit data for injury work.

## Updates From Previous Report

Our syndrome validation work during the previous contract year (Year 1) revealed conflicting intent categorizations when the CDC syndrome definition for firearm-related injuries was applied to our NC DETECT data. In response, the NC-FASTER team developed a novel intent and shooter coding schema, which separated the overall intent of each firearm injury from the shooter. When the team applied this novel schema to the original study sample via chart review, it was often found that open-text fields (i.e. chief complaint and triage note) did not match the reported discharge diagnosis code in terms of intent. For example, the triage note would describe an assault injury, but the diagnosis code entered was “W34. Accidental discharge from unspecified firearm.” In several records, the chief complaint used the exact same verbiage as the W34 ICD-10-CM code, making it difficult to distinguish if the injury was truly accidental or simply a reflection of an electronic medical record protocol. Given the limitations that were discovered, this year the team will focus on identifying specific facilities and/or counties that frequently used W34 codes in the chief complaint and discharge diagnosis fields.

Additionally, in 2021, NC DETECT transitioned to a new data aggregator. While this did not alter the data elements reported from individual facilities, it did change the process by which the facilities provide data to the aggregator and how the data are made available for our NC DETECT database. Because our team has already evaluated the efficacy of firearm-related injury identification in pre-transition data, we pulled an additional 8 weeks of data from Q3 and Q4 of 2021 (4 weeks per quarter) after the transition to Care Evolution was complete. For this Year 2 update, the team intends to look at both the application of the CDC syndrome definition and the use of W34 codes in this new data and compare trends to the older data, in order to identify any major discrepancies since the transition. Ideally, no discrepancies should be found as the transition should not have impacted the quality of the data itself.

## General Methods

In the Year 1 report, we used data from a sample of 1,475 firearm injury related ED visits in NC DETECT identified by the CDC firearm injury SyS definitions. The sample was created by randomly selecting 4 weeks from each quarter of July 2019-June 2020, for a total of 16 weeks. A week was defined as extending from Friday to the following Thursday to ensure contiguous weekend days were included in the sample. CDC firearm injury SyS definitions, comprised of ICD-10-CM discharge diagnosis codes and chief complaint keywords and exclusion terms, were used to identify these firearm injury visits, resulting in five categories: all-intents, assault, intentional self-directed, unintentional, and undetermined intent. To assess the accuracy of the CDC SyS firearm injury classifications, two medically-trained independent reviewers conducted

hand reviews of the full sample to identify false positives and evaluate intent, using all record level information available, including the chief complaint (CC) and triage notes (TN) text fields, to compare to the intent(s) assigned by the ICD-10-CM discharge diagnosis codes.

For this Year 2 report, we revisited the sample of 1,475 ED visits from 2019-2020. We reapplied the CDC V.2 SyS definition to these observations to determine which definition components were used to identify each visit. Because the coding scheme used for this re-evaluation was more conservative in the order in which it applied each of the CDC SyS definition components, it removed an additional 7 visits due to exclusionary ICD-10-CM codes or keywords, leading to a final sample of 1,468 ED visits. Using this sample, we built upon our previous investigation by looking at trends by facility and patient county of residence, as well as specifically investigating the use of W34 ICD-10-CM codes in the listed discharge diagnoses and chief complaint text fields for these observations.

Additionally, we pulled a new sample of 739 ED visits from Q3 and Q4 of 2021 to serve as a comparator group. This sample included 8 weeks of data (4 from each quarter) reported after the transition to the new Care Evolution data aggregator was completed. We evaluated these data in parallel with the 2019-2020 data, looking at the application of both the CDC SyS definition and the use of W34 codes, in order to identify any changes in the data over time. We did not investigate false positives in the 2021 sample data. During this investigation, there were 127 facilities sending ED visit data to NC DETECT (a full list of participating EDs is available at <http://ncdetect.org/participating-hospitals>).<sup>1</sup>

## High Level Findings

### Identification of Non-Fatal Firearm Injuries

The CDC SyS definition for non-fatal firearm-related injuries was applied to two different NC DETECT data samples. In both samples it was found that roughly 20% of visits were identified by ICD-10-CM discharge diagnosis codes, 20% of visits were identified by chief complaint keyword terms, and 55% of visits were identified through a combination of both codes and keywords. The code + keyword combination was most commonly used to identify visits. Nonetheless, 40+% of visits were identified solely by a code or keyword, indicating that both are necessary components of a firearm-related SyS definition in order to capture all true firearm-related visits. Trends in identification were also stratified by individual facilities. Between the 2019-2020 sample and the 2021 sample, a number of facilities increased their utilization of ICD-10-CM codes and the code + keyword combination. Notably, Facility 3 increased its reliance on ICD-10-CM codes. Facility 7, Facility 8, Facility 9, Facility 28, and Facility 37 all saw increases in the number of visits identified by the combination.

### Identification of Injury Intent

The CDC SyS definition groups ICD-10-CM codes and keyword terms into designated intent categories. In both the 2019-2020 sample and the 2021 sample, roughly 12% of visits were categorized as assaults, 1% of visits as intentional self-harm, 64-66% of visits as unintentional, and 18-21% of visits as unknown intent. Approximately 3% of visits in each sample had multiple intent categories. Most commonly, multiple intent visits were coded as both unintentional injuries and assault injuries. Upon further investigation, these visits were flagged because they had conflicting ICD-10-CM codes listed in the discharge diagnoses. We often saw the W34.00XA code (accidental discharge from unspecified firearms or gun, initial encounter)

and the X95.9XXA code (assault by unspecified firearm discharge, initial encounter) present in the same record.

### Utilization of W34 ICD-10-CM Codes and Text Excerpts

In the 2019-2020 sample, approximately 861 encounters (59%) utilized a W34 code in the discharge diagnosis. Specifically, W34.00XA was used for 826 visits (96%). The utilization of W34 ICD-10-CM codes increased by 4% between the two samples; this was evident at both the facility and county level. In the 2021, we found 63% of our sample used a W34 code. While the use of W34 codes is increasing over time, the use of the W34 text in the chief complaint is decreasing. In the sample from 2019-2020, 12% of visits had the W34 code entered into the chief complaint text field, whereas the 2021 sample had a total of 3 visits, approximately 0.4% of visits. This is major progress because our previous report demonstrated that the use of the W34 code in the chief complaint has been shown to complicate intent identification efforts.

### False Positives by Facility and County

Building on our previous Year 1 Syndrome Validation report, we re-visited the false positives identified in the 2019-2020 data. In this sample of 1,468 firearm-related ED visits, 78 were conservatively identified as false positive visits. We stratified false positive rates by facility and patient county. For facilities with 5-9 encounters, 47% had at least one false positive, with individual rates ranging from 20% to 60%. For facilities with  $\geq 10$  encounters, 11 had false positive rates  $\geq 10\%$ . A number of counties were also identified to have unusually high false positive rates, but bias attributed to small sample size limited our ability to draw meaningful conclusions at the level of individual facilities and/or counties.

## Identification of Non-Fatal Firearm Injuries

The CDC V.2 Firearm Injury Syndrome Definition (CDC SyS) is designed to capture initial ED encounters for firearm-related injuries when applied to syndromic surveillance data. It categorizes both ICD-10-CM discharge diagnosis codes as well as chief complaint text keywords into inclusion and exclusion criteria.<sup>4</sup> Firearm-related ED visits can be identified solely through an ICD-10-CM code or chief complaint keyword in the visit record, or through a combination of the two. The ICD-10-CM codes and chief complaint keywords used for inclusion are further divided into four subcategories that allow for determination of injury intent: unintentional, intentional, assault, and undetermined injuries. NC DETECT relies upon the CDC SyS definition to identify non-fatal firearm injuries among NC ED visits. We applied the CDC definition to both old (2019-2020) and new (2021) data samples and stratified visits based on the definition components used for identification (**Tables 1 and 2**).

**Table 1. Firearm-Related ED Visits Identified by each CDC V.2 Definition Component (2019-2020)**

CDC V.2 Definition Component	Visit Count (%)
ICD-10-CM Code Only	319 (22%)
Keyword + ICD-10-CM Code Combination	802 (55%)
Keyword Only	347 (24%)
<b>Total</b>	<b>1468 (100%)</b>

**Table 2. Firearm-Related ED Visits Identified by each CDC V.2 Definition Component (2021)**

CDC V.2 Definition Component	Visit Count (%)
ICD-10-CM Code Only	172 (23%)
Keyword + ICD-10-CM Code Combination	411 (56%)
Keyword Only	156 (21%)
<b>Total</b>	<b>739 (100%)</b>

We found that both the listed ICD-10-CM discharge diagnosis codes and the chief complaint keyword terms in the CDC definition were crucial to identifying non-fatal firearm visits, and this held true over time. The code + keyword combination was used to identify >55% of visits. Nonetheless, the ICD-10-CM codes alone and the keyword terms alone each identified over 20% of visits. Thus, both forms of identification, numerical and text-based, are necessary for accurate identification and should be used in conjunction in order to avoid underestimating the prevalence of non-fatal firearm injuries.

**Visit Identification By Facility – Top 5 by ED Visit Volume**

While both aggregated samples demonstrated roughly a **20% vs. 55% vs. 20%** split among visits identified by ICD-10-CM code alone, the code+ keyword combination, and the keyword terms alone, this pattern did not hold true for all individual facilities. To investigate this further, we looked at the **top five facilities** in each sample **based on their number of firearm-related ED visits (Tables 3 and 4)**. In order to account for selection bias within our random sample, we also looked at the complete sample of firearm-related ED visits during the study time period (not just the weeks we selected for detailed review), and the five facilities identified in our random sample were also included in the top six facilities identified by volume in the full sample of ED visits. Thus, we are confident that our simple random sample did not over-sample from any one of the facilities identified below, and that the five facilities listed in each table represent the largest contributors to the number of firearm-related ED visits during each time period.

**Table 3. Firearm-Related ED Visits Identified by each CDC V.2 Definition Component for Top 5 Facilities Based on Firearm-Related ED Visit Volume (2019-2020)**

Top 5 Facilities	ICD-10-CM Code Only	Keyword + ICD-10-CM Code Combination	Keyword Only	Total Visits
Facility 1	11 (11%)	64 (64%)	25 (25%)	100
Facility 2	4 (4%)	80 (78%)	18 (18%)	102
Facility 3	6 (6%)	31 (29%)	69 (65%)	106
Facility 4	17 (16%)	80 (75%)	9 (8%)	106
Facility 5	6 (4%)	86 (60%)	51 (36%)	143
<b>Total</b>	<b>44 (8%)</b>	<b>341 (61%)</b>	<b>174 (31%)</b>	<b>557 (100%)</b>

**Table 4. Firearm-Related ED Visits Identified by each CDC V.2 Definition Component for Top 5 Facilities Based on Firearm-Related ED Visit Volume (2021)**

Top 5 Facilities	ICD-10-CM Code Only	Keyword + ICD-10-CM Code Combination	Keyword Only	Total Visits
Facility 6	9 (23%)	17 (43%)	14 (35%)	40
Facility 2	3 (6%)	37 (73%)	11 (22%)	51
Facility 5	7 (13%)	41 (73%)	8 (14%)	56
Facility 4	18 (32%)	34 (60%)	5 (9%)	57
Facility 3	15 (19%)	44 (55%)	21 (26%)	80
<b>Total</b>	<b>52 (18%)</b>	<b>173 (61%)</b>	<b>59 (21%)</b>	<b>284 (100%)</b>

In the 2019-2020 sample (**Table 3**), the top five facilities by visit volume relied **more heavily on the use of keyword-based identification** compared to the sample as a whole. From these five facilities, 61% of the visits were identified via the keyword + ICD-10-CM code combination, 31% were identified using keywords only, and only 8% were identified solely using the ICD-10-CM code. This indicates that these facilities did not use the firearm injury ICD-10-CM codes as well as the state as a whole. In contrast, the top five facilities by volume from the 2021 sample (**Table 4**) more closely mirrored the aggregated sample pattern of 20/55/20% for each of the identification categories. This may indicate that they improved their use of ICD-10-CM firearm injury codes in the 2021 data. **In particular, visits to Facility 3 and Facility 4 were more frequently identified using ICD-10-CM codes in the 2021 data, balancing out the distribution.**

**Visit Identification By Facility – Any Facility with 10 or More ED Visits**

We also looked at firearm-related visit identification among **facilities that reported 10 or more firearm-related ED visits** during each sample time period (**Tables 5 and 6**). The purpose of this additional analysis was to identify patterns within individual facilities.

**2019-2020 Sample (Table 5):**

- 3 of 35 facilities had distributions similar to the sample average.
- 3 facilities only used keywords in combination with an ICD-10-CM code.
- 2 facilities only relied on keywords (Facility 7 and Facility 8)
- 1 facility only used ICD-10-CM codes in combination with keyword terms (Facility 35).

**2021 Sample (Table 6):**

- 3 of 19 facilities had distributions similar to the sample average.
- 1 facility only used keywords in combination with an ICD-10-CM code (Facility 40).
- 3 facilities only used ICD-10-CM codes in combination with keyword terms.
- 1 facility only used ICD-10-CM codes (Facility 12).

**Notable Changes Over Time (Table 5 → Table 6)**

Of the 18 facilities listed in both **Tables 5 and 6**, six of them demonstrated an increase in ICD-10-CM code utilization and saw increases in both the ICD-10-CM only category as well as the combination category, with concurrent decreases in visits solely identified by keyword. As stated previously, **Facility 3** was one facility with major changes over time. Additionally, **Facility 7** went from solely relying on keywords in Table 5 to having 73% of its visits identified via the code + keyword combination in **Table 6**. **Facility 8** went from solely relying on keywords to having 76% of its visits identified via the code + keyword combination. Alongside these six

facilities, three others saw increases in visit identification via code + keyword combination. **Facility 9** and **Facility 10** both saw increases in the use of keywords alone and in combination, while **Facility 11** increased identification via the combination and decreased identification via ICD-10-CM code or keyword term alone.

**Over time (from 2019-2020 in Table 5 to 2021 in Table 6), there was an overall 5 percentage point increase in the use of the code + keyword combination.** This is reassuring as identification via the combination implies concurrence between the discharge diagnosis codes and the recorded chief complaint, which increases the likelihood of identifying a true positive firearm-related ED visit. For the most part, facilities in **Table 6** that did not identify visits via the ICD-10-CM code alone or the keyword term alone did still identify visits via the combination. The exception is Facility 12. All 10 of the ED visits reported from Facility 12 were identified solely by the ICD-10-CM discharge diagnosis code in **Table 6**. This is a change from **Table 5**, where Facility 12 demonstrated a more diverse identification distribution. This raises concerns about either a lack of keyword utilization at the level of the facility or a failure to report text fields through Care Evolution such that keywords cannot be identified in NC DETECT.

**Table 5. Firearm-Related ED Visits Identified by each CDC V.2 Definition Component for Facilities with ≥10 Firearm-Related ED Visits in the Sample (2019-2020)**

Facility	ICD-10-CM Code Only	Keyword + ICD-10-CM Code Combination	Keyword Only	Total Visits
Facility 13	3 (27%)	7 (64%)	1 (9%)	11
Facility 14	2 (12%)	15 (88%)	0 (0%)	17
Facility 15	4 (31%)	8 (62%)	1 (8%)	13
Facility 5	6 (4%)	86 (60%)	51 (36%)	143
Facility 16	4 (40%)	6 (60%)	0 (0%)	10
Facility 17	2 (12%)	11 (65%)	4 (24%)	17
Facility 6	13 (17%)	61 (78%)	4 (5%)	78
Facility 18	1 (9%)	9 (82%)	1 (9%)	11
Facility 19	2 (7%)	23 (85%)	2 (7%)	27
Facility 20	3 (27%)	6 (55%)	2 (18%)	11
Facility 21	1 (8%)	4 (33%)	7 (58%)	12
Facility 3	6 (6%)	31 (29%)	69 (65%)	106
Facility 22	1 (6%)	5 (31%)	10 (63%)	16
Facility 23	3 (27%)	4 (36%)	4 (36%)	11
Facility 26	0 (0%)	0 (0%)	11 (100%)	11
Facility 12	31 (66%)	5 (11%)	11 (23%)	47
Facility 1	11 (11%)	64 (64%)	25 (25%)	100
Facility 24	10 (29%)	23 (66%)	2 (6%)	35
Facility 27	7 (54%)	5 (38%)	1 (8%)	13
Facility 28	4 (21%)	12 (63%)	3 (16%)	19
Facility 29	1 (9%)	6 (55%)	4 (36%)	11
Facility 30	2 (11%)	14 (74%)	3 (16%)	19
Facility 31	0 (0%)	0 (0%)	31 (100%)	31
Facility 32	1 (8%)	5 (42%)	6 (50%)	12
Facility 33	5 (20%)	19 (76%)	1 (4%)	25
Facility 34	6 (27%)	15 (68%)	1 (5%)	22
Facility 9	29 (50%)	24 (41%)	5 (9%)	58
Facility 35	0 (0%)	9 (90%)	1 (10%)	10

Facility 36	3 (25%)	6 (50%)	3 (25%)	12
Facility 2	4 (4%)	80 (78%)	18 (18%)	102
Facility 37	5 (21%)	8 (33%)	11 (46%)	24
Facility 38	1 (8%)	11 (85%)	1 (8%)	13
Facility 39	66 (84%)	12 (15%)	1 (1%)	79
Facility 4	17 (16%)	80 (75%)	9 (8%)	106
Facility 25	2 (11%)	16 (89%)	0 (0%)	18
<b>Sub-Sample Total</b>	<b>256 (20%)</b>	<b>690 (55%)</b>	<b>304 (24%)</b>	<b>1250</b>

**Table 6. Firearm-Related ED Visits Identified by each CDC V.2 Definition Component for Facilities with ≥10 Firearm-Related ED Visits in the Sample (2021)**

Facility	ICD-10-CM Code Only	Keyword + ICD-10-CM Code Combination	Keyword Only	Total Visits
Facility 5	7 (13%)	41 (73%)	8 (14%)	56
Facility 17	1 (6%)	13 (81%)	2 (13%)	16
Facility 6	9 (23%)	17 (43%)	14 (35%)	40
Facility 19	0 (0%)	8 (62%)	5 (38%)	13
Facility 40	3 (23%)	10 (77%)	0 (0%)	13
Facility 3	15 (19%)	44 (55%)	21 (26%)	80
Facility 26	2 (18%)	8 (73%)	1 (9%)	11
Facility 12	10 (100%)	0 (0%)	0 (0%)	10
Facility 1	10 (32%)	16 (52%)	5 (16%)	31
Facility 24	2 (17%)	6 (50%)	4 (33%)	12
Facility 28	1 (8%)	9 (69%)	3 (23%)	13
Facility 30	1 (10%)	8 (80%)	1 (10%)	10
Facility 33	0 (0%)	7 (50%)	7 (50%)	14
Facility 31	3 (12%)	19 (76%)	3 (12%)	25
Facility 9	3 (20%)	8 (53%)	4 (27%)	15
Facility 2	3 (6%)	37 (73%)	11 (22%)	51
Facility 37	0 (0%)	9 (82%)	2 (18%)	11
Facility 39	20 (56%)	11 (31%)	5 (14%)	36
Facility 4	18 (32%)	34 (60%)	5 (9%)	57
<b>Sub-Sample Total</b>	<b>108 (21%)</b>	<b>305 (60%)</b>	<b>101 (20%)</b>	<b>514</b>

Overall, individual facilities have seen major changes in their coding and documentation of non-fatal firearm-related ED visits between 2019-2020 and 2021. Nonetheless, these changes have averaged out such that the **general utilization of each of the CDC V.2 definition components** for identification of these visits has **not changed substantially over time**. Encouragingly, the use of the code + keyword combination has increased by 5 percentage points, which may indicate increased concurrence between code-based and text-based fields and increased use of the ICD-10-CM firearm injury codes.

Of note, we decided to make a cut-off of 10 firearm-related ED visits for these tables in order to avoid drawing conclusions from small sample sizes. It is important to note that the timeframe of the 2021 sample is half that of the 2019-2020 sample (6 months versus 12 months), resulting in fewer facilities meeting inclusion criteria for **Table 6** as compared to **Table 5**. This did limit the number of comparisons we were able to make over time.

## Identification of Injury Intent

Within the CDC V.2 syndrome definition, the listed ICD-10-CM codes and chief complaint keywords are divided into four intent categories, allowing for identification of injury intent.<sup>4</sup> These four categories include: assault, intentional, unintentional, and undetermined injuries. When applying the CDC definition in our data, we made a few adjustments. First, we relabeled the “intentional” category as “intentional self-harm” since all ICD-10-CM codes included in the definition were self-harm codes. Second, we did not use the “undetermined” category, which identifies very few cases in our data. Instead, we created an “unknown” category that included the few visits receiving an “undetermined” code and other visits that did not fall into the three named intent categories. We also looked at visits that met criteria for multiple intent categories. In NC DETECT, these visits are traditionally counted twice when considering frequency of intent.

The CDC V.2 definition specifies that intent categories are first identified using designated ICD-10-CM codes, and then chief complaint keywords unique to each intent category (i.e. for an assault injury the chief complaint must include a mechanism keyword such as “gsw” as well as the word “assault.”) If the ICD-10-CM code is absent, but the chief complaint keyword requirements are met, the visit will still be coded into the appropriate intent category. Visits that did not include a categorized ICD-10-CM code nor the appropriate chief complaint keyword combination (mechanism + intent keyword) were placed in the “unknown” category. Because almost all ICD-10-CM codes included in the CDC SyS definition were associated with an intent category, encounters identified as firearm-related visits via an ICD-10-CM code or the code + keyword combination almost always were assigned an intent category. On the other hand, encounters identified as firearm-related visits solely by chief complaint keywords comprised the largest portion of the “unknown” intent category, because while their chief complaint fields included mechanism terms such as “gsw,” they often lacked intent keywords such as “assault” or “accidental,” and thus could not be categorized.

In both the 2019-2020 sample and the 2021 sample, roughly 12% of visits were categorized as assaults, 1% of visits as intentional self-harm, 64-66% of visits as unintentional, and 18-21% of visits as unknown intent. Approximately 3% of visits in each sample were categorized as multiple intent categories. **Tables 7 and 8** look at how firearm-related ED visits in each intent category were identified. Trends were consistent over time. With the exception of the “unknown” category, which was discussed previously, **all intent categories relied heavily upon the code + keyword combination for identification.** This was expected given that most firearm-related ED visits were identified via the combination.

In the 2019-2020 sample, there were 41 visits coded as multiple intents. Of these visits, 3 were coded as both unintentional injury and intentional self-harm and the remaining 38 visits were coded as both unintentional injury and assault. These intent categories are in conflict with one another and should not co-occur. These visits were flagged because they have conflicting ICD-10-CM codes listed in the discharge diagnoses. **Most commonly, we saw the W34.00XA code (accidental discharge from unspecified firearms or gun, initial encounter) and the X95.9XXA code (assault by unspecified firearm discharge, initial encounter) present in the same record.** This code combination explained the conflicting intents identified among 29 of the 38 (76%) unintentional + assault visits.

In the 2021 sample, there were 19 visits coded as multiple intents, and all 19 were identified as both unintentional injury and assault. **Of these 19 visits with conflicting ICD-10-CM codes, 16 of them (84%) demonstrated the same code combination seen in the 2019-2020 sample of W34.00XA (flags unintentional) and X95.9XXA (flags assault).** The next section of this report further explores the utilization of W34 codes and may provide insight into why overuse of W34 codes can result in conflicting intent categorizations.

**Table 7. Firearm-Related ED Visits Identified by each CDC V.2 Definition Component, Stratified by CDC V.2 Definition Intent Category (2019-2020)**

Definition component	Assaults	Intentional Self-Harm	Unintentional	Unknown	Multiple Intents
ICD-10-CM Code Only	25 (14%)	5 (29%)	280 (29%)	0 (0%)	9 (22%)
Keyword + ICD-10-CM Code Combination	148 (84%)	12 (71%)	607 (62%)	3 (1%)	32 (78%)
Keyword Only	3 (2%)	0 (0%)	88 (9%)	256 (99%)	0 (0%)
<b>Total</b>	<b>214 (100%)</b>	<b>20 (100%)</b>	<b>975 (100%)</b>	<b>259 (100%)</b>	<b>41 (100%)</b>

**Table 8. Table 7. Firearm-Related ED Visits Identified by each CDC V.2 Definition Component, Stratified by CDC V.2 Definition Intent Category (2021)**

Definition component	Assaults	Intentional Self-Harm	Unintentional	Unknown	Multiple Intents
ICD-10-CM Code Only	20 (23%)	1 (17%)	149 (32%)	0 (0%)	2 (11%)
Keyword + ICD-10-CM Code Combination	67 (77%)	5 (83%)	322 (68%)	0 (0%)	17 (89%)
Keyword Only	0 (0%)	0 (0%)	0 (0%)	156 (100%)	0 (0%)
<b>Total</b>	<b>87 (100%)</b>	<b>6 (100%)</b>	<b>471 (100%)</b>	<b>156 (100%)</b>	<b>19 (100%)</b>

## Use of W34 ICD-10-CM Codes and Text Excerpts

In our Year 1 report for the last contract year, we manually reviewed the sample from 2019-2020 in order to validate a new method of identifying intent, as well as look at rates of false positives when applying the CDC V.2 syndromic surveillance definition within NC DETECT. One of our key findings was the frequent use of W34 ICD-10-CM codes, most commonly W34.00XA – accidental discharge from unspecified firearms or gun, initial encounter, both in the listed discharge diagnosis codes and copied as text into the chief complaint field. For this updated report, we quantified how often these codes were used both in the initial sample, as well as the updated 2021 sample.

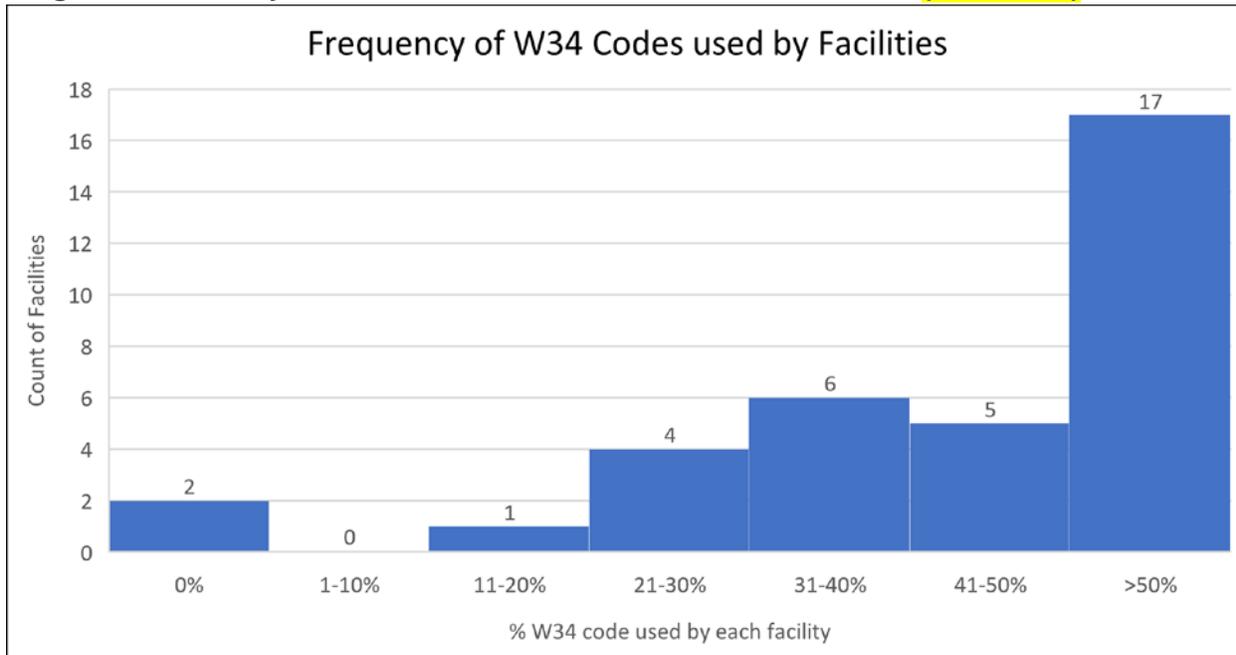
### **W34.00XA Discharge Diagnosis Code Utilization**

For this investigation we looked at all W34 codes, not just W34.00XA, though the majority of visits relied on this specific W34 code. In the 2019-2020 sample, of the 1468 ED visits, 861 visits had a W34 code (59%), and of those 861 visits, 826 of them had W34.00XA listed in the discharge diagnosis codes (96%). The remaining 35 visits used other W34 variations including subsequent encounter codes and specified firearm codes. In the 2021 sample, of the 739, 463 visits had a W34 code (63%), and of those 463 visits, 453 of them had W34.00XA listed in the discharge diagnosis codes (98%). The remaining 10 visits used other W34 variations including subsequent encounter codes and specified firearm codes. **There was a 4 percentage point increase in the use of W34 codes in the list of discharge diagnoses when comparing the 2019-2020 sample to the 2021 sample.**

**The small increase in W34 utilization was also seen when we stratified utilization of the codes by facility and patient county. Figures 1 and 2** below stratify facilities by their rates of utilization of the W34 codes. In the 2019-2020 sample, 17 of the 35 facilities (49%) with  $\geq 10$  firearm-related ED visits in the sample employed W34 codes  $>50\%$  of the time. In the 2021 sample, 13 of the 19 facilities (68%) with  $\geq 10$  firearm-related ED visits in the sample employed W34 codes  $>50\%$  of the time. In **Figure 2**, all facilities employed W34 codes  $\geq 30\%$  of the time. **In comparison to Figure 1, this suggests that utilization of W34 codes is becoming more common over time.**

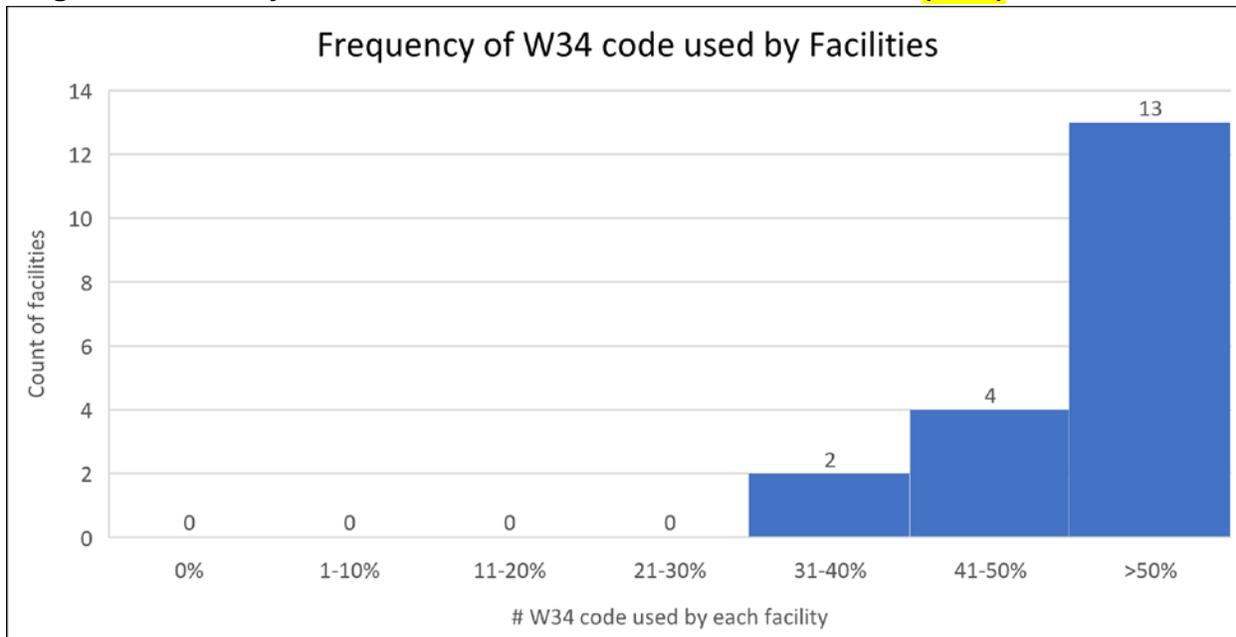
While the reason for this increase needs to be further investigated, we can postulate that it may have occurred because the code is offered as a default firearm injury code in electronic health records, or there may be protocols in place that require use of this code for billing purposes. **Nonetheless, because most of these codes, particularly W34.00XA, are considered part of the “unintentional” intent category within the CDC SyS definition, their use needs to be carefully monitored.** If used correctly, an increase in these codes over time may indicate an increase in unintentional injuries, which was not reflected in the previous section. Alternatively, if this code is being used more frequently, but not just for unintentional injuries, that confounds the accuracy of the CDC SyS intent coding.

**Figure 1. Frequency of W34 ICD-10-CM Code Utilization in the List of Discharge Diagnosis Codes by Facilities with  $\geq 10$  Firearm-Related ED Visits (2019-2020)**



Note: Only includes facilities with  $\geq 10$  firearm injury encounters in the 2019-2020 sample.

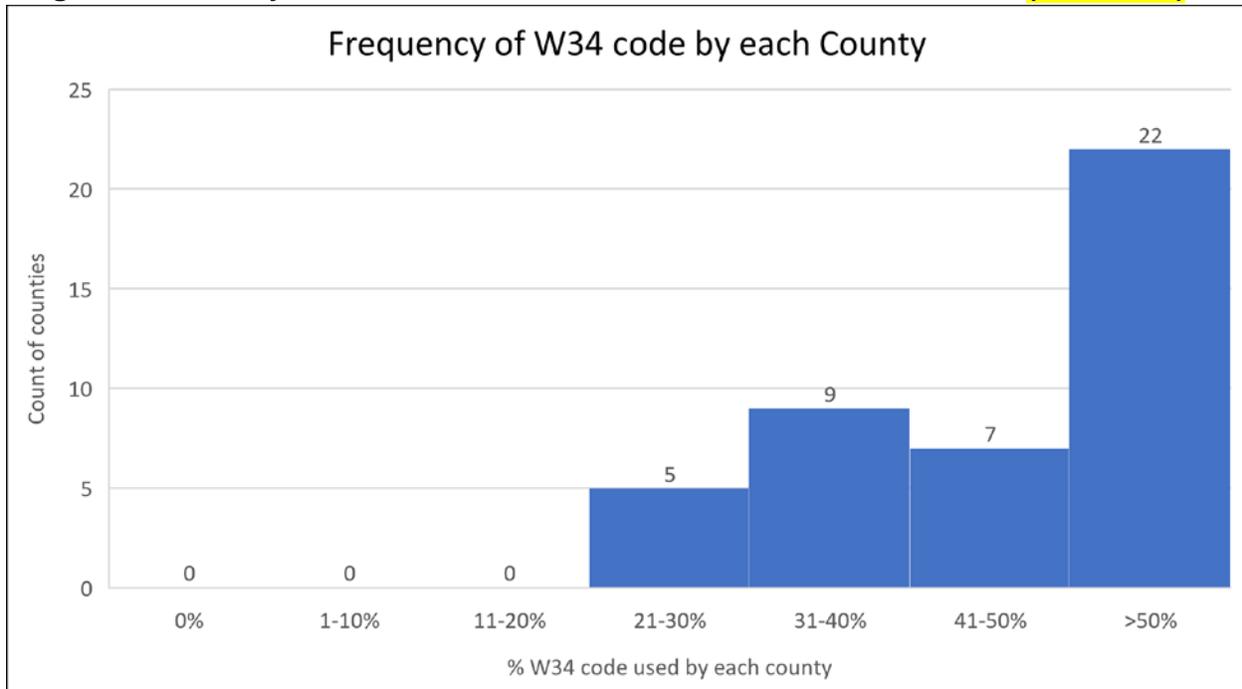
**Figure 2. Frequency of W34 ICD-10-CM Code Utilization in the List of Discharge Diagnosis Codes by Facilities with  $\geq 10$  Firearm-Related ED Visits (2021)**



Note: Only includes facilities with  $\geq 10$  firearm injury encounters in the 2021 sample.

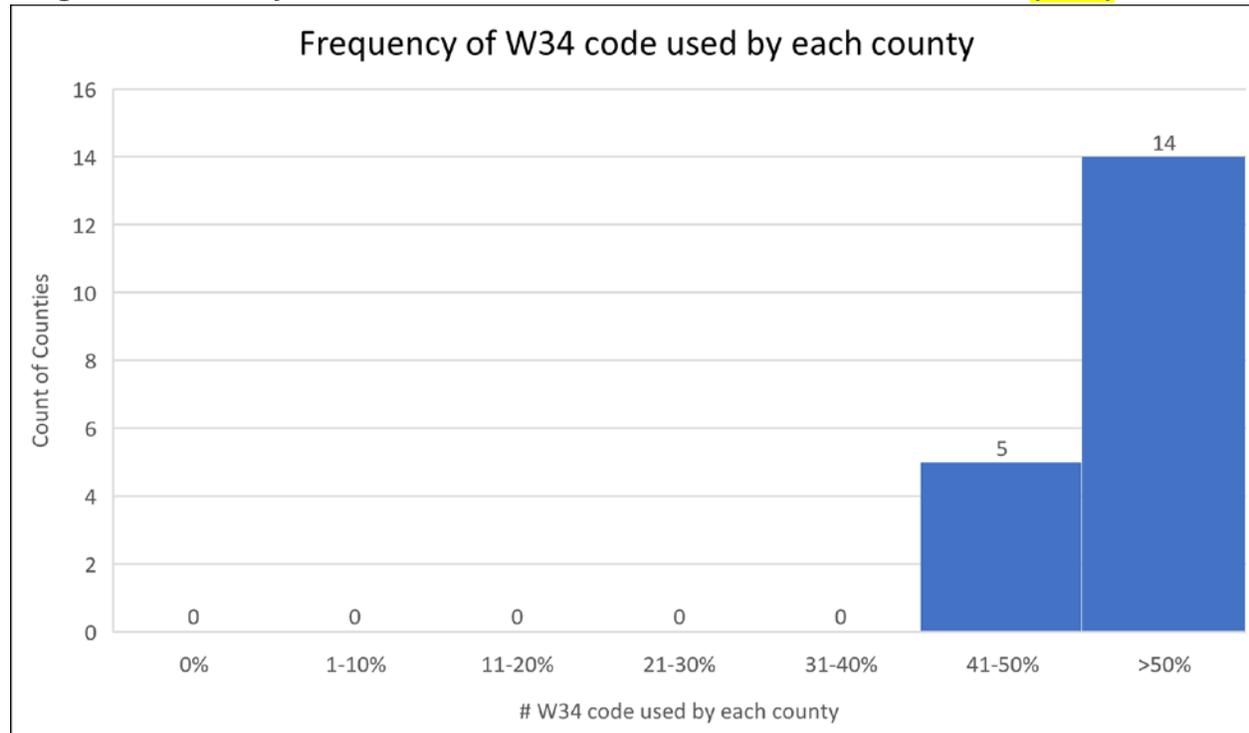
**Figures 3 and 4** below stratify patient counties of residence by their rates of utilization of the W34 codes. Of note, in the **2019-2020** sample of 1468 ED visits, **Mecklenburg** (162 visits), **Guilford** (126 visits), **Durham** (86 visits), **Wake** (79 visits) and **Cumberland** (71 visits) were the top five patient counties reported. In the **2021** sample of 739 ED visits, **Mecklenburg** (90 visits), **Durham** (56 visits), **Forsyth** (50 visits), **Guildford** (45 visits) and **Wake** (38 visits) were the **top five patient counties reported**. We looked at patient county as an additional proxy for facility. In the 2019-2020 sample, 22 of the 43 counties (51%) with  $\geq 10$  firearm-related ED visits in the sample employed W34 codes  $>50\%$  of the time. In the 2021 sample, 14 of the 19 counties (74%) with  $\geq 10$  firearm-related ED visits in the sample employed W34 codes  $>50\%$  of the time. In **Figure 4**, all facilities employed W34 codes  $\geq 40\%$  of the time. **Consistent with the trends by facility, utilization of the W34 codes has increased over time when assessed by patient county.**

**Figure 3. Frequency of W34 ICD-10-CM Code Utilization in the List of Discharge Diagnosis Codes by Patient Counties with  $\geq 10$  Firearm-Related ED Visits (2019-2020)**



Note: Only includes counties with  $\geq 10$  firearm injury encounters in the 2019-2020 sample.

**Figure 4. Frequency of W34 ICD-10-CM Code Utilization in the List of Discharge Diagnosis Codes by Patient Counties with  $\geq 10$  Firearm-Related ED Visits (2021)**



Note: Only includes counties with  $\geq 10$  firearm injury encounters in the 2021 sample.

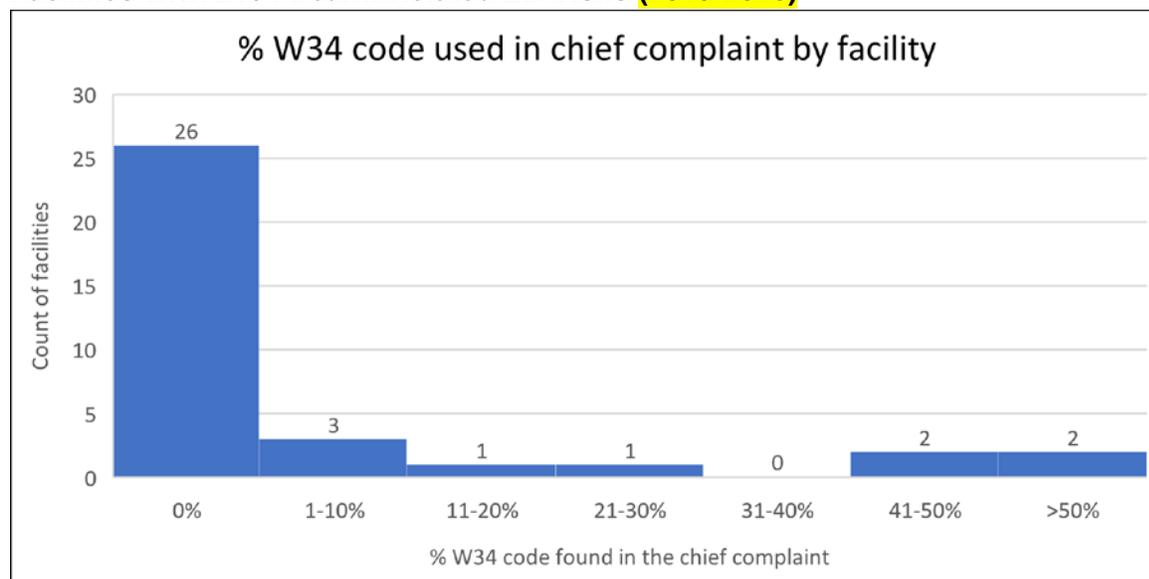
#### **Utilization of W34 Text in Chief Complaint**

As shown in our previous report from Year 1, the text of the ICD-10-CM code W34.00XA – “accidental discharge from unspecified firearms or gun, initial encounter” sometimes shows up in the chief complaint text field. What makes this problematic is its ability to disrupt intent identification when it conflicts with the ICD-10-CM codes listed in the discharge diagnoses. Because the chief complaint text often mirrors the code text verbatim, this is concerning for documentation purposes as it is evidence of a chief complaint that does not reflect the patient’s concerns in their own words. **For this investigation, we searched the chief complaint field for text that matched “accidental discharge from unsp.”** We chose to use this truncated phrase in order to capture minor variations in the text, such as abbreviating the word “unspecified”. Of note, this did not capture the small handful of visits that used assault codes or specified firearm codes in their chief complaint fields, which are also inappropriate uses of code text in the chief complaint field. **We chose to focus on W34.00X because it was the most common offender.**

In the 2019-2020 sample, there were 173 visits (12%) that were found to have the W34.00X text in the chief complaint field. We stratified these visits by facility (**Figure 5**) and found that, of the 35 facilities with  $\geq 10$  firearm-related visits in the sample, 9 of them (25%) used the W34.00X text in the chief complaint field at least once. In contrast, in the 2021 data, there were only 3 visits (<1%) that were found to have the W34.00X text in the chief complaint field. While not pictured here, those 3 visits were attributed to 2 of the 19 facilities (11%) with  $\geq 10$  firearm-related visits in the 2021 sample. The two facilities were Facility 3 and Facility 5 - 2 out of 80 encounters identified at Facility 3 (2.5%) and 1 out of 56 encounters identified at

Facility 5 (1.8%) used the W34.00X text in the chief complaint field in the 2021 sample. **Overall, our data indicate that utilization of the W34.00X text in the chief complaint field substantially decreased between the 2019-2020 and 2021 samples.**

**Figure 5. Frequency of W34.00X Language Utilized in the Chief Complaint Text Field by Facilities with ≥10 Firearm-Related ED Visits (2019-2020)**



Note: Only includes facilities with ≥10 firearm injury encounters in the 2019-2020 sample.

## False Positives by Facility and Patient County

Using the false positive data from the Year 1 Syndrome Validation report (2019-2020 sample only), we investigated the distribution of identified false positives by facilities and counties. For this investigation, false positives were defined conservatively as visits for which there was *clear evidence* in the ED visit record that the visit was either 1) not associated with a firearm-related injury, 2) a subsequent encounter for a firearm-related injury, and/or 3) met exclusion criteria under the CDC V.2 SyS all-intents definition. Once individual review was complete, the two research assistants met to discuss and reconcile disagreements until a consensus was reached on all observations. **In our sample of 1468 ED visits, 78 (5.31%) encounters were identified as false positives.** Unfortunately, we were unable to manually review and determine false positives in the 2021 sample for the Year 2 report. Therefore, we are unable to compare the number and proportion of false positives from year to year.

We stratified results by both facility and patient county of residence in order to determine if there were particular facilities or geographic regions that had higher proportions of false positives. Since the number of visits varied widely by facility and county, stratification was done in two phases. First we looked at facilities and counties with between 5-9 total firearm-related visits in the sample (**Tables 9 and 10**). Second, we looked at facilities and counties with 10 or more total firearm-related visits in the sample (**Tables 11 and 12**). This was done in an effort to limit comparison based on denominator variability.

For the first phase of stratification (facilities/counties with 5-9 firearm-related ED visits in the sample), we used 20% as our threshold for abnormality. Among the 15 facilities in **Table 9**, seven (47%) facilities had at least one false positive, while four facilities had “high proportions” of false positives, determined by our threshold. False positive rates ranged from 20% at Facility 41 to 60% at Facility 42. However, it is important to consider that both of these facilities had only five total firearm injury related ED visits in our sample. The only county (**Table 10**) where the proportion of false positives was 20% or greater was Montgomery County where there were 5 encounters, one of which was a false positive.

The second phase of stratification included facilities and counties that had 10 or more firearm-related encounters (**Tables 11 and 12**). A proportion of 10% or more false positives was used as the cutoff to flag locations where false positive reporting may be an issue. Of the 35 facilities with  $\geq 10$  visits (**Table 11**), 23 (66%) identified at least one false positive; however, only 11 had a proportion of greater than 10% false positives. In this group of 11 facilities, the raw number of false positives per facility ranged from 1 to 3 false positives. Whereas Facility 4 had the largest raw number of false positives (n=6), the false positives only accounted for approximately 5% of their over 100 total firearm injury related ED visits in our sample. Similarly, of the 42 counties with  $\geq 10$  firearm-related encounters in this sample (**Table 12**), 29 (69%) counties had at least 1 false positive. The counties highlighted in bold are not necessarily the counties with the greatest number of false positives, but rather the highest proportion of false positives.

**Table 9. False Positive Rates Among Facilities with 5-9 Firearm-Related ED Visits**

Facility	Visit Count	False Positive Count	Proportion False Positive
Facility 43	7	0	0%
Facility 44	9	2	<b>22%</b>
Facility 45	8	1	13%
Facility 46	7	1	14%
Facility 42	5	3	<b>60%</b>
Facility 47	6	0	0%
Facility 40	7	0	0%
Facility 48	7	2	<b>29%</b>
Facility 49	9	0	0%
Facility 50	7	1	14%
Facility 51	7	0	0%
Facility 52	5	0	0%
Facility 53	5	0	0%
Facility 41	5	1	<b>20%</b>
Facility 54	6	0	0%
<b>Total</b>	<b>100</b>	<b>11</b>	<b>11%</b>

**Table 10. False Positive Rates Among Counties with 5-9 Firearm-Related ED Visits**

County	Visit Count	False Positive Count	Proportion False Positive
Anson	6	1	17%
Brunswick	7	1	14%

Iredell	9	1	11%
Montgomery	5	1	<b>20%</b>
Swain	8	1	13%
<b>Total</b>	<b>35</b>	<b>5</b>	<b>14%</b>

**Table 11. False Positive Rates Among Facilities with  $\geq 10$  Firearm-Related ED Visits**

<b>Facility</b>	<b>Visit Count</b>	<b>False Positive Count</b>	<b>Proportion False Positive</b>
Facility 13	11	2	<b>18%</b>
Facility 14	17	0	0%
Facility 15	13	3	<b>23%</b>
Facility 5	143	1	1%
Facility 16	10	1	<b>10%</b>
Facility 17	17	0	0%
Facility 6	78	1	1%
Facility 18	11	0	0%
Facility 19	27	1	4%
Facility 20	11	3	<b>27%</b>
Facility 21	12	0	0%
Facility 3	106	1	1%
Facility 22	16	2	<b>13%</b>
Facility 23	11	2	<b>18%</b>
Facility 26	11	0	0%
Facility 12	47	1	2%
Facility 1	100	4	4%
Facility 24	35	1	3%
Facility 27	13	3	<b>23%</b>
Facility 28	19	2	<b>11%</b>
Facility 29	11	2	<b>18%</b>
Facility 30	19	0	0%
Facility 31	31	0	0%
Facility 32	12	3	<b>25%</b>
Facility 33	25	0	0%
Facility 34	22	2	9%
Facility 9	58	3	5%
Facility 35	10	0	0%
Facility 36	12	3	<b>25%</b>
Facility 2	102	1	1%
Facility 37	24	0	0%
Facility 38	13	0	0%
Facility 39	79	5	6%
Facility 4	106	6	6%
Facility 25	18	0	0%
<b>Total</b>	<b>1250</b>	<b>53</b>	<b>4%</b>

**Table 12. False Positive Rates Among Counties with ≥10 Firearm-Related ED Visits**

<b>County</b>	<b>Visit Count</b>	<b>False Positive Count</b>	<b>Proportion False Positive</b>
Alamance	18	0	0%
Beaufort	14	0	0%
Buncombe	31	0	0%
Burke	14	2	<b>14%</b>
Cabarrus	17	1	6%
Caldwell	10	0	0%
Catawba	15	3	<b>20%</b>
Chatham	10	2	<b>20%</b>
Cleveland	16	3	<b>19%</b>
Craven	14	0	0%
Cumberland	71	0	0%
Davidson	16	2	<b>13%</b>
Durham	86	3	3%
Edgecombe	28	3	<b>11%</b>
Forsyth	62	5	8%
Gaston	38	1	3%
Guilford	126	7	6%
Halifax	30	1	3%
Harnett	13	2	<b>15%</b>
Hertford	10	0	0%
Johnston	11	2	<b>18%</b>
Lee	23	2	9%
Lenoir	23	2	9%
Lincoln	10	1	<b>10%</b>
Mecklenburg	162	6	4%
Nash	29	0	0%
New Hanover	28	1	4%
Northampton	14	0	0%
Onslow	15	2	<b>13%</b>
Orange	18	0	0%
Person	10	1	<b>10%</b>
Pitt	18	0	0%
Randolph	15	0	0%
Richmond	10	2	<b>20%</b>
Robeson	59	1	2%
Rockingham	20	2	<b>10%</b>
Scotland	18	0	0%
Union	15	1	7%
Vance	23	1	4%
Wake	79	7	9%
Wayne	32	3	9%
Wilson	18	1	6%
<b>Total</b>	<b>1289</b>	<b>70</b>	<b>5%</b>

# Conclusions

## Identification of Non-Fatal Firearm Injuries

Syndromic surveillance definitions used to identify non-fatal firearm-related injuries in emergency department data should employ both ICD-10-CM discharge diagnosis codes and chief complaint keyword terms. Absence of one or the other may result in underestimating the prevalence of firearm-related injuries. The majority of firearm-related ED visits will likely be identified by a code + keyword combination, which helps support the identification of true positives, given multiple points of concurrent evidence in the patient record. An additional goal of this investigation was to ensure that the transition to a new data aggregator in 2021 did not disrupt the application of syndromic surveillance definitions within NC DETECT. Given the similar distribution of firearm-related ED visits based on each component of the CDC SyS definition across the two data samples, we feel confident that the SyS definition continues to be applied as expected within our data. We found no evidence that the transition to the new data aggregator impacted our nonfatal firearm injury surveillance using NC DETECT ED visit data.

## Identification of Injury Intent

As with overall visit identification, most intent categories were identified via an ICD-10-CM code + chief complaint keyword combination, supporting data concurrence within a patient record. Nonetheless, roughly 3% of visits in both samples were coded with multiple intent categories, most commonly unintentional + assault. This resulted from either the presence of both W34.00XA and X95.9XXA in the discharge diagnosis codes, or use of these codes (text only) in the chief complaint field. This warranted further investigation of the overuse of W34 codes both within the list of discharge diagnoses and the chief complaint.

## Utilization of W34 ICD-10-CM Codes and Text Excerpts

The use of W34 codes in the discharge diagnosis field has increased over time, while the use of the W34 text in the chief complaint field has decreased. We investigated W34 codes in particular due to their confounding presence in visits identified as both assaults and unintentional injuries. It is encouraging to see a decrease in the presence of the code text in the chief complaint field, as the chief complaint should reflect the patient's presenting complaint in close to their own words, rather than an ICD-10-CM code. Meanwhile, an increase in the use of the W34 ICD-10-CM code is expected since we saw an increase in the use of ICD-10-CM codes to identify firearm-related ED visits overall. The hope is that the code continues to be used appropriately, rather than in conjunction with other conflicting codes.

## False Positives by Facility and County

In our 2019-2020 sample of 1468 firearm-related ED visits, 78 were conservatively identified as false positive visits. Among facilities with at least 5 firearm-related encounters, 60% of them had at least one false positive. Among counties with at least 10 firearm-related encounters, 72% of them had at least one false positive. However, identifying facilities and/or counties where the number of false positives is a significant issue is complicated by small sample sizes. While we attempted to control for small denominator numbers by separating the facilities and counties into two groups, those with 5-9 encounters in the sample versus those with 10 or more, there were instances where 1 visit would trigger a significant percentage of false positives. Larger sample sizes would provide more useful information about the proportion of false positives across North Carolina facilities and counties, but hand reviewing each record to identify false positives is resource intensive and not feasible for the entire population of firearm-related ED visits in NC.

## Recommendations and Next Steps

Based on our findings, we recommend the following considerations as new SyS definitions for non-fatal firearm-related injuries are developed and validated:

- New SyS definitions should include both ICD-10-CM code and chief complaint keyword components in order to avoid underestimating prevalence of firearm-related visits.
- Identification of firearm-related ED visits using the code + keyword combination should be considered the ideal standard as this allows for concurrence among differing components of the patient's record.
- Utilization of W34 codes in both the discharge diagnosis and the chief complaint fields should continue to be monitored and use of any ICD code in the chief complaint field should be discouraged.
- Investigation of false positive rates needs to be continued at the level of individual facilities and counties in order to make actionable recommendations, as time and resources allow.

Potential next steps include:

- Consider over-sampling small counties and/or rural counties in order to further investigate false positive rates at the county level in order to counter small sample bias.
- Consider investigating urban-rural differences in the application of firearm-related SyS definitions – specifically the use of W34 codes.
- Consider investigating urban-rural differences in false positives rates – particularly the use of subsequent encounter codes which can be identified without hand review of records.
- Consider use of machine-based text analysis to improve accuracy of intent designation and identification of false positives in larger data samples.

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