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Linkage to Care Methods and Rates in U.S. Emergency Department-Based HIV Testing Programs – A Systematic Literature Review Brief Report

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Abstract

Background—An increasing number of U.S. emergency departments (EDs) have implemented ED-based HIV testing programs since the Centers for Disease Control and Prevention issued revised HIV testing recommendations for clinical settings in 2006. In 2010, the National HIV/AIDS Strategy (NHAS) set an LTC rate goal of 85% within 90 days of HIV diagnosis. Linkage to care (LTC) rates for newly diagnosed HIV-infected patients vary markedly by site, and many are suboptimal. The optimal approach for LTC in the ED setting remains unknown.

Objective—To perform a brief descriptive analysis of the LTC methods practiced in EDs across the United States in order to determine the overall linkage rate of ED-based HIV testing programs.

Methods—We conducted a systematic review of literature related to U.S. ED HIV testing in the adult population using PubMed, Embase, Web of Science, Scopus and Cochrane. There were 333 articles were identified; 31 articles were selected after a multiphasic screening process. We analyzed data from the 31 articles to assess LTC methods and rates. LTC methods that involved physical escort of the newly diagnosed patient to an HIV/infectious disease (ID) clinic or interaction with a specialist health care provider at the ED were operationally defined as ‘intensive’ LTC protocol. ‘Mixed’ LTC protocol was defined as a program that employed intensive linkage only part of the coverage hours. All other forms of linkage was defined as ‘non-

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intensive” LTC protocol. An LTC rate of 85% was used to identify characteristics of ED-based HIV testing program associated with a higher LTC rate.

Results—There were 37 ED-based HIV testing programs in the 31 articles. The overall LTC rate was 74.4%. Regarding type of protocol, 9 (24.3%) employed intensive LTC protocols, 25 (67.6%) non-intensive, 2 (5.4%) mixed, and 1 (2.7%) had unclear protocols. LTC rates for programs with intensive and non-intensive LTC protocols were 80.0% and 72.7%, respectively. Four (44.4%) with intensive protocols and nine (36.0%) with the non-intensive protocols had LTC rates >85%. The linkage staff employed was different between ED programs. Among them, 25 (67.6%) programs used exogenous staff, ten (27.0%) used the ED staff, and 2 had no information. All the programs in the non-intensive group utilized drop-in HIV/ID clinic or medical appointments while seven out of nine of the programs in the intensive group physically escorted the patients to the initial medical intake appointment. There were no significant differences in characteristics of ED-based HIV testing programs between those with 85% LTC rate versus those with <85% within the intensive or non-intensive group.

Conclusion—Intensive LTC protocols had a higher LTC rate and a higher proportion of programs that surpassed the >85% NHAS goal as compared to non-intensive methods, suggesting that, when possible, ED-based HIV testing programs should adopt intensive LTC strategies to improve LTC outcomes. However, intensive LTC protocols most often required involvement of multidisciplinary non-ED professionals and external research funding. Our findings provide a foundation for developing best practices for ED-based HIV LTC programs.

Keywords

HIV testing; emergency department; linkage to care

INTRODUCTION

Background

The Centers for Disease Control and Prevention (CDC) key strategies to control the HIV epidemic include routinizing HIV testing and linking newly diagnosed patients to care in healthcare settings, including emergency departments (ED).¹ In 2009, the national linkage to care (LTC) rate was estimated at 66%.⁴ In 2010, the National HIV/AIDS Strategy (NHAS) set an LTC rate goal of 85% within 90 days of HIV diagnosis.⁵ While there exists a need for knowledge regarding current trends and optimal strategies for linking newly diagnosed patients to care, the literature on LTC of the ED-based screening program is relatively sparse and comprehensive information regarding LTC methods is lacking. An up-to-date and detailed synthesis of the available literature assessing U.S. ED-based LTC practices is needed. Identification of effective LTC methods through systematic analysis of existing ED-based HIV testing programs will provide valuable guidance for developing best practices for ED-based HIV LTC programs.

We performed a systematic review of studies that reported LTC data from U.S. adult ED HIV testing programs. The study aimed to (1) summarize and compare types of LTC protocols and (2) determine whether specific LTC methods were more effective than others.

METHODS

Study selection and Data Abstraction

We conducted a comprehensive search on Pubmed, Embase, Web of Science, Scopus and Cochrane databases for studies published as of June 2013, using search terms related to HIV, linkage to care, and emergency department (Appendix 1). Only full text articles and conference abstracts were selected. Studies that reported data in commentaries or editorials, contained pediatric data, had no LTC data, or had overlapped data from the same study site were excluded. The study selection process and the result are presented in Appendix 1.

Data Items and Definitions

Each program's LTC data from the final selected articles were independently extracted both quantitatively and qualitatively and verified through discussion and consensus with the senior author. The key data included are outlined in Table 1.

Following rigorous examination of the linkage modalities, each study was categorized based on the type of LTC protocol used. We operationally defined LTC protocols as "Intensive", "Non-intensive" or "Mixed". Only "direct linkage", operationally defined as LTC as a result of an active or passive referral process from an ED testing program,⁶ was analyzed in our study. "Intensive" LTC protocol was defined as when a patient who had an HIV positive test was linked to care (1) by a healthcare worker who physically escorted the patient to a specialty clinic, or (2) when the patient received in-person interaction from an HIV specialist [e.g. Infectious Disease (ID) specialist, ID fellow, HIV specialty nurse] while in the ED. "Mixed" LTC protocol was defined as a program that employed intensive LTC protocol only part of the coverage hours which varied by the time of the day or day of the week. All other forms of linkage protocols were defined as "non-intensive" LTC protocol. "Unclear protocol" was when the LTC protocol was not described in the article.

RESULTS

A total of 37 testing programs from 31 publications (28 journal articles and three conference abstracts) which met inclusion criteria were included (Table 1).⁷⁻³⁷ All programs except one were reported from academic EDs in urban settings and 27 (72.9%) reported receiving extramural funding (Table 1). The 37 programs accounted for 204,783 HIV tests of which 1,816 were HIV infected (0.9% seropositivity). Most programs (59.5%) used point-of-care (POC) tests. Overall, nine (24.3%) utilized an intensive LTC protocol, 25 (67.6%) non-intensive, two (5.4%) mixed, and one (2.7%) unclear. The overall LTC rate was 74.4%. The programs that employed intensive LTC protocols had an average LTC rate of 80.0% and the non-intensive protocol ones had 72.7%. Four (44.4%) programs with intensive protocols and nine (36.0%) programs with the non-intensive protocols had LTC rates >85%.

We observed substantial heterogeneity with regard to the exact methods of linkage modalities and key program data reporting as summarized and detailed on Table 1. The composition of the linkage staff also varied: 25 (67.6%) programs used exogenous staff, ten (27.0%) used the ED staff, and 2 (5.4%) had no information. Twenty-two (59.5%) programs made attempts to call patients to ensure LTC, six (16.2%) did not, and the remaining nine

(24.3%) did not report the information. Only 8 (21.6%) programs reported duration from diagnosis to LTC which varied from zero to 365 days and only 4 reported an LTC rate of >85% within 90 days of diagnosis. There were no significant differences in ED volume, type of HIV test, linkage staff, use of follow-up call, and receipt of extramural funding between those with ≥85% LTC rate versus those with <85% within the intensive or non-intensive group.

DISCUSSION

This descriptive review included 37 U.S. adult ED HIV testing programs that performed over 200,000 HIV tests and identified approximately 1,800 HIV infected individuals. The overall LTC rate of 74% is comparable to the 76% found in a systematic review and meta-analysis by Marks *et al* on LTC in HIV testing programs in ED and urgent care center settings on studies conducted mostly prior to the 2006 CDC HIV testing recommendations.³⁸ Our data showed that ED-based LTC rates are yet to reach the national goal of 85% while some types of LTC protocols might possess some promising results toward reaching this goal. These findings provide baseline comprehensive data on ED-based LTC rates that can be used to evaluate future progress with continued adoption of the 2006 CDC recommendations.

Programs with intensive LTC protocols had an average LTC rate of 80% while the non-intensive LTC protocols had an average of 72.7%. In fact, 44.4% of the programs that utilized intensive LTC protocols surpassed the national goal of 85% (36.0% in the non-intensive group did). The findings from this study suggest that intensive LTC protocols might be a better practice model for ED-based programs. Intensive LTC protocols may be more successful in linking patients to care because they provide an opportunity for a relatively immediate, in-person, guided transition of the patient from the testing staff to an HIV specialty or primary care provider. This model may help to earn patients' trust in the provider and healthcare system by providing support and a direct introduction to comprehensive HIV care.³⁹

However, one of the major limitations of implementing an intensive LTC protocol in an ED is that it requires multidisciplinary collaboration (ED staff, subspecialty ID/HIV physicians, and public health professionals), resources, and involvement of multiple agencies for best LTC outcomes. For those reasons, EDs with limited or no extramural funding and resources may not be able to implement the intensive protocol. It is therefore imperative to collaborate with public health or community-based resources to enforce success in such resource-limited settings. From our study, there were no notable differences (e.g. POC assay) between those with ≥85% LTC rate versus those with <85% within the non-intensive group. The difference in LTC outcomes may have been due to how they implemented their protocol by having better follow-up call processes, helping the patient make the appointment, and/or collaborations with the health department and community-based organizations to help follow up with patients. The next step to facilitate implementation and improvement of LTC services is to develop detailed recommendations for LTC best practices for ED settings with different levels of resources and capacity.

The definition of LTC by each program varied and might not truly indicate a successful linkage. Using indicators such as CD4 counts and viral loads may be more indicative of a successful LTC but these data are often not accessible to the ED testing programs. In addition, the measure of subsequent second or third visits is more indicative of retention to care, which is beyond the scope of ED testing programs.

While our analyses were rigorously conducted, several limitations exist. Many studies from our literature search did not provide comprehensive LTC information. This limited the analyses that could be performed and the strength of inferences that could be drawn. Future researchers should report comprehensive testing and LTC data to minimize this limitation. In addition, only eight programs reported the duration to successful linkage. The NHAS goal of 85% linkage within 90 days can only be assessed if this information is reported. Publication bias likely exists due to unbalanced publication between programs with high LTC rate and those with inadequate LTC rate. In addition, programs with research resources and publication expectations from funders are more likely to publish. The data included in this literature review are mostly generated from academic EDs. Thus, the practices in community EDs are unknown. Though our operational classification as intensive and non-intensive, simplifies the diverse LTC modalities into few broad categories, it may not reflect all the true characteristics of the various linkage protocols in practice currently. Lastly, despite the rigorous literature review, we may have missed some relevant publications. The search was completed for studies published by June 2013. Therefore, we might have missed more recent data on current practices.

CONCLUSION

The average LTC rate of an ED-based HIV testing programs published prior to July 2013 was still below NHAS's goal of 85%. However, approximately 45% of the programs that utilized intensive protocols surpassed the 85% NHAS goal, trended more favorably than the 36% in those that utilized non-intensive protocols. This suggests that, when possible, ED-based HIV testing programs should adopt intensive LTC strategies to improve LTC outcomes. Standardization for reporting HIV LTC methods and results would improve future syntheses of trends and best practices. Future research should utilize in-depth qualitative and implementation science methodologies to gather data that will inform LTC best practices. Continued efforts to improve LTC modalities and practices in EDs are crucial to the health of ED patients newly diagnosed with HIV and in controlling the HIV epidemic.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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References

1. Branson B, Handsfield H, Lampe M, et al. Revised recommendations for HIV testing of adults, adolescents, and pregnant women in health-care settings. *MMWR Recomm Rep*. 2006; 55:1–17. [PubMed: 16988643]
2. Hoover J, Tao G, Heffelfinger J. Monitoring HIV testing at visits to emergency departments in the United States: very-low rate of HIV testing. *J Acquir Immune Defic Syndr*. 2013; 62:90–4. [PubMed: 23018376]
3. Rothman R, Hsieh Y-H, Harvey L, et al. 2009 US Emergency Department HIV Testing Practices. *Ann Emerg Med*. 2011; 58:S3–S9. e4. [PubMed: 21684405]
4. Hall H, Frazier E, Rhodes P, et al. Differences in human immunodeficiency virus care and treatment among subpopulations in the United States. *JAMA Intern Med*. 2013; 173:1337–44. [PubMed: 23780395]
5. National HIV/AIDS Strategy for the United States, White House Office of National AIDS Policy. [Accessed January 6, 2014] 2010. 2014. <http://www.aids.gov/federalresources/policies/national-hiv-aids-strategy/nhas.pdf>
6. Lyons M, Lindsell C, Haukoos J, et al. Nomenclature and definitions for emergency department human immunodeficiency virus (HIV) testing: report from the 2007 conference of the National Emergency Department HIV Testing Consortium. *Acad Emerg Med*. 2009; 16:168–77. [PubMed: 19076107]
7. Kelen G, Hexter D, Hansen K, et al. Feasibility of an emergency department-based, risk-targeted voluntary HIV screening program. *Ann Emerg Med*. 1996; 27:687–92. [PubMed: 8644953]
8. Kelen G, Shahan J, Quinn T. Emergency department-based HIV screening and counseling: experience with rapid and standard serologic testing. *Ann Emerg Med*. 1999; 33:147–55. [PubMed: 9922409]
9. Glick N, Silva A, Zun L, Whitman S. HIV testing in a resource-poor urban emergency department. *AIDS Educ Prev*. 2004; 16:126–36. [PubMed: 15134121]
10. Kendrick S, Kroc K, Couture E, Weinstein R. Comparison of point-of-care rapid HIV testing in three clinical venues. *AIDS*. 2004; 18:2208–10. [PubMed: 15577658]
11. Lyons M, Lindsell C, Ledyard H, Frame P, Trott A. Emergency department HIV testing and counseling: an ongoing experience in a low-prevalence area. *Ann Emerg Med*. 2005; 46:22–8. [PubMed: 15988422]
12. Centers for Disease Control and Prevention (CDC). Rapid HIV testing in emergency departments--three U.S. sites, January 2005–March 2006. *MMWR Morb Mortal Wkly Rep*. 2007; 56:597–601. [PubMed: 17585288]
13. Brown J, Shesser R, Simon G, et al. Routine HIV screening in the emergency department using the new US Centers for Disease Control and Prevention Guidelines: results from a high-prevalence area. *J Acquir Immune Defic Syndr*. 2007; 46:395–401. [PubMed: 18077831]
14. Silva A, Glick N, Lyss S, et al. Implementing an HIV and sexually transmitted disease screening program in an emergency department. *Ann Emerg Med*. 2007; 49:564–72. [PubMed: 17113684]
15. Lyss S, Branson B, Kroc K, Couture E, Newman D, Weinstein R. Detecting unsuspected HIV infection with a rapid whole-blood HIV test in an urban emergency department. *J Acquir Immune Defic Syndr*. 2007; 44:435–42. [PubMed: 17224850]
16. Haukoos J, Hopkins E, Eliopoulos V, et al. Development and implementation of a model to improve identification of patients infected with HIV using diagnostic rapid testing in the emergency department. *Acad Emerg Med*. 2007; 14:1149–57. [PubMed: 18045889]
17. Mehta S, Hall J, Lyss S, Skolnik P, Pealer L, Kharasch S. Adult and pediatric emergency department sexually transmitted disease and HIV screening: programmatic overview and outcomes. *Acad Emerg Med*. 2007; 14:250–8. [PubMed: 17331918]
18. White D, Scribner A, Schulden J, Branson B, Heffelfinger J. Results of a Rapid HIV Screening and Diagnostic Testing Program in an Urban Emergency Department. *Ann Emerg Med*. 2009; 54:56–64. [PubMed: 18990468]

19. Christopoulos K, Schackman B, Lee G, Green R, Morrison E. Results from a New York City emergency department rapid HIV testing program. *J Acquir Immune Defic Syndr*. 2010; 53:420–2. [PubMed: 20190591]
20. Haukoos J, Hopkins E, Conroy A, et al. Routine opt-out rapid HIV screening and detection of HIV infection in emergency department patients. *JAMA*. 2010; 304:284–92. [PubMed: 20639562]
21. Torres G, Heffelfinger J, Pollack H, Barrera S, Rothman R. HIV screening programs in US emergency departments: a cross-site comparison of structure, process, and outcomes. *Ann Emerg Med*. 2011; 58:S104–S13. [PubMed: 21684388]
22. Sattin R, Wilde J, Freeman A, Miller K, Dias J. Rapid HIV Testing in a Southeastern Emergency Department Serving a Semiurban-Semirural Adolescent and Adult Population. *Ann Emerg Med*. 2011; 58:S60–4. [PubMed: 21684410]
23. Schrantz S, Babcock C, Theodosis C, et al. A Targeted, Conventional Assay, Emergency Department HIV Testing Program Integrated With Existing Clinical Procedures. *Ann Emerg Med*. 2011; 58:S85–S8. e1. [PubMed: 21684415]
24. Christopoulos K, Kaplan B, Dowdy D, et al. Testing and linkage to care outcomes for a clinician-initiated rapid HIV testing program in an urban emergency department. *AIDS Patient Care STDS*. 2011; 25:439–44. [PubMed: 21545296]
25. Hoxhaj S, Davila J, Modi P, et al. Using Nonrapid HIV Technology for Routine, Opt-out HIV Screening in a High-Volume Urban Emergency Department. *Ann Emerg Med*. 2011; 58:S79–84. [PubMed: 21684414]
26. Wheatley M, Copeland B, Shah B, Heilpern K, Del Rio C, Houry D. Efficacy of an emergency department-based HIV screening program in the Deep South. *J Urban Health*. 2011; 88:1015–9. [PubMed: 21630105]
27. White D, Scribner A, Vahidnia F, et al. HIV Screening in an Urban Emergency Department: Comparison of Screening Using an Opt-In Versus an Opt-Out Approach. *Ann Emerg Med*. 2011; 58:S89–95. [PubMed: 21684416]
28. Wilbur L, Huffman G, Lofton S, Finnell J. The Use of a Computer Reminder System in an Emergency Department Universal HIV Screening Program. *Ann Emerg Med*. 2011; 58:S71–S3. e1. [PubMed: 21684412]
29. Martin I, Klein P, Leone P. A Collaborative Opt-Out, Non-Rapid HIV Testing Model between an Emergency Department and Infectious Disease Clinic. *Acad Emerg Med*. 2012; 19:S300.
30. Rothman R, Kelen G, Harvey L, et al. Factors associated with no or delayed linkage to care in newly diagnosed human immunodeficiency virus (HIV)-1-infected patients identified by emergency department-based rapid HIV screening programs in two urban EDs. *Acad Emerg Med*. 2012; 19:497–503. [PubMed: 22594352]
31. Humphrey J, Hadi C, Richey L. HIV testing and re-engagement for individuals with previously diagnosed HIV Infection in New Orleans, Louisiana. *AIDS Patient Care STDS*. 2012; 26:509–11. [PubMed: 22780688]
32. Bernstein E, Heeren T, Winter M, et al. Long-term follow-up after voluntary human immunodeficiency virus/sexually transmitted infection counseling, point-of-service testing, and referral to substance abuse treatment from the emergency department. *Acad Emerg Med*. 2012; 19:386–95. [PubMed: 22506942]
33. Schlesinger S, Arora S, Menchine M, et al. Routine, Non-Targeted Screening for HIV: Year One Findings of the “R/O HIV in the LAC+USC ED” Program. *Ann Emerg Med*. 2012; 60:S24–5.
34. Calderon Y, Chou K, Cowan E, et al. Analysis of HIV testing acceptance and risk factors of an adolescent cohort using emergency department-based multimedia HIV testing and counseling. *Sex Transm Dis*. 2013; 40:624–8. [PubMed: 23859908]
35. Christopoulos K, Zetola N, Klausner J, et al. Leveraging a rapid, round-the-clock HIV testing system to screen for acute HIV infection in a large urban public medical center. *J Acquir Immune Defic Syndr*. 2013; 62:e30–8. [PubMed: 23117503]
36. Ruffner A, Naber M, Hart K, et al. Linkage to Care and Health Care Utilization Subsequent to HIV Diagnosis from an ED HIV Testing Program. *Acad Emerg Med*. 2013; 20:S178.

37. Haukoos J, Hopkins E, Bender B, et al. Comparison of enhanced targeted rapid HIV screening using the Denver HIV risk score to nontargeted rapid HIV screening in the emergency department. *Ann Emerg Med.* 2013; 61:353–61. [PubMed: 23290527]
38. Marks G, Gardner L, Craw J, Crepaz N. Entry and retention in medical care among HIV-diagnosed persons: a meta-analysis. *AIDS.* 2010; 24:2665–78. [PubMed: 20841990]
39. Gilman B, Hidalgo J, Thomas C, Au M, Hargreaves M. Linkages to care for newly diagnosed individuals who test HIV positive in nonprimary care settings. *AIDS Patient Care STDS.* 2012; 26:132–40. [PubMed: 22248332]

Table 1

Description of Included Studies.

First Author, Year	Journal	City	Study Period	ED Volume	Academic ED
Kelen <i>et al.</i> 1996 ⁷	<i>Ann Emerg Med</i>	Baltimore, MD	Jun – Aug 1992	50,000 visits	Yes
Kelen <i>et al.</i> 1999 ⁸ Subset A	<i>Ann Emerg Med</i>	Baltimore, MD	1993 – 1995	50,000 visits	Yes
Kelen <i>et al.</i> 1999 ⁸ Subset B	<i>Ann Emerg Med</i>	Baltimore, MD	1993 – 1995	50,000 visits	Yes
Glick <i>et al.</i> 2004 ⁹	<i>AIDS Educ Prev</i>	Chicago, IL	Jan 2001 – Jan 2002	44,000 visits	Yes
Kendrick <i>et al.</i> 2004 ¹⁰	<i>AIDS Res Let</i>	Chicago, IL	Not available	120,000 visits	Yes
Lyons <i>et al.</i> 2005 ¹¹	<i>Ann Emerg Med</i>	Cincinnati, OH	1998 – 2002	80,000 visits	Yes
MMWR June 2007 ¹² Subset LA	<i>MMWR Morb Mortal Wkly Rep</i>	Los Angeles, CA	Jan – Dec 2005	47,736 visits	Yes
MMWR June 2007 ¹² Subset NY	<i>MMWR Morb Mortal Wkly Rep</i>	New York, NY	Jan – Dec 2005	72,948 visits	No
Brown <i>et al.</i> 2007 ¹³	<i>J Acquir Immune Defic Syndr</i>	Washington, DC	Sep – Dec 2006	not provided	Yes
Silva <i>et al.</i> 2007 ¹⁴	<i>Ann Emerg Med</i>	Chicago, IL	Apr 2003 – Aug 2004	44,000 visits	Yes
Lyss <i>et al.</i> 2007 ¹⁵	<i>J Acquir Immune Defic Syndr</i>	Chicago, IL	Jan 2003 – Apr 2004	not provided	Yes
Haukoos <i>et al.</i> 2007 ¹⁶	<i>Acad Emerg Med</i>	Denver, CO	Oct 2004 – Mar 2007	55,000 visits	Yes
Mehta <i>et al.</i> 2007 ¹⁷	<i>Acad Emerg Med</i>	Boston, MA	Nov 2003 – May 2004	77,000 visits	Yes
White <i>et al.</i> 2009 ¹⁸	<i>Ann Emerg Med</i>	Oakland, CA	Apr 2005 – Dec 2006	75,000 visits	Yes
Christopoulos <i>et al.</i> 2010 ¹⁹	<i>J Acquir Immune Defic Syndr</i>	New York, NY	Jan 2006 – Dec 2007	69,398 visits	Yes
Haukoos <i>et al.</i> 2010 ²⁰	<i>JAMA</i>	Denver, CO	Apr 2007 – Apr 2009	55,000 visits	Yes
Torres <i>et al.</i> 2011 ²¹ Site B	<i>Ann Emerg Med</i>	Midwest Region	Jun 2007 – Apr 2008	87,626 visits	Yes
Torres <i>et al.</i> 2011 ²¹ Site C	<i>Ann Emerg Med</i>	South Region	Jun 2007 – Apr 2008	27,913 visits	Yes
Torres <i>et al.</i> 2011 ²¹ Site D	<i>Ann Emerg Med</i>	Midwest Region	Jun 2007 – Apr 2008	89,615 visits	Yes
Torres <i>et al.</i> 2011 ²¹ Site E	<i>Ann Emerg Med</i>	West Region	Jun 2007 – Apr 2008	52,528 visits	Yes
Torres <i>et al.</i> 2011 ²¹ Site F	<i>Ann Emerg Med</i>	Northeast Region	Jun 2007 – Apr 2008	52,542 visits	Yes
Sattin <i>et al.</i> 2011 ²²	<i>Ann Emerg Med</i>	Augusta, GA	Mar 2008 – Aug 2009	77,000 visits	Yes
Schranz <i>et al.</i> 2011 ²³	<i>Ann Emerg Med</i>	Chicago, IL	Jan 2007 – Nov 2008	not provided	Yes
Christopoulos <i>et al.</i> 2011 ²⁴	<i>AIDS Patient Care STDS</i>	San Francisco, CA	Feb 2007 – Nov 2008	55,000 visits	Yes
Hoxhaj <i>et al.</i> 2011 ²⁵	<i>Ann Emerg Med</i>	Houston, TX	Oct 2008 – Apr 2009	96,000 visits	Yes
Wheatley <i>et al.</i> 2011 ²⁶	<i>J Urban Health</i>	Atlanta, GA	May 2008 – Mar 2010	>100,000 visits	Yes
White <i>et al.</i> 2011 ²⁷	<i>Ann Emerg Med</i>	Oakland, CA	Feb 2007 – Jan 2008	75,000 visits	Yes

First Author, Year	Journal	City	Study Period	ED Volume	Academic ED
Wilbur <i>et al.</i> 2011 ²⁸	<i>Ann Emerg Med</i>	Indianapolis, IN	Mar – Apr 2008	100,000 visits	Yes
Martin <i>et al.</i> 2012 ²⁹	<i>Acad Emerg Med - Abstract</i>	North Carolina	Jun 2008 – Sep 2011	not provided	Yes
Rothman <i>et al.</i> 2012 ³⁰	<i>Acad Emerg Med</i>	Baltimore, MD	Nov 2005 – Oct 2009	60,000 at Johns Hopkins ED and 50,000 at Johns Hopkins Bayview ED 60,000 visits	Yes
Humphrey <i>et al.</i> 2012 ³¹	<i>AIDS Patient Care STDS</i>	New Orleans, LA	2008		Yes
Bernstein <i>et al.</i> 2012 ³²	<i>Acad Emerg Med</i>	Boston, MA	Nov 2004 – May 2008	not provided	Yes
Sclesinger <i>et al.</i> 2012 ³³	<i>Ann Emerg Med - Abstract</i>	Los Angeles, CA	Mar 2011	180,000 patients	Yes
Calderon <i>et al.</i> 2013 ³⁴	<i>Sex Transm Dis</i>	New York, NY	Oct 2005 – Aug 2012	not provided	Yes
Christopoulos <i>et al.</i> 2013 ³⁵	<i>J Acquir Immune Defic Syndr</i>	San Francisco, CA	Nov 2008 – Apr 2009	not provided	Yes
Ruffner <i>et al.</i> 2013 ³⁶	<i>Acad Emerg Med - Abstract</i>	Cincinnati, OH	2002 – 2010	not provided	Yes
Haukoos <i>et al.</i> 2013 ³⁷	<i>Ann Emerg Med</i>	Denver, CO	Jun 2010 – Sep 2010	55,000 visits	Yes

First Author, Year	Type of HIV Test	No. of Positive	No (%) Linked	Received Results in the ED	Description of Linkage	Type of Linkage
Kelen <i>et al.</i> 1996 ⁷	ELISA	24	23 (95.8)	No	HIV/ID clinic referral through appointments	Non intensive
Kelen <i>et al.</i> 1999 ⁸ Subset A	Standard EIA	63	25 (39.7)	No	HIV/ID clinic referral through appointments	Non intensive
Kelen <i>et al.</i> 1999 ⁸ Subset B	Rapid HIV test (SUDS)	15	6 (40.0)	Mixed [†]	HIV/ID clinic referral through appointments	Non intensive
Glick <i>et al.</i> 2004 ⁹	ELISA	13	9 (69.2)	No	Positive patients physically escorted to clinic or introduced to case manager	Intensive
Kendrick <i>et al.</i> 2004 ¹⁰	Rapid HIV test (SUDS)	46	36 (78.3)	Yes	Not available	NA
Lyons <i>et al.</i> 2005 ¹¹	Standard EIA	39	31 (79.5)	No	Positive patients physically escorted HIV clinic	Intensive
MMWR June 2007 ¹² Subset LA	Rapid HIV test (OraQuick® Advance)	13	11 (84.6)	Yes	Medical Appointment	Non intensive
MMWR June 2007 ¹² Subset NY	Rapid HIV test (OraQuick® Advance)	19	15 (78.9)	Yes	Medical Appointment	Non intensive
Brown <i>et al.</i> 2007 ¹³	Rapid HIV test (OraQuick® Rapid)	9	8 (88.9)	Yes	HIV/ID clinic referral through appointments	Non intensive
Silva <i>et al.</i> 2007 ¹⁴	Rapid HIV test (OraQuick® Rapid)	8	3 (37.5)	Yes	HIV/ID clinic referral through appointments	Non intensive
Lyss <i>et al.</i> 2007 ¹⁵	Rapid HIV test (OraQuick® Rapid)	83	65 (78.3)	Yes	HIV/ID clinic referral through appointments	Non intensive
Haukoos <i>et al.</i> 2007 ¹⁶	Rapid HIV test (OraQuick® Rapid or OraQuick® Advance)	15	12 (80.0)	Yes	HIV/ID clinic referral through appointments	Non intensive

First Author, Year	Type of HIV Test	No. of Positive	No (%) Linked	Received Results in the ED	Description of Linkage	Type of Linkage
Mehta <i>et al.</i> 2007 ¹⁷	EIA	7	4 (57.1)	No	Positive patients physically escorted to the HIV clinic for their intake appointment	Intensive
White <i>et al.</i> 2009 ¹⁸	Rapid HIV test (OraQuick® Advance)	101	90 (89.1)	Yes	HIV/ID clinic referral through appointments	Non intensive
Christopoulos <i>et al.</i> 2010 ¹⁹	Rapid HIV test (OraQuick® Advance)	24	17 (70.8)	Yes	HIV/ID clinic referral through appointments	Non intensive
Haukoos <i>et al.</i> 2010 ²⁰	Rapid HIV test (Uni-Gold™ Recombigen)	19	19 (100)	Yes	HIV/ID clinic referral through appointments	Non intensive
Torres <i>et al.</i> 2011 ²¹ Site B	ELISA	25	23 (92.0)	No	Positive patients physically escorted to the ID center for their intake appointment	Intensive
Torres <i>et al.</i> 2011 ²¹ Site C	Rapid oral	10	10 (100)	Yes	Telephonic counseling from ID fellow and follow up HIV/ID clinic appointment	Non intensive
Torres <i>et al.</i> 2011 ²¹ Site D	Rapid finger stick	70	35 (50.0)	Yes	HIV/ID clinic referral through appointments	Non intensive
Torres <i>et al.</i> 2011 ²¹ Site E	Rapid Venipuncture	50	50 (100)	Yes	HIV/ID clinic referral through appointments	Non intensive
Torres <i>et al.</i> 2011 ²¹ Site F	Rapid Venipuncture	34	27 (79.4)	Yes	HIV/ID clinic referral through appointments	Non intensive
Sattin <i>et al.</i> 2011 ²²	Rapid HIV test (OraQuick® Rapid)	35	26 (74.3)	Yes	Positive patients physically escorted ID/HIV clinic	Intensive
Schranz <i>et al.</i> 2011 ²³	ELISA	28	25 (89.3)	No	ID clinic social worker attempted to reach out and make appointments for patients who tested positive	Non intensive
Christopoulos <i>et al.</i> 2011 ²⁴	Rapid HIV test (Uni-Gold™ Recombigen)	65	46 (70.8)	Yes	The linkage team met patients in person if notified during business hours and otherwise contacted patients for providing HIV clinic appointment	Mixed
Hoxhaj <i>et al.</i> 2011 ²⁵	Chemiluminescence testing (ADVIA, Centaur®)	80	34 (42.5)	Mixed [†]	HIV/ID clinic referral through appointments	Non intensive
Wheatley <i>et al.</i> 2011 ²⁶	Rapid HIV test (OraQuick® Rapid)	126	94* (74.6)	Yes	Positive patients provided appointment at either the local health department or hospital-affiliated ID program	Non intensive
White <i>et al.</i> 2011 ²⁷	Rapid HIV test (OraQuick® Advance)	29	22 (75.9)	Yes	HIV/ID clinic referral through appointments	Non intensive
Wilbur <i>et al.</i> 2011 ²⁸	Rapid HIV test (OraQuick® Advance)	5	4 (80.0)	Yes	HIV/ID clinic referral through appointments	Non intensive
Martin <i>et al.</i> 2012 ²⁹	3 rd Generation ELISA	22	22 (100)	Mixed [†]	Positive patients physically escorted to the HIV clinic for their intake appointment	Intensive
Rothman <i>et al.</i> 2012 ³⁰	Rapid HIV test (OraQuick® Advance)	100	83 (83.0)	Yes	HIV/ID clinic referral through appointments	Non intensive
Humphrey <i>et al.</i> 2012 ³¹	Rapid HIV test	99	59 (59.6)	NA	HIV/ID clinic referral through appointments	Non intensive
Bernstein <i>et al.</i> 2012 ³²	ELISA	13	12 (92.3)	No	HIV/ID clinic referral through appointments	Non intensive
Sclesinger <i>et al.</i> 2012 ³³	Rapid HIV test	25	22 (88.0)	Yes	In person encounter by ID specialist in the ED	Intensive

First Author, Year	Type of HIV Test	No. of Positive	No (%) Linked	Received Results in the ED	Description of Linkage	Type of Linkage
Calderon <i>et al.</i> 2013 ³⁴	Rapid HIV test (OraQuick® Advance)	295	227 (76.9)	Yes	Positive patients physically escorted to the HIV clinic for their intake appointment	Intensive
Christopoulos <i>et al.</i> 2013 ³⁵	Rapid HIV test (Uni-Gold™ Recombigen)	23	23 (100)	Mixed [†]	Linkage team performed clinic intake and medical assessment and nurse practitioner provided primary care till hand-off to specialist	Intensive
Ruffner <i>et al.</i> 2013 ³⁶	Not Available	170	119 (70.0)	NA	Linkage procedures included in-person and telephone follow-up, attempts at repeat contact for missed appointments, and accompanying patients to initial appointments	Mixed
Haukoos <i>et al.</i> 2013 ³⁷	Rapid HIV test (OraQuick® Advance)	14	14 (100)	Yes	HIV/ID clinic referral through appointments	Non intensive
First Author, Year	Linkage Staff	Follow-up Phone Call	Duration to Linkage	Extramural Funding		
Kelen <i>et al.</i> 1996 ⁷	Exogenous	Yes	NA	Emergency Medicine Foundation		
Kelen <i>et al.</i> 1999 ⁸ Subset A	Exogenous	Yes	NA	HIV test kits were donated by Murex		
Kelen <i>et al.</i> 1999 ⁸ Subset B	Exogenous	Yes	NA	HIV test kits were donated by Murex		
Glick <i>et al.</i> 2004 ⁹	Exogenous	Yes	NA	Receiving funding from unspecified source		
Kendrick <i>et al.</i> 2004 ¹⁰	Exogenous	NA	NA	CDC		
Lyons <i>et al.</i> 2005 ¹¹	Exogenous	Yes	NA	Ohio Department of Health and the Cincinnati Health Network (Ryan White Title III funds).		
MMWR June 2007 ¹² Subset LA	Exogenous	NA	NA	Not available		
MMWR June 2007 ¹² Subset NY	Exogenous	NA	NA	Not available		
Brown <i>et al.</i> 2007 ¹³	Exogenous	Yes	NA	Department of Health, District of Columbia, and Gilead Sciences		
Silva <i>et al.</i> 2007 ¹⁴	Exogenous	Yes	NA	CDC		
Lyss <i>et al.</i> 2007 ¹⁵	Exogenous	Yes	Within 4 months	CDC		
Haukoos <i>et al.</i> 2007 ¹⁶	Indigenous	Yes	NA	Colorado Department of Public Health and Environment and CDC		
Melita <i>et al.</i> 2007 ¹⁷	Exogenous	Yes	0,0,17,128 days	CDC		
White <i>et al.</i> 2009 ¹⁸	Indigenous	Yes	Median 14 d	CDC and NIH		
Christopoulos <i>et al.</i> 2010 ¹⁹	Exogenous	Yes	NA	NIH		
Haukoos <i>et al.</i> 2010 ²⁰	Exogenous	NA	NA	CDC, AHRQ, Colorado Center for AIDS Research		
Torres <i>et al.</i> 2011 ²¹ Site B	Exogenous	Yes	NA	CDC and HRSA		
Torres <i>et al.</i> 2011 ²¹ Site C	Exogenous	No	NA	Foundation grant, local health department		
Torres <i>et al.</i> 2011 ²¹ Site D	Exogenous	No	NA	CDC and HRSA		
Torres <i>et al.</i> 2011 ²¹ Site E	Indigenous	Yes	NA	No, hospital and laboratory budget		

First Author, Year	Linkage Staff	Follow-up Phone Call	Duration to Linkage	Extramural Funding
Torres <i>et al.</i> 2011 ²¹ Site F	Indigenous	No	NA	CDC and HRSA
Satin <i>et al.</i> 2011 ²²	Exogenous	No	NA	CDC
Schrauntz <i>et al.</i> 2011 ²³	Indigenous	Yes	NA	Bristol-Myers Squibb Virology Fellows Research Training Program
Christopoulos <i>et al.</i> 2011 ²⁴	Indigenous	Yes	90% by 90 days	NIH
Hoxhaj <i>et al.</i> 2011 ²⁵	Indigenous	Yes	NA	CDC and Houston Department of Health and Human Services
Wheatley <i>et al.</i> 2011 ²⁶	Exogenous	NA	NA	CDC
White <i>et al.</i> 2011 ²⁷	Indigenous	Yes	Median 7 days for opt-in and 14 days for opt-out	CDC
Wilbur <i>et al.</i> 2011 ²⁸	Exogenous	NA	NA	Marion County Ryan White Part A.
Martin <i>et al.</i> 2012 ²⁹	Indigenous	No	NA	Not available
Rothman <i>et al.</i> 2012 ³⁰	Exogenous	Yes	1 Year	Maryland Department of Health and Mental Hygiene, Baltimore City Health Department, The Gilead Foundation
Humphrey <i>et al.</i> 2012 ³¹	NA	NA	6 months	Not available
Bernstein <i>et al.</i> 2012 ³²	Exogenous	Yes	NA	NIH
Sclesinger <i>et al.</i> 2012 ³³	Exogenous	NA	NA	Not available
Calderon <i>et al.</i> 2013 ³⁴	Exogenous	No	NA	Public Health Solutions of New York City
Christopoulos <i>et al.</i> 2013 ³⁵	Indigenous	Yes	Median-3.5days	NIH
Ruffner <i>et al.</i> 2013 ³⁶	NA	Yes	NA	Not available
Haukoos <i>et al.</i> 2013 ³⁷	Exogenous	NA	NA	Colorado Department of Public Health and Environment, NIH

HIV- Human immunodeficiency virus; ELISA-Enzyme linked immunosorbent assay; EIA- Enzyme immunoassay; SUDS-Single use diagnostic systems MMWR June 2007²⁰ Subset Oakland was not included as we were able to infer that the data from this site would be included under White *et al.* 2009²⁶ Torres *et al.* 2011²⁹ Site A was not included, as it did not have any linkage data in the article.

* Number linked to care was obtained from rounding off the percentage linked from total number of positives.

[†]Mixed meant that some patients received test results before leaving the ED while others didn't.

Indigenous linkage staff meant that the ED clinical providers or staff who were employed as part of regular ED operations performed linkage to care; exogenous linkage staff meant that the personnel who were employed specifically for HIV testing program and not as part of regular ED operations performed linkage to care