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<td>bmjopen-2016-011436</td>
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<td>Research</td>
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<td>Date Submitted by the Author</td>
<td>03-Mar-2016</td>
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<td>Complete List of Authors:</td>
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Title:
Basic Life Support Education in Secondary Schools: a cross-sectional survey in London, United Kingdom

Authors:
Justin D Salciccioli¹, Dominic C Marshall¹, Mark Sykes¹, Alexander D Wood¹, Stephanie Joppa¹, Madhurima Sinha¹, P Boon Lim²

Affiliations:
1 – Imperial College London, London, UK
2 – Department of Cardiology, Hammersmith Hospital, London UK W12 0HS

Correspondence:
P Boon Lim
Consultant Cardiologist
Imperial College Healthcare NHS Trust
Hammersmith Hospital
Du Cane Road
London W12 0Hs
Email: p.b.lim@imperial.nhs.uk
Tel: 0203 313 4967
Fax: 0203 313 4095
**Abstract:**

**Objectives**

Basic life support training in schools is associated with improved outcomes from cardiac arrest. International consensus statements have previously recommended universal BLS training for school-aged children. The current practice of BLS training in London schools is unknown. The aim of this study was to assess current practices of BLS training in London secondary schools.

**Setting, Population and Outcomes**

A prospective audit of BLS training in London secondary schools was conducted. Schools were contacted by email and a subsequent telephone interview was conducted with staff familiar with local training practices. Response data were anonymised and captured electronically. Universal training was defined as any programme which delivers BLS training to all students in the school. Simple descriptive statistics were used to summarise the results.

**Results**

A total of 65 schools completed the survey covering an estimated student population of 65,396 across 19 of 32 London boroughs. There were 5 (8%) schools that provide universal training programs for students and an additional 31 (48%) offering training as part of an extra-curricular program or chosen module. An AED was available in 18 (28%) schools, unavailable in 40 (61%) and 7 (11%) reported their AED provision as unknown. The most common reasons for not having a universal BLS training programme are the requirement for additional class time (28%) and that funding is unavailable for such program (28%). There were 5 students who died from sudden cardiac arrest over the period of the past 10 years.

**Conclusion**

BLS training rates in London secondary schools are low and the majority of schools do not have an AED available in case of emergency. These data highlight an opportunity to improve BLS training and to improve AEDs provision. Future studies should assess programmes which are cost-effective and do not require significant amounts of additional class time.
**Key words**: cardiopulmonary resuscitation, automatic external defibrillator, education, cardiac arrest

**Article Summary:**

The strengths of this investigation are that data was collected prospectively from school administrators who are responsible for BLS training at their institution. We used an electronic data capture tool to with pre-specified variable responses, standardizing the data and reducing inter-questioner variability. We were able to collect survey data from 65 secondary schools from 19 boroughs across London, with responses reflecting practices as recent as October 2014. A number of schools however are not represented in our data set. A further limitation owes to the lack of external validation for the electronic data capture tool and questionnaire. Finally, we collected data regarding the number school children who have died on school premises of sudden cardiac death. This figure is inevitably subject to recall bias.

Relatable points:

- Basic life support (BLS) training in schools improves outcomes in cardiac arrest
- BLS training in schools has been advocated by international councils
- BLS training rates in London schools is low
- Few London schools have an on-site automated external defibrillator (AED)
Introduction

Out-of-hospital cardiac arrest (OHCA) is a major public health burden which poses significant strain on healthcare systems [1] with approximately 420,000 arrests in the United States [2] and 275,000 in Europe [3] annually. Basic life support (BLS) training is associated with improved outcomes from cardiac arrest [4]. Rates of bystander cardiopulmonary resuscitation (CPR) vary by location [5] a result which is thought to be the result of poor training and education in CPR practices or the result of poor implementation of training practices.

The chain of survival has been promoted broadly as a means to optimize the community’s response to out-of-hospital cardiac arrest [6]. Previous investigations have shown that BLS measures may be more important than advanced care in survival from out-of-hospital cardiac arrest [7] and more recent evidence has provided further support for this effect across healthcare systems [8].

In order to improve the rate of early bystander CPR and early defibrillation the International Liaison Committee on Resuscitation (ILCOR) recommended training in CPR and familiarisation with Automated External Defibrillator (AED) as part of secondary school curricula [9]. BLS training has since become a requirement for graduation in multiple states throughout the United States (http://tinyurl.com/o8hmwwb). However, the requirement for BLS training is not part of the educational curriculum in the United Kingdom (UK) and the current practice of BLS training in schools throughout the UK is unknown.

We sought to investigate the current practices relating to BLS training in London secondary schools. The primary aim of this study was to identify the rate of universal student training programs. In order to identify such programs, we performed a cross-sectional survey to ascertain current training practices for students in London secondary schools.

Methods

Study Design and Setting
A registered audit was conducted as a cross-sectional survey of BLS and AED training in London secondary schools between June 2014 and October 2014. The project was approved as an audit at Hammersmith Hospital, Imperial College Healthcare Trust (Registration number 1673). Interviewers received preliminary training in survey details and appropriate administration of the telephone interviews. All schools were contacted by email initially and a subsequent telephone interview was conducted with school staff familiar with local training practices. Response data were anonymised and captured electronically in a standardized electronic database.

Survey Design and Data Collection

The survey was developed in two phases. First, a preliminary survey was created and school administrators in three pre-specified London boroughs were contacted to complete the survey. Interviewers were responsible for recording survey results data as well as recording aspects of the survey tool which requiring additional clarification. Second, the survey tool was updated to incorporate suggestions from the initial series of telephone interviews and data collection.

Response data were collected and managed using an electronic data capture tool which provided pre-specified variable responses and missing value-response alerts to minimize incomplete responses. During the course of the telephone interview data were captured directly into the standardized web-based survey tool.

Outcomes and Analysis

The primary outcome of interest was a current universal training program which delivers BLS training to all students in the school. Secondary outcomes of interest included the presence of an AED in the school and the perceived barriers to implementation of a universal student training program. The survey also included a single question to estimate the rate of death in school children during the 10-year period prior to the current
investigation. Simple descriptive statistics including means or medians and frequencies with
percentages were used to summarise the results, as appropriate.

Post-Hoc Analysis

We performed a single post-hoc analysis to estimate the cost to treat a single case of
student cardiac arrest. During the course of the data collection period, the UK Department of
Education issued a public statement which recommends placement of AEDs in all UK
primary and secondary schools [10]. The DoE statement supports purchasing of AEDs by
the NHS Supply Chain and with this program, the cost per AED would be £452.78 [10]. For
this analysis, we used reported incidence of student sudden cardiac arrest as a single case
of cardiac arrest and computed the rate of cardiac arrest per secondary school surveyed.

Results

Characteristics

Surveys were completed in 19 (52%) of the 32 London boroughs. Of 449 schools,
representatives from 71 (16%) schools were contacted successfully and a total of 65 (15%) completed the survey. There were 6 schools which refused to participate (8%). The student population from the surveyed schools completed covers an estimated population of 65,396 students between the ages of 11 and 19 years. In this sample, the earliest that students are exposed to BLS training is in Year 7 (approximately 11 years of age). Specialist First Aid and CPR educators from outside organizations (e.g. St. John’s Ambulance, British Heart Foundation, etc.) are most commonly responsible for providing educational programs and training for students (15%).

Primary and Secondary Outcomes

There were 5 (8%) schools that provide universal training programs for students and
an additional 31 (48%) offered training as part of an extra-curricular program or chosen
module. The most common reasons for not having a universal BLS training program is the requirement for additional class time (28%) and that funding is unavailable for such program (28%). An AED was available in 18 (28%) schools, unavailable in 40 (61%) and 7 (11%) reported their AED provision as unknown. There were 5 students who died from sudden cardiac arrest over the period of the past 10 years. However, the administrator reporting 1 of the 5 cases was unable to confirm whether the sudden cardiac arrest happened at the school or away from school premises.

Cost Analysis

Of the 65 schools surveyed there were at least 5 sudden cardiac arrests reported during the preceding 10-year period. As such, an AED would need to be placed in 13 secondary schools in order to provide the opportunity to treat at least 1 sudden cardiac arrest within a 10-year period. The NHS Supply Chain will provide AEDs in schools throughout the UK for £452.78 and for a total of 3628 state funded secondary schools this would amount to a cost of £1,642,685.84 in order to place one AED in every secondary school in England.[11]

Discussion

In this prospective audit of London secondary schools there were overall low rates of universal BLS training programmes for students. Specifically, fewer than half the schools surveyed offer some form of optional BLS training for students with only 8% offering a universal BLS training program. The most common reasons stated for not having universal BLS training were the requirement for additional class time and the lack of funding to support such programs. Further, we found less than a third of schools had an AED on the school premises available in case of emergency. Although small, the estimated number of students suffering sudden cardiac arrest while on school premises (5) in the preceding decade highlights the importance of current government and public health campaigns to equip schools with AEDs and to improve the rate of CPR training in schools. We estimate that an
AED placed in a minimum of 13 schools would be required in order to treat a single case of a child with sudden cardiac arrest.

Advances in cardiac arrest care have, since it was first described in 1991, focused on improving performance in the chain of survival [6]. While the past decade has significant improvement in the advanced care of the post-arrest patient, multiple recent investigations have demonstrated in large populations of patients the overall importance of improving the early links in the chain of survival, namely early identification of cardiopulmonary arrest and early initiation of bystander CPR efforts via large-scale educational programs [12,13]. Two recent reports have shown that CPR prior to emergency medical service arrival in OHCA is associated with improved survival [8], and that this basic intervention may be as effective or better than pre-hospital advanced life support [7]. However, one area that remains unanswered is whether legislation to require schools to teach BLS will improve outcomes for patients suffering cardiac arrest.

The primary aim of this investigation was to appreciate the current practices of CPR and AED training in school-aged children in London. Our hypothesis that there would be a small proportion of London secondary schools currently offering universal BLS training programs was based primarily on previous reports which have suggested low rates of BLS training in the UK compared to European countries [14]. This hypothesis was made despite consensus statements from local and international professional resuscitation bodies. These data are relevant as they highlight potential areas for significant improvement in public health initiatives. Since the 2011 ILCOR consensus statement recommending CPR training in secondary schools, a number of political bodies in jurisdictions outside the UK have made CPR training a legal requirement for graduation from secondary school, a measure which has not been adopted in the UK. To the best of our knowledge this investigation is the only study to have assessed the rate of BLS training in London secondary schools since these consensus statements have been made.

Our results demonstrate the significant room for improvement in student training in schools. We identified a small proportion (8%) of schools which provide CPR training for all
students while 48% of schools offer some optional training for students. These results are in line with a recent investigation from Toronto, Canada, which found that 51% of secondary schools provide CPR training for students although it is unclear whether CPR training programs were required for all students in the institution or whether these were optional programs [15]. There are important differences relating to the legislation between the two locations that raise the issue of making CPR training a requirement of school curriculum. While the government of Ontario, Canada has made it mandatory for students to demonstrate an understanding of cardiopulmonary resuscitation in order to obtain their secondary school diploma the UK government has yet to make such a change to curriculum requirements. It is unclear, therefore, what effect legislation has on the overall rate for students receiving CPR training. Despite this difference one recent report has also shown a temporal trend toward improving outcomes from OHCA in Denmark since instituting mandatory resuscitation training programs in elementary schools [13].

In the UK, where legislation for BLS training in schools has not been written, the Department of Education has recently published guidance for schools to equip the institution with an AED [10] and offer financial support for purchasing an AED. As financial requirements were cited as one of the most common reasons for not having BLS training programs, such additional financial support should help improve public access AEDs in schools. Other campaigns such as the “Defib in schools” campaign, by the Arrhythmia Alliance (http://www.defibssavelives.org/defibs-in-schools), and the British Heart Foundation “Nation of Lifesavers” community campaign to support AED installation in schools can help to increase public awareness and improve AED installation rates. Such campaigns are important especially in light of the fact that previous investigations have shown a significant improvement in neurologically intact survival with onsite AEDs compared to AEDs which have been dispatched via emergency services [16]. In the absence of legislation for BLS and AED training, local champions have been able to significantly increase rates of BLS and AED training and such endeavours should be encouraged, with successful local frameworks for provision of training adopted and implemented nationally.
The strengths of this investigation are that data were collected prospectively from school administrators who were responsible with BLS training practices at each of the institutions. We used an electronic data capture tool with pre-specified variable responses and error-response elements to minimize incomplete responses. A number of limitations should also be considered when interpreting the results of this investigation. While we were able to capture survey results data on a large number of London secondary schools there are a number of schools which are not represented. We have however collected complete survey data from 65 secondary schools from 19 boroughs across London which represents a large estimated student population with responses reflecting practices as recent as October 2014. One further limitation is that the survey tool that was used for the investigation has not been validated in a separate population. We attempted to mitigate this weakness with a pilot phase of the survey during which time respondents were able to provide feedback about the questionnaire. Finally, as we have attempted to obtain an estimate of the number of school children which have died as a result of cardiac arrest this data is inevitably limited by recall bias and larger population studies would be necessary to confirm our findings.

Conclusion

BLS training rates in London secondary schools are low and the majority of schools do not have an AED available in case of emergency. As a number of international health and resuscitation organizations are attempting to improve overall training rates these data highlight an opportunity to vastly improve training in schools throughout the United Kingdom.

Acknowledgements

The authors are grateful for the illustration prepared by Will Mower. This work is supported by the National Institute for Health Research Biomedical Research Centre based at Imperial College Healthcare NHS Trust and Imperial College London. The views expressed in this publication are those of the author(s) and not necessarily those of the NHS, the National Institute for Health Research or the Department of Health.
Contributions

JDS and PBL were responsible for project design and survey development. ADW was responsible for acquiring survey contact information. DCM, MCS, SJ and MS were responsible for primary survey data collection. JDS, DCM and MCS were responsible for data analysis and PBL for interpretation of results. All authors contributed to the first draft of the manuscript and have reviewed the final version before submission.

Competing Interests

The authors have no competing interests to declare. The corresponding author affirms that the manuscript is an honest, accurate, and transparent account of the study being reported and that no important aspects of the study have been omitted.

Data Sharing

No additional data available.
References


Figures

Figure 1: Map of London boroughs. Colors represent boroughs with surveys completed from all secondary schools within the borough (green), from a proportion but not all of the secondary schools (blue), or borough without completed survey data (grey).
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Affiliations:
1 – Imperial College London, London, UK
2 – Department of Cardiology, Hammersmith Hospital, London UK W12 0HS

Correspondence:
P Boon Lim
Consultant Cardiologist
Imperial College Healthcare NHS Trust
Hammersmith Hospital
Du Cane Road
London W12 0Hs
Email: pblim@imperial.nhs.uk
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Abstract:

Objectives

Basic life support training (BLS) in schools is associated with improved outcomes from cardiac arrest. International consensus statements have recommended universal BLS training for school-aged children. The current practice of BLS training in London schools is unknown. The aim of this study was to assess current practices of BLS training in London secondary schools.

Setting, Population and Outcomes

A prospective audit of BLS training in London secondary schools was conducted. Schools were contacted by email and a subsequent telephone interview was conducted with staff familiar with local training practices. Response data were anonymised and captured electronically. Universal training was defined as any programme which delivers BLS training to all students in the school. Simple descriptive statistics were used to summarise the results.

Results

A total of 65 schools completed the survey covering an estimated student population of 65,396 across 19 of 32 London boroughs. There were 5 (8%) schools that provide universal training programs for students and an additional 31 (48%) offering training as part of an extra-curricular program or chosen module. An Automated External Defibrillator (AED) was available in 18 (28%) schools, unavailable in 40 (61%) and 7 (11%) reported their AED provision as unknown. The most common reasons for not having a universal BLS training programme are the requirement for additional class time (28%) and that funding is unavailable for such program (28%). There were 5 students who died from sudden cardiac arrest over the period of the past 10 years.

Conclusion

BLS training rates in London secondary schools are low and the majority of schools do not have an AED available in case of emergency. These data highlight an opportunity to improve
BLS training and AEDs provision. Future studies should assess programmes which are cost-effective and do not require significant amounts of additional class time.

**Key words:** cardiopulmonary resuscitation, automatic external defibrillator, education, cardiac arrest

**Article Summary:**

The strengths of this investigation are that data was collected prospectively from school administrators who are responsible for Basic Life Support training at their institution. We used an electronic data capture tool to with pre-specified variable responses, standardizing the data and reducing inter-questioner variability. We were able to collect survey data from 65 secondary schools from 19 boroughs across London, with responses reflecting practices as recent as October 2014. A number of schools however are not represented in our data set. Finally, we collected data regarding the number school children who have died on school premises of sudden cardiac death. This figure is inevitably subject to recall bias.

Relatable points:

- Basic life support (BLS) training in schools improves outcomes in cardiac arrest
- BLS training in schools has been advocated by international councils
- BLS training rates in London schools are low
- Few London schools have an on-site automated external defibrillator (AED)
Introduction

Out-of-hospital cardiac arrest (OHCA) is a major public health burden which poses significant strain on healthcare systems [1] with approximately 420,000 arrests in the United States [2] and 275,000 in Europe [3] annually. Basic life support (BLS) training is associated with improved outcomes from cardiac arrest [4]. Rates of bystander cardiopulmonary resuscitation (CPR) vary by location [5] a result which is thought to be the result of poor training and education in CPR practices or the result of poor implementation of training practices.

The chain of survival has been promoted broadly as a means to optimize the community’s response to out-of-hospital cardiac arrest [6]. Previous investigations have shown that BLS measures may be more important than advanced care in survival from out-of-hospital cardiac arrest [7] and more recent evidence has provided further support for this effect across healthcare systems [8]. In order to improve the rate of early bystander CPR and early defibrillation the International Liaison Committee on Resuscitation (ILCOR) recommended training in CPR and familiarisation with Automated External Defibrillator (AED) as part of secondary school curricula [9]. BLS training has since become a requirement for graduation in multiple states throughout the United States (http://tinyurl.com/o8hmvwb). However, the requirement for BLS training is not part of the educational curriculum in the United Kingdom (UK) and the current practice of BLS training in schools throughout the UK is unknown.

The primary aim of this investigation was to appreciate the current practices of CPR and AED training in school-aged children in London. Our hypothesis was that, despite consensus statements from local and international professional resuscitation bodies, there would be a small proportion of London secondary schools currently offering universal BLS training programs. This was based primarily on previous reports which have suggested low rates of BLS training in the UK compared to European countries [10]. These data are relevant as they may highlight potential areas for improvement in public health initiatives. In order to identify training programs, we performed a cross-sectional survey to ascertain current
training practices for students in London secondary schools. To the best of our knowledge
this investigation is the only study to have assessed the rate of BLS training in London
secondary schools since these consensus statements have been made.

Methods

Study Design and Setting

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training in London secondary schools between June 2014 and October 2014. The project
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initially and a subsequent telephone interview was conducted with school staff familiar with
local training practices. Response data were anonymised and captured electronically in a
standardized electronic database.

Survey Design and Data Collection

The survey was developed in two phases. First, a preliminary survey was created
and school administrators in three pre-specified London boroughs were contacted to
complete the survey. Interviewers were responsible for recording survey results data as well
as recording aspects of the survey tool which requiring additional clarification. Second, the
survey tool was updated to incorporate suggestions from the initial series of telephone
interviews and data collection. The final survey tool (see Supplemental files) was brief,
included fewer than 20 response elements, and could typically be completed over the
telephone in less than 10 minutes.

Response data were collected and managed using an electronic data capture tool
which provided pre-specified variable responses and missing value-response alerts to
minimize incomplete responses. During the course of the telephone interview data were captured directly into the standardized web-based survey tool.

**Outcomes and Analysis**

The primary outcome of interest was a current universal training program which delivers BLS training to all students in the school. Secondary outcomes of interest included the presence of an AED in the school and the perceived barriers to implementation of a universal student training program. The survey also included a single question to estimate the rate of death in school children during the 10-year period prior to the current investigation. Simple descriptive statistics including frequencies with percentages were used to summarise the results, as appropriate.

**Post-Hoc Analysis**

We performed a single post-hoc analysis to estimate the cost to treat a single case of student cardiac arrest. During the course of the data collection period, the UK Department of Education (DoE) issued a public statement which recommends placement of AEDs in all UK primary and secondary schools [11]. The DoE statement supports purchasing of AEDs by the UK National Health Service (NHS) Supply Chain and with this program, the cost per AED would be £452.78 [11]. For this analysis, we used reported incidence of student sudden cardiac arrest as a single case of cardiac arrest and computed the rate of cardiac arrest per secondary school surveyed.

**Results**

**Characteristics**

Surveys were completed in 19 (52%) of the 32 London boroughs (Figure 1). Of 449 schools, representatives from 71 (16%) schools were contacted successfully and a total of 65 (15%) completed the survey. There were 6 schools which refused to participate (8%).
The student population from the surveyed schools completed covers an estimated population of 65,396 students between the ages of 11 and 19 years. In this sample, the earliest that students are exposed to BLS training is in Year 7 (approximately 11 years of age). Specialist First Aid and CPR educators from outside organizations (eg. St. John’s Ambulance, British Heart Foundation, etc.) are most commonly responsible for providing educational programs and training for students (15%).

**Primary and Secondary Outcomes**

There were 5 (8%) schools that provide universal training programs for students and an additional 31 (48%) offered training as part of an extra-curricular program or chosen module. The most common reasons for not having a universal BLS training program is the requirement for additional class time (28%) and that funding is unavailable for such program (28%). An AED was available in 18 (28%) schools, unavailable in 40 (61%) and 7 (11%) reported their AED provision as unknown. There were 5 students who died from sudden cardiac arrest over the period of the past 10 years. However, the administrator reporting 1 of the 5 cases was unable to confirm whether the sudden cardiac arrest happened at the school or away from school premises.

**Cost Analysis**

Of the 65 schools surveyed there were at least 5 sudden cardiac arrests reported during the preceding 10-year period. As such, an AED would need to be placed in 13 secondary schools in order to provide the opportunity to treat at least 1 sudden cardiac arrest within a 10-year period. The NHS Supply Chain will provide AEDs in schools throughout the UK for £452.78 and for a total of 3628 state funded secondary schools this would amount to a cost of £1,642,685.84 in order to place one AED in every secondary school in England.[12]

**Discussion**
In this prospective audit of London secondary schools there were overall low rates of universal BLS training programmes for students. Specifically, fewer than half the schools surveyed offer some form of optional BLS training for students with only 8% offering a universal BLS training program. The most common reasons stated for not having universal BLS training were the requirement for additional class time and the lack of funding to support such programs. Further, we found less than a third of schools had an AED on the school premises available in case of emergency. Although small, the estimated number of students suffering sudden cardiac arrest while on school premises (5) in the preceding decade highlights the importance of current government and public health campaigns to equip schools with AEDs and to improve the rate of CPR training in schools. We estimate that an AED placed in a minimum of 13 schools would be required in order to treat a single case of a child with sudden cardiac arrest.

Advances in cardiac arrest care have, since it was first described in 1991, focused on improving performance in the chain of survival [6]. While the past decade has significant improvement in the advanced care of the post-arrest patient, multiple recent investigations have demonstrated in large populations of patients the overall importance of improving the early links in the chain of survival, namely early identification of cardiopulmonary arrest and early initiation of bystander CPR efforts via large-scale educational programs [13,14]. Two recent reports have shown that CPR prior to emergency medical service arrival in OHCA is associated with improved survival [8], and that this basic intervention may be as effective or better than pre-hospital advanced life support [7]. While two recent randomized studies have demonstrated that trained teachers are able to provide adequate training in for resuscitation in schools[15,16] , one area that remains unanswered is whether legislation to require schools to teach BLS will improve outcomes for patients suffering cardiac arrest.

Our results demonstrate the significant room for improvement in student training in schools. We identified a small proportion (8%) of schools which provide CPR training for all students while 48% of schools offer some optional training for students. These results are in line with a recent investigation from Toronto, Canada, which found that 51% of secondary
schools provide CPR training for students although it is unclear whether CPR training programs were required for all students in the institution or whether these were optional programs [17]. There are important differences relating to the legislation between the two locations that raise the issue of making CPR training a requirement of school curriculum. While the government of Ontario, Canada has made it mandatory for students to demonstrate an understanding of cardiopulmonary resuscitation in order to obtain their secondary school diploma the UK government has yet to make such a change to curriculum requirements. It is unclear, therefore, what effect legislation has on the overall rate for students receiving CPR training. Despite this difference one recent report has also shown a temporal trend toward improving outcomes from OHCA in Denmark since instituting mandatory resuscitation training programs in elementary schools [14].

Our findings would suggest a rate of approximately one cardiac arrest per 130 school years (0.04 per 5 years), a similar rate to previous reports in the United States [18]. Based on current evidence ERC guidelines support the cost-effectiveness of placement of AEDS in public areas where there is one cardiac arrest per 5 years [19]. Although below the threshold for cost-effectiveness recommended by the ERC, placement of an AED in schools may fall within the acceptable cost per QALY recommended by the National Institute of Clinical Excellence and further will increase awareness and familiarity with AEDs amongst school children. In the UK, where legislation for BLS training in schools has not been written, the Department of Education has recently published guidance for schools to equip the institution with an AED [11] and offer financial support for purchasing an AED. As financial requirements were cited as one of the most common reasons for not having BLS training programs, such additional financial support should help improve public access AEDs in schools. Other campaigns such as the “Defib in schools” campaign, by the Arrhythmia Alliance (http://www.defibssavelives.org/defibs-in-schools), and the British Heart Foundation “Nation of Lifesavers” community campaign to support AED installation in schools can help to increase public awareness and improve AED installation rates. Such campaigns are important especially in light of the fact that previous investigations have shown a significant
improvement in neurologically intact survival with onsite AEDs compared to AEDs which have been dispatched via emergency services [20]. In the absence of legislation for BLS and AED training, local champions have been able to significantly increase rates of BLS and AED training and such endeavours should be encouraged, with successful local frameworks for provision of training adopted and implemented nationally.

The strengths of this investigation are that data were collected prospectively from school administrators who were responsible with BLS training practices at each of the institutions. We used an electronic data capture tool with pre-specified variable responses and error-response elements to minimize incomplete responses. A number of limitations should also be considered when interpreting the results of this investigation. While we were able to capture survey results data on a large number of London secondary schools there are a number of schools which are not represented. We have however collected complete survey data from 65 secondary schools from 19 boroughs across London which represents a large estimated student population with responses reflecting practices as recent as October 2014. One further limitation is that the survey tool that was used for the investigation has not been validated in a separate population. We attempted to mitigate this weakness with a pilot phase of the survey during which time respondents were able to provide feedback about the questionnaire. Finally, as we have attempted to obtain an estimate of the number of school children which have died as a result of cardiac arrest this data is inevitably limited by recall bias and larger population studies would be necessary to confirm our findings.

Conclusion

BLS training rates in London secondary schools are low and the majority of schools do not have an AED available in case of emergency. As a number of international health and resuscitation organizations are attempting to improve overall training rates these data highlight an opportunity to vastly improve training in schools throughout the United Kingdom.
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Contributions

JDS and PBL were responsible for project design and survey development. ADW was responsible for acquiring survey contact information. DCM, MCS, SJ and MS were responsible for primary survey data collection. JDS, DCM and MCS were responsible for data analysis and PBL for interpretation of results. All authors contributed to the first draft of the manuscript and have reviewed the final version before submission.

Competing Interests

The authors have no competing interests to declare. The corresponding author affirms that the manuscript is an honest, accurate, and transparent account of the study being reported and that no important aspects of the study have been omitted.

Data Sharing

No additional data available.
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12. UK Department of Education. Number of secondary schools and their size in student numbers. 2014.


Figures

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Supplementary Appendix

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4. What is the maximum age and minimum age of pupils in this school? (Give range, e.g. 8-14)

5. Is there currently any universal CPR education or training program for students in place in this institution, i.e. will ALL students at some point receive? (Y/N)
   a. If yes, continue to Q6
   b. If no, continue to Q10

6. In which year(s) are students introduced universally to CPR and AED training? Provide earliest year in which students are exposed to CPR training.
   a. Year 7
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   g. Year 13 (upper 6th)
   h. Other (specify)

7. Are students exposed to CPR training at any other time? If so, in which years? Choose one.
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9. What has been the biggest challenge to maintain universal CPR training in this institution? Choose one.
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e. Other (specify)

10. Is there any non-universal CPR training program for students at this institution? (Y/N)
   a. If yes, continue to Q13
   b. If no, continue to Q11

11. For schools without current CPR training/education programs:
   a. What do you perceive to be the biggest barrier to student training?
      Choose one.
      i. Requirement for additional class time
      ii. Funding unavailable for these programs
      iii. Cost of purchasing and/or maintaining equipment is prohibitive
      iv. School population is too small to be cost effective
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   a. How might students be exposed to CPR training at this institution?
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4. Other (specify)

14. Is there an automated external defibrillator in case of emergency? (Y/N/unknown)
15. To the best of your knowledge, in the past 10 years, have any students passed away from sudden cardiac arrest (SCA)? Y/N/unknown
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16. We are planning to survey a number of secondary schools in order to better understand CPR training practices across London. Would you be interested in receiving a summary of the results of this survey in the coming months? (This question is optional as a response here may remove anonymity in the survey. We do not plan to use this information for any other purposes) Y/N

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Basic Life Support Education in Secondary Schools: a cross-sectional survey in London, United Kingdom

Authors:
Justin D Salciccioli¹, Dominic C Marshall¹, Mark Sykes¹, Alexander D Wood¹, Stephanie Joppa¹, Madhurima Sinha¹, P Boon Lim²

Affiliations:
1 – Imperial College London, London, UK
2 – Department of Cardiology, Hammersmith Hospital, London UK W12 0HS

Correspondence:
P Boon Lim
Consultant Cardiologist
Imperial College Healthcare NHS Trust
Hammersmith Hospital
Du Cane Road
London W12 0Hs
Email: pblim@imperial.nhs.uk
Tel : 0203 313 4967
Fax: 0203 313 4095
Abstract:

Objectives

Basic life support (BLS) training in schools is associated with improved outcomes from cardiac arrest. International consensus statements have recommended universal BLS training for school-aged children. The current practice of BLS training in London schools is unknown. The aim of this study was to assess current practices of BLS training in London secondary schools.

Setting, Population and Outcomes

A prospective audit of BLS training in London secondary schools was conducted. Schools were contacted by email and a subsequent telephone interview was conducted with staff familiar with local training practices. Response data were anonymised and captured electronically. Universal training was defined as any programme which delivers BLS training to all students in the school. Simple descriptive statistics were used to summarise the results.

Results

A total of 65 schools completed the survey covering an estimated student population of 65,396 across 19 of 32 London boroughs. There were 5 (8%) schools that provide universal training programs for students and an additional 31 (48%) offering training as part of an extra-curricular program or chosen module. An Automated External Defibrillator (AED) was available in 18 (28%) schools, unavailable in 40 (61%) and 7 (11%) reported their AED provision as unknown. The most common reasons for not having a universal BLS training programme are the requirement for additional class time (28%) and that funding is unavailable for such program (28%). There were 5 students who died from sudden cardiac arrest over the period of the past 10 years.

Conclusion

BLS training rates in London secondary schools are low and the majority of schools do not have an AED available in case of emergency. These data highlight an opportunity to improve
BLS training and AEDs provision. Future studies should assess programmes which are cost-effective and do not require significant amounts of additional class time.

**Key words:** cardiopulmonary resuscitation, automatic external defibrillator, education, cardiac arrest

**Article Summary:**

The strengths of this investigation are that data was collected prospectively from school administrators who are responsible for Basic Life Support training at their institution. We used an electronic data capture tool to with pre-specified variable responses, standardizing the data and reducing inter-questioner variability. We were able to collect survey data from 65 secondary schools from 19 boroughs across London, with responses reflecting practices as recent as October 2014. A number of schools however are not represented in our data set. Finally, we collected data regarding the number school children who have died on school premises of sudden cardiac death. This figure is inevitably subject to recall bias.

**Relatable points:**

- Basic life support (BLS) training in schools improves outcomes in cardiac arrest
- BLS training in schools has been advocated by international councils
- BLS training rates in London schools are low
- Few London schools have an on-site automated external defibrillator (AED)
Introduction

Out-of-hospital cardiac arrest (OHCA) is a major public health burden which poses significant strain on healthcare systems [1] with approximately 420,000 arrests in the United States [2] and 275,000 in Europe [3] annually. Basic life support (BLS) training is associated with improved outcomes from cardiac arrest [4]. Rates of bystander cardiopulmonary resuscitation (CPR) vary by location [5] a result which is thought to be the result of poor training and education in CPR practices or the result of poor implementation of training practices.

Advances in cardiac arrest care have, since it was first described in 1991, focused on improving performance in the chain of survival [6]. While the past decade has significant improvement in the advanced care of the post-arrest patient, multiple recent investigations have demonstrated in large populations of patients the overall importance of improving the early links in the chain of survival, namely early identification of cardiopulmonary arrest and early initiation of bystander CPR efforts via large-scale educational programs [7,8]. Previous investigations have shown that BLS measures may be more important than advanced care in survival from out-of-hospital cardiac arrest [9] and more recent evidence has provided further support for this effect across healthcare systems [10]. One area that remains unanswered is whether legislation to require schools to teach BLS will improve outcomes for patients suffering cardiac arrest.

In order to improve the rate of early bystander CPR and early defibrillation the International Liaison Committee on Resuscitation (ILCOR) recommended training in CPR and familiarisation with Automated External Defibrillator (AED) as part of secondary school curricula [11]. BLS training has since become a requirement for graduation in multiple states throughout the United States [12]. Recent efforts have been made globally to train children in CPR and the World Health Organization has endorsed the ‘Kids Save Lives’ statement from the European Resuscitation Council to further improve training for school-aged children [13,14]. However, within Europe variation exists between countries regarding the methods used to train and how much time is spent training children, the general public and healthcare...
professionals alike [15–17]. While the requirement for BLS training is not part of the educational curriculum in the United Kingdom (UK) and the current practice of BLS training in schools throughout the UK is unknown.

The primary aim of this investigation was to appreciate the current practices of CPR and AED training in school-aged children in London. Our hypothesis was that, despite consensus statements from local and international professional resuscitation bodies, there would be a small proportion of London secondary schools currently offering universal BLS training programs. This was based primarily on previous reports which have suggested low rates of BLS training in the UK compared to European countries [15]. These data are relevant as they may highlight potential areas for improvement in public health initiatives. In order to identify training programs, we performed a cross-sectional survey to ascertain current training practices for students in London secondary schools. To the best of our knowledge this investigation is the only study to have assessed the rate of BLS training in London secondary schools since these consensus statements have been made.

Methods

Study Design and Setting

A registered audit was conducted as a cross-sectional survey of BLS and AED training in London secondary schools between June 2014 and October 2014. The project was approved as an audit at Hammersmith Hospital, Imperial College Healthcare Trust (Registration number 1673). A total of eight interviewers administered the survey during the course of two afternoon sessions (24/09/2014 and 01/10/2014). Prior to each session interviewers received via lecture presentation preliminary training in survey details and delivery for appropriate administration of the telephone interviews. All schools were contacted by email initially and a subsequent telephone interview was conducted with school staff familiar with local training practices. Response data were anonymised and captured.
electronically in a standardized electronic database. In order to ensure standardisation of response data the database contained pre-specified variable responses as described below.

**Survey Design and Data Collection**

The survey was developed in two phases. First, a preliminary survey was created and school administrators in three pre-specified London boroughs were contacted to complete the survey. Interviewers were responsible for recording survey results data as well as recording aspects of the survey tool which requiring additional clarification. Second, the survey tool was updated to incorporate suggestions from the initial series of telephone interviews and data collection. The final survey tool (see Supplementary files) was brief, included fewer than 20 response elements, and could typically be completed over the telephone in less than 10 minutes.

Response data were collected and managed using an electronic data capture tool which provided pre-specified variable responses and missing value-response alerts to minimize incomplete responses. During the course of the telephone interview data were captured directly into the standardized web-based survey tool.

**Outcomes and Analysis**

The primary outcome of interest was a current universal training program which delivers BLS training to all students in the school. Secondary outcomes of interest included the presence of an AED in the school and the perceived barriers to implementation of a universal student training program. The survey also included a single question to estimate the rate of death in school children during the 10-year period prior to the current investigation. Simple descriptive statistics including frequencies with percentages were used to summarise the results, as appropriate.

**Post-Hoc Analysis**
We performed a single post-hoc analysis to estimate the cost to treat a single case of student cardiac arrest. During the course of the data collection period, the UK Department of Education (DoE) issued a public statement which recommends placement of AEDs in all UK primary and secondary schools [18]. The DoE statement supports purchasing of AEDs by the UK National Health Service (NHS) Supply Chain and with this program, the cost per AED would be £452.78 [18]. For this analysis, we used reported incidence of student sudden cardiac arrest as a single case of cardiac arrest and computed the rate of cardiac arrest per secondary school surveyed.

Results

Characteristics

Surveys were completed in 19 (52%) of the 32 London boroughs (Figure 1). Of 449 schools, representatives from 71 (16%) schools were contacted successfully and a total of 65 (15%) completed the survey. There were 6 schools which refused to participate (8%). The student population from the surveyed schools completed covers an estimated population of 65,396 students between the ages of 11 and 19 years. In this sample, the earliest that students are exposed to BLS training is in Year 7 (approximately 11 years of age). Specialist First Aid and CPR educators from outside organizations (eg. St. John’s Ambulance, British Heart Foundation, etc.) are most commonly responsible for providing educational programs and training for students (15%).

Primary and Secondary Outcomes

There were 5 (8%) schools that provide universal training programs for students and an additional 31 (48%) offered training as part of an extra-curricular program or chosen module. The most common reasons for not having a universal BLS training program is the requirement for additional class time (28%) and that funding is unavailable for such program (28%). An AED was available in 18 (28%) schools, unavailable in 40 (61%) and 7 (11%)
reported their AED provision as unknown. There were 5 students who died from sudden
cardiac arrest over the period of the past 10 years. However, the administrator reporting 1 of
the 5 cases was unable to confirm whether the sudden cardiac arrest happened at the
school or away from school premises.

Cost Analysis

Of the 65 schools surveyed there were at least 5 sudden cardiac arrests reported
during the preceding 10-year period. As such, an AED would need to be placed in 13
secondary schools in order to provide the opportunity to treat at least 1 sudden cardiac
arrest within a 10-year period. The NHS Supply Chain will provide AEDs in schools
throughout the UK for £452.78 and for a total of 3628 state funded secondary schools this
would amount to a cost of £1,642,685.84 in order to place one AED in every secondary
school in England.[19]

Discussion

In this prospective audit of London secondary schools there were overall low rates of
universal BLS training programmes for students. Specifically, fewer than half the schools
surveyed offer some form of optional BLS training for students with only 8% offering a
universal BLS training program. The most common reasons stated for not having universal
BLS training were the requirement for additional class time and the lack of funding to support
such programs. Further, we found less than a third of schools had an AED on the school
premises available in case of emergency. Although small, the estimated number of students
suffering sudden cardiac arrest while on school premises (5) in the preceding decade
highlights the importance of current government and public health campaigns to equip
schools with AEDs and to improve the rate of CPR training in schools. We estimate that an
AED placed in a minimum of 13 schools would be required in order to treat a single case of a
child with sudden cardiac arrest.
Our results demonstrate the significant room for improvement in student training in schools. We identified a small proportion (8%) of schools which provide CPR training for all students while 48% of schools offer some optional training for students. Our findings reflect the results of a similar survey of schools in Yorkshire, England which found only three of the fourteen schools delivered universal training[20]. Our results are further in line with a recent investigation from Toronto, Canada, which found that 51% of secondary schools provide CPR training for students although it is unclear whether CPR training programs were required for all students in the institution or whether these were optional programs [21].

There are important differences relating to the legislation between the two locations that raise the issue of making CPR training a requirement of school curriculum. While the government of Ontario, Canada has made it mandatory for students to demonstrate an understanding of cardiopulmonary resuscitation in order to obtain their secondary school diploma the UK government has yet to make such a change to curriculum requirements. It is unclear, therefore, what effect legislation has on the overall rate for students receiving CPR training. Despite this difference one recent report has also shown a temporal trend toward improving outcomes from OHCA in Denmark since instituting mandatory resuscitation training programs in elementary schools [8]. A recent report from Denmark assessed which factors school leaders and teachers value in the aim to train school children in BLS [22]. It is important to note that other investigations have demonstrated that effective BLS training is possible in the absence of trained or experienced BLS instructors [23]. Further, while two randomized studies have demonstrated that trained teachers are able to provide adequate training in for resuscitation in schools and a systematic review has summarised the methods to best teach CPR to children [24–26].

Our findings would suggest a rate of approximately one cardiac arrest per 130 school years (0.04 per 5 years), a similar rate to previous reports in the United States [27]. Based on current evidence ERC guidelines support the cost-effectiveness of placement of AEDS in public areas where there is one cardiac arrest per 5 years [28]. Although below the threshold
for cost-effectiveness recommended by the ERC, placement of an AED in schools may fall within the acceptable cost per QALY recommended by the National Institute of Clinical Excellence and will further increase awareness and familiarity with AEDs amongst school children. In the UK, where legislation for BLS training in schools has not been written, the Department of Education has recently published guidance for schools to equip the institution with an AED [18] and offer financial support for purchasing an AED. As financial requirements were cited as one of the most common reasons for not having BLS training programs, such additional financial support should help improve public access AEDs in schools. Other campaigns such as the “Defib in schools” campaign, by the Arrhythmia Alliance (http://www.defibssavelives.org/defibs-in-schools), and the British Heart Foundation “Nation of Lifesavers” community campaign to support AED installation in schools can help to increase public awareness and improve AED installation rates. Such campaigns are important especially in light of the fact that previous investigations have shown a significant improvement in neurologically intact survival with onsite AEDs compared to AEDs which have been dispatched via emergency services [29]. In the absence of legislation for BLS and AED training, local champions have been able to significantly increase rates of BLS and AED training and such endeavours should be encouraged, with successful local frameworks for provision of training adopted and implemented nationally.

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Conclusion

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Competing Interests

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml
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**Data Sharing**

No additional data available.
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<td>Primary Subject Heading:</td>
<td>Cardiovascular medicine</td>
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<tr>
<td>Secondary Subject Heading:</td>
<td>Public health</td>
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<tr>
<td>Keywords:</td>
<td>cardiopulmonary resuscitation, automatic external defibrillator, education, cardiac arrest</td>
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Title:
Basic Life Support Education in Secondary Schools: a cross-sectional survey in London, United Kingdom

Authors:
Justin D Salciccioli¹, Dominic C Marshall¹, Mark Sykes¹, Alexander D Wood¹, Stephanie Joppa¹, Madhurima Sinha¹, P Boon Lim²

Affiliations:
1 – Imperial College London, London, UK
2 – Department of Cardiology, Hammersmith Hospital, London UK W12 0HS

Correspondence:
P Boon Lim
Consultant Cardiologist
Imperial College Healthcare NHS Trust
Hammersmith Hospital
Du Cane Road
London W12 0Hs

Email: pblim@imperial.nhs.uk
Tel : 0203 313 4967
Fax: 0203 313 4095
Abstract:

Objectives

Basic life support (BLS) training in schools is associated with improved outcomes from cardiac arrest. International consensus statements have recommended universal BLS training for school-aged children. The current practice of BLS training in London schools is unknown. The aim of this study was to assess current practices of BLS training in London secondary schools.

Setting, Population and Outcomes

A prospective audit of BLS training in London secondary schools was conducted. Schools were contacted by email and a subsequent telephone interview was conducted with staff familiar with local training practices. Response data were anonymised and captured electronically. Universal training was defined as any programme which delivers BLS training to all students in the school. Descriptive statistics were used to summarise the results.

Results

A total of 65 schools completed the survey covering an estimated student population of 65,396 across 19 of 32 London boroughs. There were 5 (8%) schools that provide universal training programs for students and an additional 31 (48%) offering training as part of an extra-curricular program or chosen module. An Automated External Defibrillator (AED) was available in 18 (28%) schools, unavailable in 40 (61%) and 7 (11%) reported their AED provision as unknown. The most common reasons for not having a universal BLS training programme are the requirement for additional class time (28%) and that funding is unavailable for such program (28%). There were 5 students who died from sudden cardiac arrest over the period of the past 10 years.

Conclusion

BLS training rates in London secondary schools are low and the majority of schools do not have an AED available in case of emergency. These data highlight an opportunity to improve BLS training and AEDs provision. Future studies should assess programmes which are cost-effective and do not require significant amounts of additional class time.
Key words: cardiopulmonary resuscitation, automatic external defibrillator, education, cardiac arrest

Article Summary:

Article Focus:

International health and resuscitation committees have recommended training in CPR and familiarisation with Automated External Defibrillator (AED) as part of secondary school curricula and recent efforts have been made globally to train children in CPR. However, the requirement for BLS training is not a part of the educational curriculum in the United Kingdom (UK).

Key Messages:

BLS training rates in London secondary schools are low and the majority of schools do not have an AED available in case of emergency. These data highlight an opportunity to vastly improve training in schools throughout the United Kingdom.

Strengths and Limitations:

Strengths include data collected prospectively from secondary schools across London, with responses reflecting practices as recent as October 2014. A number of schools, however, are not represented in our data set. Recall bias limits our ability to generalize our findings relating to the number school children who have died on school premises of sudden cardiac death.
Introduction

Out-of-hospital cardiac arrest (OHCA) is a major public health burden which poses significant strain on healthcare systems [1] with approximately 420,000 arrests in the United States [2] and 275,000 in Europe [3] annually. Basic life support (BLS) training is associated with improved outcomes from cardiac arrest [4]. Rates of bystander cardiopulmonary resuscitation (CPR) vary by location [5] a result which is thought to be the result of poor training and education in CPR practices or the result of poor implementation of training practices.

Advances in cardiac arrest care have, since it was first described in 1991, focused on improving performance in the chain of survival [6]. While the past decade has significant improvement in the advanced care of the post-arrest patient, multiple recent investigations have demonstrated in large populations of patients the overall importance of improving the early links in the chain of survival, namely early identification of cardiopulmonary arrest and early initiation of bystander CPR efforts via large-scale educational programs [7,8]. Previous investigations have shown that BLS measures may be more important than advanced care in survival from out-of-hospital cardiac arrest [9] and more recent evidence has provided further support for this effect across healthcare systems [10]. One area that remains unanswered is whether legislation to require schools to teach BLS will improve outcomes for patients suffering cardiac arrest.

In order to improve the rate of early bystander CPR and early defibrillation the International Liaison Committee on Resuscitation (ILCOR) recommended training in CPR and familiarisation with Automated External Defibrillator (AED) as part of secondary school curricula [11]. BLS training has since become a requirement for graduation in multiple states throughout the United States [12]. Recent efforts have been made globally to train children in CPR and the World Health Organization has endorsed the ‘Kids Save Lives’ statement from the European Resuscitation Council to further improve training for school-aged children [13,14]. However, within Europe variation exists between countries regarding the methods used to train and how much time is spent training children, the general public and healthcare
professionals alike [15–17]. The requirement for BLS training is not part of the educational curriculum in the United Kingdom (UK) and the current practice of BLS training in schools throughout the UK is unknown.

The primary aim of this investigation was to appreciate the current practices of CPR and AED training in school-aged children in London. Our hypothesis was that, despite consensus statements from local and international professional resuscitation bodies, there would be a small proportion of London secondary schools currently offering universal BLS training programs. This was based primarily on previous reports which have suggested low rates of BLS training in the UK compared to European countries [15]. These data are relevant as they may highlight potential areas for improvement in public health initiatives. In order to identify training programs, we performed a cross-sectional survey to ascertain current training practices for students in London secondary schools. To the best of our knowledge this investigation is the only study to have assessed the rate of BLS training in London secondary schools since these consensus statements have been made.

Methods

Study Design and Setting

A registered audit was conducted as a cross-sectional survey of BLS and AED training in London secondary schools between June 2014 and October 2014. The project was approved as an audit at Hammersmith Hospital, Imperial College Healthcare Trust (Registration number 1673). A total of eight interviewers administered the survey during the course of two afternoon sessions. Prior to each session interviewers received via lecture presentation preliminary training in survey details and delivery for appropriate administration of the telephone interviews. All schools were contacted by email initially and a subsequent telephone interview was conducted with school staff familiar with local training practices. Response data were anonymised and captured electronically in a standardized electronic
database. In order to ensure standardisation of response data the database contained pre-
specified variable responses as described below.

Survey Design and Data Collection

The survey was developed in two phases. First, a preliminary survey was created
and school administrators in three pre-specified London boroughs were contacted to
complete the survey. Interviewers were responsible for recording survey results data as well
as recording aspects of the survey tool which requiring additional clarification. Second, the
survey tool was updated to incorporate suggestions from the initial series of telephone
interviews and data collection. The final survey tool (see Supplementary files) was brief,
included fewer than 20 response elements, and could typically be completed over the
telephone in less than 10 minutes.

Response data were collected and managed using an electronic data capture tool
which provided pre-specified variable responses and missing value-response alerts to
minimize incomplete responses. During the course of the telephone interview data were
captured directly into the standardized web-based survey tool.

Outcomes and Analysis

The primary outcome of interest was a current universal training program which
delivers BLS training to all students in the school. Secondary outcomes of interest included
the presence of an AED in the school and the perceived barriers to implementation of a
universal student training program. The survey also included a single question to estimate
the rate of death in school children during the 10-year period prior to the current
investigation. Simple descriptive statistics including frequencies with percentages were used
to summarise the results, as appropriate.

Post-Hoc Analysis
We performed a single post-hoc analysis to estimate the cost to treat a single case of student cardiac arrest. During the course of the data collection period, the UK Department of Education (DoE) issued a public statement which recommends placement of AEDs in all UK primary and secondary schools [18]. The DoE statement supports purchasing of AEDs by the UK National Health Service (NHS) Supply Chain and with this program, the cost per AED would be £452.78 [18]. For this analysis, we used reported incidence of student sudden cardiac arrest as a single case of cardiac arrest and computed the rate of cardiac arrest per secondary school surveyed.

Results

Characteristics

Surveys were completed in 19 (52%) of the 32 London boroughs (Figure 1). Of 449 schools, representatives from 71 (16%) schools were contacted successfully and a total of 65 (15%) completed the survey. There were 6 schools which refused to participate (8%). The student population from the surveyed schools completed covers an estimated population of 65,396 students between the ages of 11 and 19 years. In this sample, the earliest that students are exposed to BLS training is in Year 7 (approximately 11 years of age). Specialist First Aid and CPR educators from outside organizations (eg. St. John’s Ambulance, British Heart Foundation, etc.) are most commonly responsible for providing educational programs and training for students (15%).

Primary and Secondary Outcomes

There were 5 (8%) schools that provide universal training programs for students and an additional 31 (48%) offered training as part of an extra-curricular program or chosen module. The most common reasons for not having a universal BLS training program is the requirement for additional class time (28%) and that funding is unavailable for such program (28%). An AED was available in 18 (28%) schools, unavailable in 40 (61%) and 7 (11%)
reported their AED provision as unknown. There were 5 students who died from sudden cardiac arrest over the period of the past 10 years. However, the administrator reporting 1 of the 5 cases was unable to confirm whether the sudden cardiac arrest happened at the school or away from school premises.

Cost Analysis

Of the 65 schools surveyed there were at least 5 sudden cardiac arrests reported during the preceding 10-year period. As such, an AED would need to be placed in 13 secondary schools in order to provide the opportunity to treat at least 1 sudden cardiac arrest within a 10-year period. The NHS Supply Chain will provide AEDs in schools throughout the UK for £452.78 and for a total of 3628 state funded secondary schools this would amount to a cost of £1,642,685.84 in order to place one AED in every secondary school in England.[19]

Discussion

In this prospective audit of London secondary schools there were overall low rates of universal BLS training programmes for students. Specifically, fewer than half the schools surveyed offer some form of optional BLS training for students with only 8% offering a universal BLS training program. The most common reasons stated for not having universal BLS training were the requirement for additional class time and the lack of funding to support such programs. Further, we found less than a third of schools had an AED on the school premises available in case of emergency. Although small, the estimated number of students suffering sudden cardiac arrest while on school premises (5) in the preceding decade highlights the importance of current government and public health campaigns to equip schools with AEDs and to improve the rate of CPR training in schools. We estimate that an AED placed in a minimum of 13 schools would be required in order to treat a single case of a child with sudden cardiac arrest.
Our results demonstrate the significant room for improvement in student training in schools. We identified a small proportion (8%) of schools which provide CPR training for all students while 48% of schools offer some optional training for students. Our findings reflect the results of a similar survey of schools in Yorkshire, England which found only three of the fourteen schools delivered universal training[20]. Our results are further in line with a recent investigation from Toronto, Canada, which found that 51% of secondary schools provide CPR training for students although it is unclear whether CPR training programs were required for all students in the institution or whether these were optional programs [21].

There are important differences relating to the legislation between the two locations that raise the issue of making CPR training a requirement of school curriculum. While the government of Ontario, Canada has made it mandatory for students to demonstrate an understanding of cardiopulmonary resuscitation in order to obtain their secondary school diploma the UK government has yet to make such a change to curriculum requirements. It is unclear, therefore, what effect legislation has on the overall rate for students receiving CPR training. Despite this difference one recent report has also shown a temporal trend toward improving outcomes from OHCA in Denmark since instituting mandatory resuscitation training programs in elementary schools [8]. A recent report from Denmark assessed which factors school leaders and teachers value in the aim to train school children in BLS [22]. It is important to note that other investigations have demonstrated that effective BLS training is possible in the absence of trained or experienced BLS instructors [23]. Further, while two randomized studies have demonstrated that trained teachers are able to provide adequate training in for resuscitation in schools and a systematic review has summarised the methods to best teach CPR to children [24–26].

Our findings would suggest a rate of approximately one cardiac arrest per 130 school years (0.04 per 5 years), a similar rate to previous reports in the United States [27]. Based on current evidence ERC guidelines support the cost-effectiveness of placement of AEDS in public areas where there is one cardiac arrest per 5 years [28]. Although below the threshold
for cost-effectiveness recommended by the ERC, placement of an AED in schools may fall 
within the acceptable cost per QALY recommended by the National Institute of Clinical 
Excellence and will further increase awareness and familiarity with AEDs amongst school 
children. In the UK, where legislation for BLS training in schools has not been written, the 
Department of Education has recently published guidance for schools to equip the institution 
with an AED [18] and offer financial support for purchasing an AED. As financial 
requirements were cited as one of the most common reasons for not having BLS training 
programs, such additional financial support should help improve public access AEDs in 
schools. Other campaigns such as the “Defib in schools” campaign, by the Arrhythmia 
Alliance (http://www.defibssavelives.org/defibs-in-schools), and the British Heart Foundation 
“Nation of Lifesavers” community campaign to support AED installation in schools can help 
to increase public awareness and improve AED installation rates. Such campaigns are 
important especially in light of the fact that previous investigations have shown a significant 
 improvement in neurologically intact survival with onsite AEDs compared to AEDs which 
have been dispatched via emergency services [29]. In the absence of legislation for BLS and 
AED training, local champions have been able to significantly increase rates of BLS and 
AED training and such endeavours should be encouraged, with successful local frameworks 
for provision of training adopted and implemented nationally.

The strengths of this investigation are that data were collected prospectively from 
school administrators who were responsible with BLS training practices at each of the 
institutions. We used an electronic data capture tool with pre-specified variable responses 
and error-response elements to minimize incomplete responses. A number of limitations 
should also be considered when interpreting the results of this investigation. While we were 
able to capture survey results data on a large number of London secondary schools there 
are a number of schools which are not represented. We have however collected complete 
survey data from 65 secondary schools from 19 boroughs across London which represents a 
large estimated student population with responses reflecting practices as recent as October
2014. One further limitation is that the survey tool that was used for the investigation has not been validated in a separate population. We attempted to mitigate this weakness with a pilot phase of the survey during which time respondents were able to provide feedback about the questionnaire. Finally, as we have attempted to obtain an estimate of the number of school children which have died as a result of cardiac arrest this data is inevitably limited by recall bias and larger population studies would be necessary to confirm our findings.

Conclusion

BLS training rates in London secondary schools are low and the majority of schools do not have an AED available in case of emergency. As a number of international health and resuscitation organizations are attempting to improve overall training rates these data highlight an opportunity to vastly improve training in schools throughout the United Kingdom.

Acknowledgements

The authors are grateful for the illustration prepared by Will Mower. This work is supported by the National Institute for Health Research Biomedical Research Centre based at Imperial College Healthcare NHS Trust and Imperial College London. The views expressed in this publication are those of the author(s) and not necessarily those of the NHS, the National Institute for Health Research or the Department of Health.

Contributions

JDS and PBL were responsible for project design and survey development. ADW was responsible for acquiring survey contact information. DCM, MCS, SJ and MS were responsible for primary survey data collection. JDS, DCM and MCS were responsible for data analysis and PBL for interpretation of results. All authors contributed to the first draft of the manuscript and have reviewed the final version before submission.

Competing Interests
The authors have no competing interests to declare. The corresponding author affirms that the manuscript is an honest, accurate, and transparent account of the study being reported and that no important aspects of the study have been omitted.

Data Sharing

No additional data available.
References


Figures

Figure 1: Map of London boroughs. Colors represent boroughs with surveys completed from all secondary schools within the borough (green), from a proportion but not all of the secondary schools (blue), or borough without completed survey data (grey).
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Supplementary Appendix

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Survey Instrument

1. Borough: drop down list

2. School ID

3. What is the current enrollment (number of pupils) in this school?

4. What is the maximum age and minimum age of pupils in this school? (Give range, e.g. 8-14)

5. Is there currently any universal CPR education or training program for students in place in this institution, i.e. will ALL students at some point receive? (Y/N)
   a. If yes, continue to Q6
   b. If no, continue to Q10

6. In which year(s) are students introduced universally to CPR and AED training? Provide earliest year in which students are exposed to CPR training.
   a. Year 7
   b. Year 8
   c. Year 9
   d. Year 10
   e. Year 11
   f. Year 12 (lower 6th)
   g. Year 13 (upper 6th)
   h. Other (specify)

7. Are students exposed to CPR training at any other time? If so, in which years?
   Choose one.
   a. No follow-up training program in place
   b. Year 7
   c. Year 8
   d. Year 9
   e. Year 10
   f. Year 12 (lower 6th)
   g. Year 13 (upper 6th)
   h. Other (specify)

8. Who is responsible for providing CPR training / education for these students?
   Choose one.
   a. Teachers
   b. Specialist first aid/CPR educators employed at the institution
   c. Specialist first aid/CPR educators from an outside organization (e.g. St. John’s ambulance, British Heart Foundation, etc.)
   d. Other (specify)

9. What has been the biggest challenge to maintain universal CPR training in this institution? Choose one.
a. Instructor training or scheduling
b. Class scheduling
c. Initial purchase of equipment
d. Maintenance of equipment
e. Other (specify)

10. Is there any non-universal CPR training program for students at this institution? (Y/N)
   a. If yes, continue to Q13
   b. If no, continue to Q11

11. For schools without current CPR training/education programs:
   a. What do you perceive to be the biggest barrier to student training? Choose one.
      i. Requirement for additional class time
      ii. Funding unavailable for these programs
      iii. Cost of purchasing and/or maintaining equipment is prohibitive
      iv. School population is too small to be cost effective
      v. School population is too large to offer training to everyone
      vi. No perceived need for this training
      vii. Other (specify)

12. Other CPR training programs
   a. Are teachers or staff members required to have CPR training (Y/N)
      i. If yes, is this training optional or a requirement? Choose one.
         1. Required for all teachers in this institution
         2. Required for select teachers in this institution
         3. Other (specify)
   b. Who is responsible for providing CPR training/education for these individuals?
      i. Teachers
      ii. Specialist first aid/CPR educators employed at the institution
      iii. Specialist first aid/CPR educators from an outside organization (e.g. St Johns ambulance, British Heart Foundation, etc.)
      iv. Other (specify)
   c. With what frequency, if any, do these individuals complete their CPR training? Choose one.
      i. Annually
      ii. Every second year
      iii. Every third year
      iv. Less than once every third year
      v. Never
      vi. Other

13. Non-universal CPR training for Students
   a. How might students be exposed to CPR training at this institution? Choose one.
      i. As part of Duke in Edinburgh scheme
      ii. Physical education classes
      iii. Social health and wellness class
iv. Other scheduled class time
v. Other (specify)
b. Who is responsible for providing CPR training/education for these students? Choose one.
   1. Teachers
   2. Specialist First Aid / CPR educators employed at the institution
   3. Specialist First Aid / CPR educators from an outside organization
      (eg St. John’s ambulance, British Heart Foundation, etc.)
   4. Other (specify)

14. Is there an automated external defibrillator in case of emergency? (Y/N/unknown)
15. To the best of your knowledge, in the past 10 years, have any students passed away from sudden cardiac arrest (SCA)? Y/N/unknown
   a. If yes, what number of students have passed away from SCA (Total # of students within the last 10 years)
16. We are planning to survey a number of secondary schools in order to better understand CPR training practices across London. Would you be interested in receiving a summary of the results of this survey in the coming months? (This question is optional as a response here may remove anonymity in the survey. We do not plan to use this information for any other purposes) Y/N
17. Are you interested in learning more about the possibility of having student volunteers into your school to teach CPR and First Aid?
18. Can you provide the best email address to contact you about the above? (Record this information on the hardcopy list of schools provided)
19. Date/Time questionnaire completed
   a. Month, day, year, hour, min, AM/PM