



**SURF  
LIFEGUARD  
KNOWLEDGE  
PRACTICE  
AND  
PERCEPTIONS  
OF CPR**

## Preface and Acknowledgements

This report is an evaluation of the 2010 collaborative project between Surf Life Saving Northern Region (SLSNR), The University of Auckland, and WaterSafe Auckland Incorporated (WAI).

The *Volunteer Lifeguard CPR Project* was set up in October 2010 in order to more fully understand what our volunteer surf lifeguards know, think, and do with regard to Cardiopulmonary Resuscitation (CPR). While all lifeguards are required to train/retrain in CPR and other emergency skills each year, little is known about their competency to perform CPR and their perceptions of the value and function of CPR.

Our thanks to the surf club administrators of 16 surf clubs in the Auckland region who willingly assisted and promoted the project among their lifeguard membership. We acknowledge the input of patrol captains who facilitated the collection of data among their patrol members when on busy weekend patrols. Their support and enthusiasm for the project has been pivotal to the success of the venture. Most importantly, we appreciate the input of 252 volunteer surf lifeguards who volunteered their time and energy to take part in the study.

The project would not have been possible without the support and advice of Surf Life Saving New Zealand national and northern region personnel including Nathan Hight, SLSNZ General Manager, Programmes and Services, Andy Kent, Programmes and Services manager (SLSNR), Brett Ward Able, Chair, SLSNR Lifesaving Operational Committee, and Stacey Willcox, WaterSafe Auckland.

We are grateful to the generous support of Kevin Ankcorn, sales manager of Laerdal New Zealand for the loan of two Resusci@Anne SkillReporter™ manikins for the summer patrol season.

Finally, a very special vote of thanks to the field assistants, Natalie Willcox, Alicia Rutherford, and Gareth Jenkin. They were the public face of the project and their importance in working alongside volunteer surf lifeguards was critical to the accurate and consistent collection of data.

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[www.watersafe.org.nz/page.asp?page=573](http://www.watersafe.org.nz/page.asp?page=573)



# Executive Summary

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## 1. BACKGROUND

In spite of comprehensive reporting of surf lifeguard rescue and preventative activity (for example, Surf Life Saving New Zealand Annual Report, 2010), not a lot is known about lifeguard experience of CPR use when on patrol or how often they are called upon to exercise their CPR skills and knowledge in an emergency. Faddy (2002) reported that most lifeguards (74%) surveyed at northern Sydney beaches had not undertaken CPR in an emergency and that the experience of those who had did not affect their expectation of successful resuscitation compared with those who had never used CPR in an emergency.

Little is known about the efficacy of training/re-training of volunteer surf lifeguards or about how lifeguard perceive of the value of CPR training and skills, or of self-estimated competency and 'real' competency demonstrated through simulation on CPR manikins, the traditional training approach to developing practical competency for volunteer surf lifeguards.

## 2. PURPOSE

The aims of the study was to comprehensively analyse volunteer surf lifeguards' real and perceived competencies in CPR, an important aspect of a lifeguard's role and function in emergency response situations. The objectives of the study were:

- To investigate the CPR skills in simulated practice among volunteer surf lifeguards
- To identify volunteer surf lifeguards' perceptions about their ability to perform CPR
- To determine volunteer surf lifeguards' experience of CPR use in an emergency
- To identify understanding of correct CPR protocols among volunteer surf lifeguards
- To identify perceptions informing lifeguards of the efficacy to perform CPR in emergency practice
- To identify currency and retention of CPR knowledge as a consequence of training/re-training

### **3. METHODS**

- The research design was a mixed method, cross-sectional study using a questionnaire survey and assessment of practical CPR skills
- The subjects of the study were volunteer surf lifeguards in the Auckland region, who volunteered take part in the study during early season patrols on 10 weekends between November 2010 and January, 2011
- The patrol captains of each randomly selected weekend patrol were contacted in the week prior to the visit requesting their assistance in allowing patrol members to voluntarily participate in the study during patrol hours
- The research instruments used to gather data on real and perceived understanding of CPR were a written self-complete anonymous survey and a practical skills test on a resuscitation manikin
- The self-compete questionnaire consisted of 14 questions, the first seven of which sought demographic information such as age, gender, length of lifeguard service, first aid and CPR training, and previous use of CPR in emergency response
- Participating lifeguards were initially asked to complete the written survey that focussed on their knowledge of CPR protocols and their perceptions of their ability to perform CPR
- Immediately after completing the questionnaire, participants undertook a simulated practice of CPR on a Laerdal Resusci®Anne SkillReporter™ manikin for 2 minutes
- The New Zealand Resuscitation Council Level 2/3 adult collapse algorithm was used to assess the correct sequence of actions (NZRC, 2006). Adequacy of compressions and ventilations, compression to ventilation ratio, and compression rate were assessed using the manikin over a 2-minute period of CPR
- Descriptive statistics using numbers and percentages were tabulated (see Tables 1-6) to report the distribution of dependent variables (such as CPR knowledge and perceptions of personal competency) and independent variables (such as gender, age, and length of service)

## **4. KEY FINDINGS**

### **4.1 Participant demographics**

- **Of the 280 volunteer surf lifeguards invited to participate in the study, 262 lifeguards from 16 clubs completed the survey and practical skills test, a response rate of 93%**
- **57% were male, 63% were aged less than 19 years**
- **77% had 5 years or less service**
- **77% had received CPR training/retraining in the previous 6 months**
- **9% had personally used CPR in an emergency**
- **10% had seen CPR use on their patrol**

### **4.2 Lifeguard perceptions of CPR - their personal competency and confidence, and beliefs about its effectiveness**

- **56% considered their CPR skills were highly effective/effective and a further 40% thought their skill level was satisfactory**
- **Almost all lifeguards (83%) were willing to perform CPR although 17% reported that they were hesitant about performing CPR**
- **Most lifeguards had a realistic view of the success of CPR in out-of-hospital cardiac arrest (OHCA). Almost one half (48%) believed that the chances of success were 25% or less**
- **Most lifeguards thought that the public would be overly optimistic about the rate of return of spontaneous circulation (ROSC) in OHCA ( $M = 71%$  success rate,  $S.D. = 25.177$ )**
- **Swimming competency was the considered the most important skill by 41% of lifeguards, followed in descending order by CPR skills (23%), first aid skills (22%), tube rescue skills (7%), and rescue craft skills (6%)**

### **4.3 Theoretical knowledge of CPR**

From the written survey, most lifeguards correctly responded to:

- **Correct compression rate of 100 per minute (86%)**
- **Clearing the airway (98%)**
- **When to stop CPR (93%)**
- **Correct compression depth (89%)**
- **Duration of breathing check (79%)**
- **When to go for help (71%)**
- **Initial response at the scene of a medical emergency (69%)**
- **The duration of rescue breaths (66%)**

### **4.4 Observed CPR skills**

When demonstrating practical skills on the manikin, most lifeguards:

- **Made the appropriate check for responsiveness using voice and touch (98%)**
- **Established the airway using the head tilt/chin lift technique (92%)**
- **Checked breathing in less than 10 seconds (94%)**
- **Commenced chest compressions (98%)**
- **Established a correct compression-to-ventilation ratio of 30:2 (90%)**
- **Maintained the airway between sets of compressions (86%)**
- **Most lifeguards (72%) did an immediate check for danger to themselves, their patient, and others (most who failed did so because they didn't put on the protective gloves)**
- **More than one quarter (29%) did not send for help after determining that the patient was unresponsive**
- **Only 28% indicated that, when alone, they would go for help after determining that the patient was not breathing**

### **4.5 Compression Skills**

- **Compression rates ( $127 \pm 17.7 \text{ min}^{-1}$ ) tended to exceed the recommended compression rate of 100 per minute, although the total number of compressions ( $142 \pm 13.6$ ) was slightly less than the**

recommended total of 150 compressions in the 5 cycles that should occur in 2 minutes

- Lifeguards were accurate in their execution of chest compressions in terms of depth of compression ( $M=40.63\text{mm}\pm 8.684$ , range 14-58mm), the recommended depth being from 40-50mm
- Some lifeguards recorded incomplete releases (3.8%), placed their hands too low (8.8%), or compressed the chest too deeply (17.9%)
- One quarter (25.2%) of lifeguards at some stage compressed the chest with the wrong hand position
- One third (34.9%) were too shallow with some compressions during the 2 minutes test duration
- No significant differences were found when compression skills were analysed by age group and gender

#### **4.6 Ventilation Skills**

- Lifeguards provide slightly less number of ventilations ( $M=8.91\pm 2.401$ , range 2-19) than the recommended 10 in 2 minutes of manikin practice and at a slightly lower rate per minute ( $M=3.98\pm 0.960$ , range 1-6)
- One quarter (27%) of the ventilations were too little, and almost two thirds (62.6%) were delivered too rapidly
- Lifeguards tended to over-ventilate the lungs on each expired air ventilation ( $M=935.55\text{ml}\pm 292.907$ , range 400-1790ml) (recommended tidal volume = 500-600ml)
- This resulted in an elevated minute volume ( $M=3709.76\text{mL}\pm 1481.886$ , range 500-8950mL) (recommended minute volume = 2500-3000ml/m)
- One third (31%) over-inflated the lungs (>1000ml) which may worsen gastric distension in an emergency
- No significant differences were found when ventilation skills were analysed by age group and length of lifeguard experience
- Male lifeguards were significantly more likely to over-inflate the lungs during testing on the manikin

## **5. RECOMMENDATIONS**

To address issues of lifeguard knowledge and perceptions reported in the survey, the authors recommend:

- **Additional training on when to leave a patient and go for help.**
- **More training to address failures in observing initial response protocols. The routine requirement of donning gloves during training/retraining sessions may make this required action more automatic in an emergency**
- **In training lifeguards in the use of AED, that the following key messages are emphasised:**
  - **Commence high-quality CPR as soon as the patient is recovered from the water. High-quality CPR improves survival and the likelihood that defibrillation will be successful**
  - **Attach the AED as soon as possible without stopping chest compressions as the pads are being applied**
  - **When the AED is attached it may or may not advise a shock. Not all patients in cardiac arrest require defibrillation so if no shock is advised, resume CPR immediately and continue until help arrives or the patient recovers.**

To address issues of technical competency of lifeguards in this study, the authors recommend:

- **Non-feedback manikins be replaced/upgraded (as funding allows) to manikins with a feedback/prompt mechanism eg. Laerdal SkillReporter™/ SkillGuide™. Furthermore, manikins equipped with a feedback mechanism should be used in all facets of lifeguard training (initial training, refresher training, and on first aid courses).**
- **For advanced resuscitation courses, it should be a requirement that these manikins are used. Whilst improving instructor-based supervision of individual candidates could address some of these issues, the only practical means by which these issues can be identified is by using a recording/reporting manikin.**
- **Every patrol should have at least one lifeguard trained in advanced resuscitation/CPR instruction to facilitate the training/re-training process and who, during an actual resuscitation is trained to observe the quality of chest-compressions (rate/depth), ensure rescue breaths/bag-mask ventilations are delivered at low pressures with appropriate volumes and give corrective feedback as required.**

- **The authors are aware that some AEDs can give real-time feedback during resuscitation on compression rates/depth and ventilations; some pre-hospital agencies in New Zealand already have this technology on their defibrillators (eg. St John Ambulance). Given the infrequent use of AEDs by lifeguards the cost/benefit of purchasing these types of AEDs has not been determined.**

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# 1. Introduction

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Survival from out-of-hospital cardiac arrest (OHCA), such as a consequence of drowning, is primarily dependent on the rapid initiation of bystander cardiopulmonary resuscitation (CPR) (Marchant, Cheng, Lam, Fahy, Sounndapound, Cass, & Browne, 2008; Venema, Groothoff, & Bierens, 2010) and the early arrival of medical assistance (Youn, Choi, Yim, & Park, 2009; Kyriacou, Arcinue, Peek, & Kraus, 1994). Bystander CPR, combined with rapid activation of emergency medical services, has been estimated to increase survival rates from sudden cardiac arrest 2–3-fold (Eisenburger & Safar, 1999). Some research indicates the nature and extent of CPR knowledge among youth (Lafferty, Larsen, & Galletly, (2003); Lester, Donnelly, Weston, & Morgan, (1996); Lester, Weston, Donnelly, Assar, & Morgan, 1994); Moran, 2006, 2009; Parnell, Pearson, Galletly, & Larsen, 2006; Reder & Quan, 2003), among police officers (Kooij, van Alem, Koster, & de Vos, 2004) and among the general population (Larsen, Pearson, & Galletly, 2004; Liu & Clark, 2009)

In the context of drowning incidents, victims are more likely to survive as a consequence of the immediate and effective application of CPR (Layon & Modell, 2009). The value of lifeguards in drowning prevention has been widely reported (for example, Branche & Stewart, 2001; Fenner, Harrison, Williamson, & Williamson, 1995; Maniolos & Mackie, 1988). A retrospective case survey of 171 resuscitation incidents on Australia surf beaches reported a success rate of 67% for immersion victims, a success rate attributable to close proximity and short response time of lifeguards to the victims (Fenner, Harrison, Williamson, & Williamson, 1995). An earlier Australian study reported that of 262 immersion victims requiring resuscitation at patrolled surf beaches during 1973-83, less than one quarter (22%) of initially pulseless and apnoeic patients survived (Maniolos & Mackie, 1988).

In spite of comprehensive reporting of surf lifeguard rescue and preventative activity (for example, Surf Life Saving New Zealand Annual Report, 2010; Surf Life Saving Australia Annual Report, 2010), not a lot is known about lifeguard experience of CPR use when on patrol or how often they are called upon to exercise their CPR skills and knowledge in an emergency. Faddy (2002) reported that most lifeguards (74%) surveyed at northern Sydney beaches had not undertaken CPR in an emergency and that the experience of those who had did not affect their expectation of successful resuscitation compared with those who had never used CPR in an emergency. Faddy also found that many (80%) lifeguards surveyed expected better than 36% chance of return of spontaneous circulation (ROSC) - an exaggerated expectation of successful CPR following cardiac arrest.

At the beginning of each season, lifeguards are trained/re-trained in rescue competency, CPR, and other first aid procedures as a pre-requisite to participation in patrol activity. While some studies have reported on the efficacy of pre- service/in-service training of medical personnel (for example, Garcia-Barbero & Caturla-Such, 1999; Fossel, Kiskaddon, & Sternbach, 1983), the effectiveness of different forms of CPR training (for example, De Vries & Bierens, 2010; Sarac & Ahmet, 2010; Lynch, Einspruch, Nichol, Becker, Aufderheide, & Idris, 2005; Reder, Cummings, & Quan, 2006; Todd, Braslow, Brennan, Lowery, Cox, Lipscombe, & Kellerman, 1998; Brennan & Maslow, 2000), and levels of retention after training (for example, Niles, Sutton, Donoghue, Kalsi, Roberts, Boyle et al., 2009; Weaver, Ramirez, Dorfma, & Raizner, 1979; Chamberlain, Smith, Woollard, Colquhoun, Handley, Leaves, et al., 2002), little is known about the efficacy of training/re-training of volunteer surf lifeguards. Furthermore, little is known about how lifeguard perception of the value of CPR training and skills, or of self-estimated competency and 'real' competency demonstrated through simulation on CPR manikins, the traditional training approach to developing practical competency for volunteer surf lifeguards. Some advocates suggest that new lifeguards and lifeguards returning from a long winter season off should have CPR skills reinforced several times a week in the early part of the season (Shaw, 1996).

Several studies have explored the physiological demands on lifeguards of performing CPR and the effect of fatigue (as a consequence of carrying out an in-water rescue) on that performance. Reilly, Wooler, and Tipton (2006) reported that British surf lifeguards possessed the necessary fitness to perform CPR after a strenuous rescue. Claesson, Karlsson, Thoren and Herlitz (2010) found similar capacities among 42 Swedish surf lifeguards whose performance of CPR was unaffected by a 100m rescue and tow/carry, and noted that the proportion of adequate compressions was identical at 8-10 minutes of CPR for both rested and fatigued lifeguards. Both studies note the limitation of testing CPR skills using manikins rather than real life situations.

It was anticipated that the study would provide a comprehensive analysis of volunteer lifeguard understanding of the theory and practice of CPR, especially as it pertains to current protocols and techniques. It was further anticipated that the results would indicate a strong relationship between real and perceived CPR ability for many volunteer surf lifeguards. It was also expected that the study would provide some indication of how important lifeguards view CPR training in comparison with the other requisite lifeguard skills (such as swimming ability and rescue skills) that are required as would-be rescuers. It was anticipated that CPR perceptions and competency would vary according to the recency of training, lifeguard age, years of lifeguard experience, and previous use of CPR.

## 2. Aims and objectives

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The aims of the study was to comprehensively analyse volunteer surf lifeguards' real and perceived competencies in CPR, an important aspect of a lifeguard's role and function in emergency response situations.

The objectives of the study were:

- To investigate the CPR skills in simulated practice among volunteer surf lifeguards
- To identify volunteer surf lifeguards' perceptions about their ability to perform CPR
- To determine volunteer surf lifeguards' experience of CPR use in an emergency
- To identify understanding of correct CPR protocols among volunteer surf lifeguards
- To identify perceptions informing lifeguards about the efficacy of CPR in emergency practice
- To identify currency and retention of CPR knowledge as a consequence of training/re-training
- To identify any strength and weaknesses of current volunteer training in CPR
- To make recommendations on how to address any weaknesses in the provision of CPR training



### **3. Method**

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#### **3.1 Study Design**

The research design was a mixed method, cross-sectional study using a questionnaire survey and assessment of practical CPR skills. Prior to the commencement of the study, ethics approval was obtained from the University of Auckland Human Ethics Committee (Project number 2010/400). Informed consent in writing was obtained from each participant after written and verbal explanations of the study were provided to club administrators, patrol captains, and volunteer surf lifeguards who had agreed to take part in the study.

#### **3.2 Participants**

The subjects of the study were volunteer surf lifeguards in the Auckland region, who volunteered to take part in the study during early season patrols on 10 weekends between November 2010 and January, 2011. The management of Surf Life Saving New Zealand (Northern region) and the 16 surf lifesaving club management boards in the greater Auckland region were asked to participate in the project (one small club in the Far North did not take part because of geographical isolation and limited funding). The patrol captains of each randomly selected weekend patrol were contacted in the week prior to the visit requesting their assistance in allowing patrol members to voluntarily participate in the study during patrol hours. Only lifeguards who had completed CPR re-training at the commencement of the season (October) were eligible to take part. Lifeguards with a health-professional background or who were employed as professional lifeguards in the Auckland region (requires additional CPR training) were excluded from the study.

#### **3.3 Research instruments**

The research instruments used to gather data on real and perceived understanding of CPR were a written self-complete anonymous survey (see Appendix 1) and a practical skills test on a resuscitation manikin (see Appendix 2). The self-complete questionnaire consisted of 14 questions, the first seven of which sought demographic information such as age, gender, length of lifeguard service, first aid and CPR training, and previous use of CPR in emergency response. Two questions used Likert-type responses to determine lifeguards' perceptions of their competency to perform CPR, how willing they would be to perform CPR in an emergency, and another two questions asked lifeguards to estimate (using percentages) how often they thought CPR was successful in out-of-hospital cardiac arrest

(OHCA) and how successful the public would think CPR was successful in OHCA. Two further questions asked lifeguards to provide the correct rate for cardiac compressions and a bank of True/False questions asked lifeguards about CPR protocols. The final question asked lifeguards to rank in order of priority a list of lifeguard-related skills including swimming skill, rescue boat skill, CPR skill, Tube rescue skill, and first aid skill.

The practical CPR skill test was conducted using two Resusci®Anne SkillReporter™ manikins (see Illustration 1). The SkillReporter™ manikin contains a built-in metronome providing a rate of 80 or 100 beats per minute, and provides feedback to the examiner to indicate correct/incorrect performance by means of colour LEDs. In addition, the SkillReporter™ provides a printed report of the performance (a complete report with ventilation and compression curves and a statistical report) (see Appendix 3). This latter short report of statistical information assisted the examiners in their observation of correct/incorrect application of CPR protocols including: **D**anger (checks safe to approach, dons gloves), **R**esponsiveness (checks using voice and touch), **S**end for help (calls 111/summons assistance), **A**irway (opens airway using head-tilt/chin-lift), **B**reathing (checks breathing  $\leq 10$  seconds), Upon being told “not breathing” goes for help (or indicates they would do so), **C**hest compressions (commences CPR), correct ratio (30:2), maintains airway between sets of compressions, and correct sequence (DRSABC).

Illustration 1. Resusci® Anne SkillReporter™ manikin

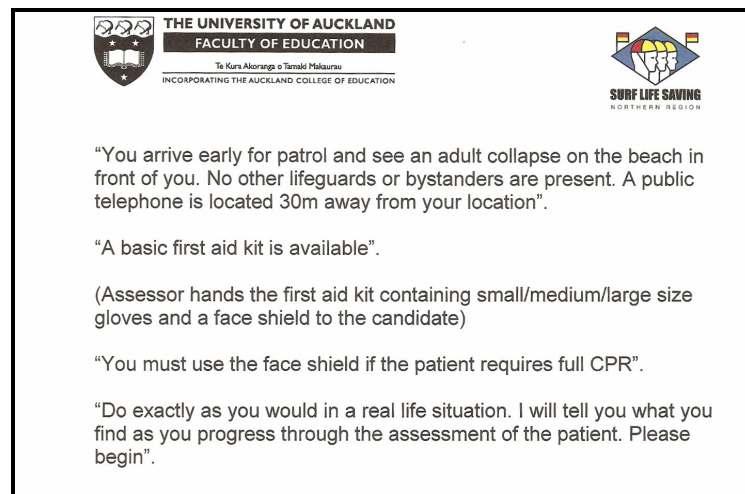


The New Zealand Resuscitation Council (NZRC) Level 2/3 adult collapse algorithm (see Appendix 5) was used to assess the correct sequence of actions (NZRC, 2006). Adequacy of compressions and ventilations, compression to ventilation ratio, and compression rate were assessed using the manikin over a 2-minute period of CPR, commencing from the delivery of the first chest compression. “Correct compressions” were defined by the manikin as 4-5cm in depth (+/- 15%) with no incomplete release, and “correct ventilations” as 400-600mL in volume (+/- 15%), with each ventilation delivered over a minimum of one second (NZRC, 2007). (Note most recent NZRC Guidelines based on the ILCOR recommendations suggest delivery of chest compressions over the lower half of the sternum at a depth of at least 5 cm). On the basis of the recommendation in Guideline 8 of the 2010 Guidelines (NZRC, 2011), it was estimated that, in 2 minutes of CPR at a 30:2 compression/ventilation ratio (with each breath given over one second), the lifeguard would perform 5 cycles of CPR, approximately 150 compressions and 10 ventilations.

### 3.4 Procedures

Standardised test procedures were developed and tested prior to the commencement of the data collection (see Appendix 3). Participating lifeguards were initially asked to complete the written survey (Appendix 1) that focussed on their knowledge of CPR protocols and their perceptions of their ability to perform CPR. Immediately after completing the questionnaire, participants undertook a simulated practice of CPR on a Laerdal Resusci®Anne SkillReporter™ manikin. Lifeguards were read a standard scenario briefing card, and informed that gloves (optional) and face shields (compulsory) were available for them to use (see Illustration 2).

Illustration 2. Scenario briefing card



While not able to represent all possible conditions for CPR application, it was assumed that the manikins provided an accurate opportunity to assess simulated CPR use on an adult (Berden, Bierens, Willems, Hendrick, Pijls, & Knape, 1994; Adelborg, Dalgas, Grove, Jørgensene, Al-Mashhadib, & Løfgren, 2011). All participants were tested individually in a designated room away from the surf patrol area. Pre-defined procedures (Appendix 4) were uniformly applied by a team of three examiners, all of whom had CPR instructor experience and advanced qualifications, and who were trained prior to data gathering at the University of Auckland Medical School by clinical tutors highly experienced in the use of Resusci®Anne SkillReporter™ manikins in CPR training.

### **3.5 Data analysis**

Data from the completed questionnaires were downloaded into SPSS Version17 for statistical analysis. Descriptive statistics were used to describe or characterize all numerical variables using frequency and percentages. Five independent variables - gender, age, length of service, time for last CPR training/retraining, and experience of use of CPR in an emergency were reported using frequencies and percentages (Table 1). Five dependent variables related to lifeguard beliefs and 11 aspects of CPR theory knowledge were tabulated using frequencies percentages and cumulative percentages (Tables 2 and 3). Continuous variables, including 10 observed performance of simulated CPR over 2 minutes (Table 4), 10 compression skills (Table 5), and 8 ventilation skills (Table 6), were reported via central tendency and dispersion (mean, standard deviation and range). Chi-square statistics were used to test associations between the socio-demographic influences of age, gender, length of lifeguard service against real and perceived CPR competencies.

Box plots (see figures 1-4, 6-7) were used to indicate gender effects on estimates of success of CPR by lifeguards and public expectation of success of CPR, compression depth and rates, and ventilation volumes and number.

## Key Findings

Of the 280 volunteer surf lifeguards invited to participate in the study, a sample of 262 lifeguards from 16 clubs in the greater Auckland region completed the survey and practical skills test, representing a response rate of 93%. Of these, 10 participants were excluded from the final analysis because of an equipment malfunction on one day of testing, leaving a total sample size of 252 lifeguards.

### 4.1 Lifeguard demographics, length of service, and CPR training

The sample population included more males than female participants (male 57%, female 43%), almost two thirds of lifeguards were aged less than 20 years (63%), and three quarters (77%) had less than 6 years of lifeguard experience.

**Table 1. Characteristic of sample population (N = 252)**

Variable		<i>n</i>	%
Gender	Male	144	57.1%
	Female	108	42.9%
Age	<19 years	158	62.7%
	20-29 years	48	19.0%
	30+ years	46	18.2%
Length of lifeguard service (N= 252)	1 year or less	76	30.2%
	2-5 years	117	46.4%
	6-10 years	27	10.7%
	>10 years	32	12.7%
Last lifeguard CPR training (N =250)	<3 months	162	64.8%
	4-6 months	31	12.4%
	7-12 months	37	14.8%
	> 1 year	20	8.0%
Use of CPR in emergency response	Yes	23	9.2%
	No, but my patrol has	25	10.0%
	No	203	80.9%

Almost two-thirds (65%) of participants had received lifeguard CPR training in the 3 months before taking part in the study, a further 27% had received training in the previous 4-12 months. When asked how effective their CPR training was, most lifeguards (83%) thought it was highly effective/effective, with a small percentage (4%) suggesting it was fair/poor. Almost two thirds (62%) of the lifeguards had also received additional first aid training and of these 156 lifeguards, almost two-thirds (65%) reported receiving intermediate (37%) or advanced (28%) levels of training. Few lifeguards ( $n = 23$ ; 9%) reported having used CPR in an emergency situation or having observed its use when on patrol ( $n = 26$ ; 10%). Of the 26 patrol incidents when CPR had been used, lifeguards reported that most had successful outcomes ( $n = 16$ ; 61%).

No significant differences were observed when the recency of training was analysed by gender. When analysed by age, younger lifeguards (<30 years of age) were significantly more likely ( $\chi^2 = 6.854$ ,  $df = 18$ ,  $p = <0.001$ ) than older lifeguards (>30 years of age) to have had training within the previous 6 months (<30 years of age, 80%; >30 years of age, 62%). Significant differences were noted when previous emergency use of CPR when on surf patrol was analysed by gender ( $\chi^2 = 49.373$ ,  $df = 2$ ,  $p = 0.032$ ) and age ( $\chi^2 = 56.878$   $df = 6$ ,  $p = <0.001$ ). More males than females reported having used CPR when on patrol (males 13%; females 4%), and more older than younger lifeguards reported having used CPR in an emergency (<30 years of age, 5%; >30 years of age, 26%).

## 4.2 Lifeguard perceptions of CPR - their personal competency and confidence, and beliefs about its effectiveness

Lifeguards were asked to indicate their confidence in their ability to perform CPR in a real situation, their willingness to perform CPR if required, and their expectations of the likely success of CPR intervention in terms of return of spontaneous circulation (ROSC).

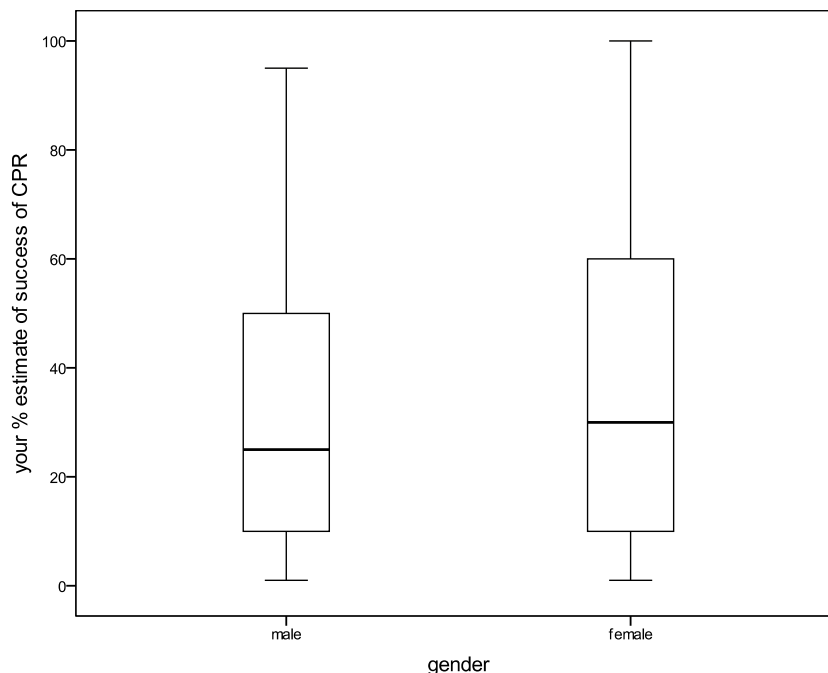
**Table 2. Lifeguard beliefs of CPR**

Lifeguard beliefs		<i>n</i> (%)	Cumulative %
Self-rated ability	Highly effective	11 (4.4%)	4.4%
	Effective	118 (46.8%)	51.2%
	Satisfactory	101 (40.1%)	91.3%
	Fair	15 (6.0%)	97.2%
	Poor	2 (0.8%)	98.0%
	Don't know	5 (3.3%)	100.0%
Willingness to perform CPR	Definite	99 (39.3%)	39.3%
	Fairly certain	109 (43.3%)	82.5%
	Hesitant	44 (17.5%)	100.0%
Lifeguard belief of success rate of CPR use in Out-of-Hospital-Cardiac- Arrest (OHCA)	0-25% success rate	120 (48.4%)	48.4%
	26-50% success rate	75 (30.2%)	78.6%
	51-75% success rate	23 (9.3%)	87.9%
	76-100% success rate	30 (12.1%)	100.0%
Lifeguard estimate of public belief of success rate of CPR use in OHCA	0-25% success rate	15 (6.1%)	6.1%
	26-50% success rate	64 (25.9%)	32.0%
	51-75% success rate	33 (13.4%)	45.4%
	76-100% success rate	135 (54.7%)	100.0%
Ranking important lifeguard skills	Swimming skill	103 (41.0%)	-
	CPR skill	59 (23.4%)	-
	First aid skill	56 (22.2%)	-
	Rescue tube skill	19 (7.4%)	-
	Rescue craft skill	15 (6.0%)	-

Table 2 shows that one half (51%) of respondents considered their CPR skills were highly effective/effective and a further 40% thought their skill level was satisfactory. A small percent (<10%) considered their CPR skill level unsatisfactory. No significant differences in self-estimates of CPR competency were reported by gender and age, although slightly more males than females (males, 54%, females 48%), and older lifeguards (<30 years of age, 50%; >30 years of age, 56%) estimated that their skill level was highly effective/effective.

Almost all lifeguards (83%) were willing to perform CPR although 17% reported that they were hesitant about performing CPR. Most lifeguards had a realistic view of the success of CPR in out-of-hospital cardiac arrest (OHCA) with one almost one half (48%) believing that the chances of success were 25% or less. Significant differences were found in lifeguard willingness to perform CPR in an emergency when analysed by both gender ( $\chi^2 = 13.340$ ,  $df = 2$ ,  $p = 0.001$ ) and age ( $\chi^2 = 54.983$ ,  $df = 6$ ,  $p = <0.001$ ). More females than males (females 18%, males, 11%) and more younger lifeguards (<30 years of age, 20%; >30 years of age, 7%) felt hesitant about having to perform CPR in an emergency.

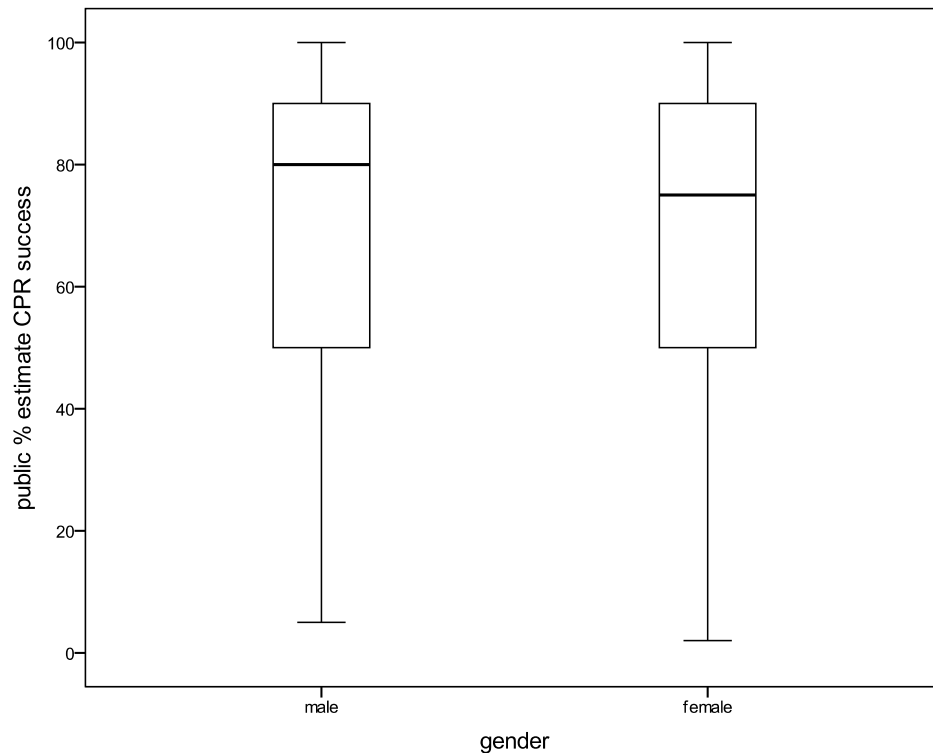
**Figure 1. Lifeguard estimation of lifeguard CPR success by gender**



When asked what they thought the public expectation of success of CPR in OHCA was, most lifeguards thought that the public would be overly optimistic about the rate of ROSC in OHCA ( $M = 71\%$  success rate,  $S.D. = 25.177$ ). No significant differences were found when estimates of successful CPR when performed by lifeguards in an emergency were analysed by gender, but significantly more younger lifeguards ( $\chi^2 = 110.142$ ,  $df = 84$ ,  $p$

= 0.029) than older lifeguards were confident of a success rate greater than 35% or less (<30 years of age, 46%; >30 years of age, 41%).

**Figure 2. Lifeguard estimation of public expectation of CPR success by gender**



Lifeguards were also asked to rank 5 lifeguard-related skills to determine how much they valued each of the skills in relation to CPR. Swimming competency was the considered the most important skill by 41% of respondents, followed in descending order of ranking by CPR skills (23%), first aid skills (22%), tube rescue skills (7%), and rescue craft skills (6%) (see Table 2). No significant differences were found when the skills rankings were analysed by gender or by age group.

### 4.3. Theoretical knowledge of CPR

Lifeguards theoretical knowledge of CPR protocols was ascertained via a multiple choice question on cardiac compression rates per minute and true/false responses to 10 statements about CPR procedures. Table 3 shows that most lifeguards (86%) could accurately recall the correct compression rate of 100 per minute.

**Table 3. Lifeguard knowledge of CPR protocols**

Correct response to the following statements -	<i>n</i>	%
What is the correct compression rate per min?	214	85.6%
Each rescue breath should be given over 1 second	161	66.0%
If alone with an adult patient, go for help before starting CPR	178	71.2%
Stop CPR if the patient has not recovered after 15-20 minutes of resuscitation	235	93.3%
The automated external defibrillator (AED) will advise a shock for all victims of cardiac arrest	120	49.4%
Take no longer than 10 seconds to check for breathing	195	77.4%
Reassess the victim after every 4 cycles of CPR to see if they have recovered	84	34.3%
Give all victims of drowning 5 initial rescue breaths before starting chest compressions	110	44.0%
The first step at the scene of a medical emergency is to check victim responsiveness	172	68.8%
If the airway is blocked by foreign objects or vomit, start CPR first before clearing	245	97.6%
The recommended compression depth for adults is 4-5cm	224	89.2%

Most lifeguards correctly responded to statements about clearing the airway (98%); when to stop CPR (93%); correct compression depth (89%); duration of breathing check (79%); when to go for help (71%); the correct initial response at the scene of a medical emergency (69%), and the duration of rescue breaths (66%). Less than half correctly responded to statements related to AED advising shock for all cardiac arrest victims (49%), initial rescue breaths prior to commencement of cardiac compression in drowning (44%), and reassessing victim during CPR (34%).

No significant differences in CPR theory knowledge were found when responses to the statements on CPR protocols were analysed by gender and age group.

#### 4.4. Practical simulated skills testing

The simulated practical test of CPR skills was based on the New Zealand Resuscitation Council (NZRC) protocols (see Appendix 5) and adopted by SLSNZ (see Appendix 6) in their training of lifeguards to deal with a cardiac arrest on a beach (not as a consequence of drowning).

##### 4.4.1 Observed CPR Skills

Table 4 shows the 10 skills that were observed by the examiners to have been undertaken by participants upon reading the scenario card (see Illustration 2). Most lifeguards (72%) did an immediate check for danger to themselves, their patient, and others, but many who failed this aspect of the emergency response did so because they failed to don the protective gloves. Almost all lifeguards made the appropriate check for responsiveness using voice and touch (98%), established the airway using the head tilt/chin lift technique (92%), checked breathing in less than 10 seconds (94%), commenced chest compressions (98%), established a correct compression-to-ventilation ratio of 30:2 (90%), and maintained the airway between sets of compressions (86%).

**Table 4. Observed CPR skills of lifeguards**

Observed skill	Pass /Fail	
	<i>n</i>	%
Danger (checks safe to approach, dons gloves)	180	72.0
Responsiveness (checks using voice and touch)	244	97.6
Send for help (calls 111/summons assistance)	178	71.2
Airway (opens airway using head-tilt/chin-lift)	231	92.4
Breathing (checks breathing $\leq$ 10 seconds)	236	94.4
Upon being told “not breathing” goes for help (or indicates they would do so)	70	28.0
Chest compressions (commences CPR)	245	98.0
Correct ratio (30:2)	225	90.0
Maintains airway between sets of compressions	214	85.6
Correct sequence (DRSABC)	120	48.0

No significant differences were reported when observed skills were analysed by gender although slightly more females than males (females 78%; males 68%) were observed checking for immediate danger ( $\chi^2 = 2.879$ ,  $df = 1$ ,  $p = 0.090$ ). Significant differences were reported when observed skills were analysed by age group with regard to the preliminary checking phase of bystander response. Younger lifeguards (<30 years old) were significantly more likely ( $\chi^2 = 19.543$ ,  $df = 3$ ,  $p = <0.001$ ) than older lifeguards (>30 years old) to check for danger at the outset of an emergency response (<30 years old, 78%; >30 years old, 46%). Younger guards were also more likely to correctly check for an initial response ( $\chi^2 = 13.021$ ,  $df = 3$ ,  $p = 0.005$ ), although most lifeguards, irrespective of age were observed making the appropriate checks for responsiveness (<30 years old, 99%; >30 years old, 94%). Younger lifeguards were also significantly more accurate in their initial call for help ( $\chi^2 = 10.458$ ,  $df = 3$ ,  $p = 0.015$ ), with three quarters of younger guards (75%) compared with over half (54%) of older guards having been observed initiating the appropriate call for help. No significant differences were observed by age with regards to the ensuing application of compression and ventilation skills.

Table 4 also shows that more than one quarter (29%) did not send for help after determining that the patient was unresponsive, and a similar proportion (28%) indicated that they would go for help after determining that the patient was not breathing (Note: the scenario card suggested that they had arrived for patrol but no others lifeguards or bystanders were present when the adult collapsed on the beach in front of them). As a consequence of these lapses, slightly less than half of the participants (48%) had performed the emergency response in the correct sequence.

#### **4.4.2 Compression Skills**

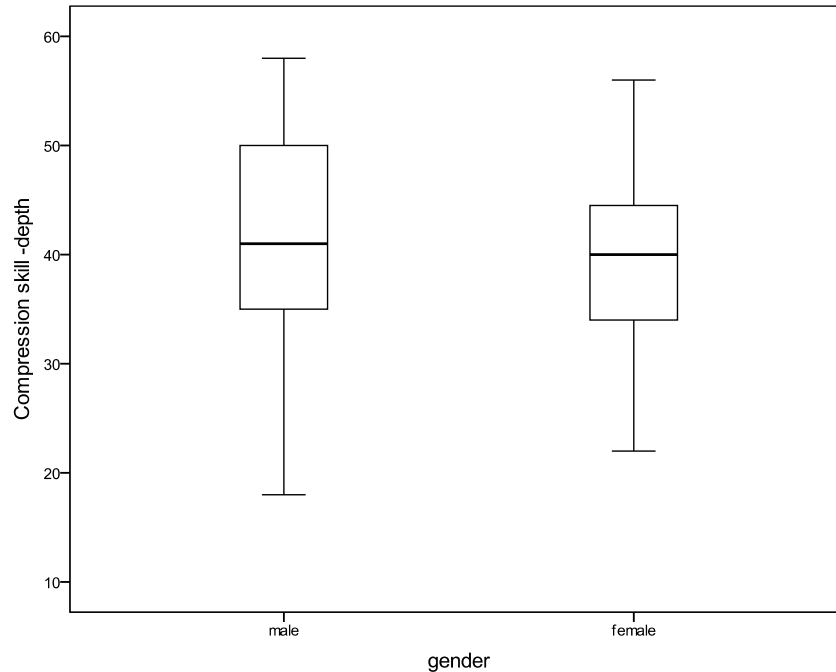
Table 5 shows the compression skills that were electronically recorded via the Resusci®Anne SkillReporter™ manikins (see Illustration 1). The data shows that lifeguards compression rates ( $127 \pm 17.7 \text{ min}^{-1}$ ) tended to exceed the recommended compression rate of 100 per minute, although the total number of compressions ( $142 \pm 13.6 \text{ min}^{-1}$ ) was slightly less than the recommended total of 150 compressions in the 5 cycles that should occur in 2 minutes according to the 2010 Guidelines (NZRC, 2011). Table 5 also shows that participants were accurate in their execution of chest compressions in terms of depth of compression ( $M = 40.63\text{mm} \pm 8.684$ , range 14-58mm) over the 2 minute test period, the recommended depth being from 40-50mm (NZRC, 2006). The most recent Guidelines (NZRC, 2011) recommend that the delivery of chest compressions over the lower half of the sternum should be at a depth of at least 5 cm, so it is possible that lifeguards will need to be instructed to increase the depth of compression in future training.

**Table 5. Compression skills of lifeguards**

<b>Compression skills</b>	<i>Mean</i>	<i>S.D.</i>	<i>Range</i>
Mean compression rate over 2 minutes (100 per minute)	127	17.699	52-172
Average compression depth over 2 minutes (4-5 cm)	40.63mm	8.684	14-58mm
Number of compressions in 1 minute (60-75)	71.7	13.599	24-128
Total number of compressions in 2 minutes (recommended total in 2 minutes = 150)	141.9	32.508	28-242
<b>Technical errors</b>			
Number of compressions over 2 minutes too deep (in excess of 5cm)	25.4	44.223	0-173
Number of compressions over 2 minutes too shallow (less than 4cm)	49.6	55.639	0-212
Number of too low hand positions over 2 minutes	12.5	32.413	0-145
Number of wrong hand positions over 2 minutes	35.46	47.627	0-195
Number of incomplete releases over 2 minutes	5.4	18.913	0-118

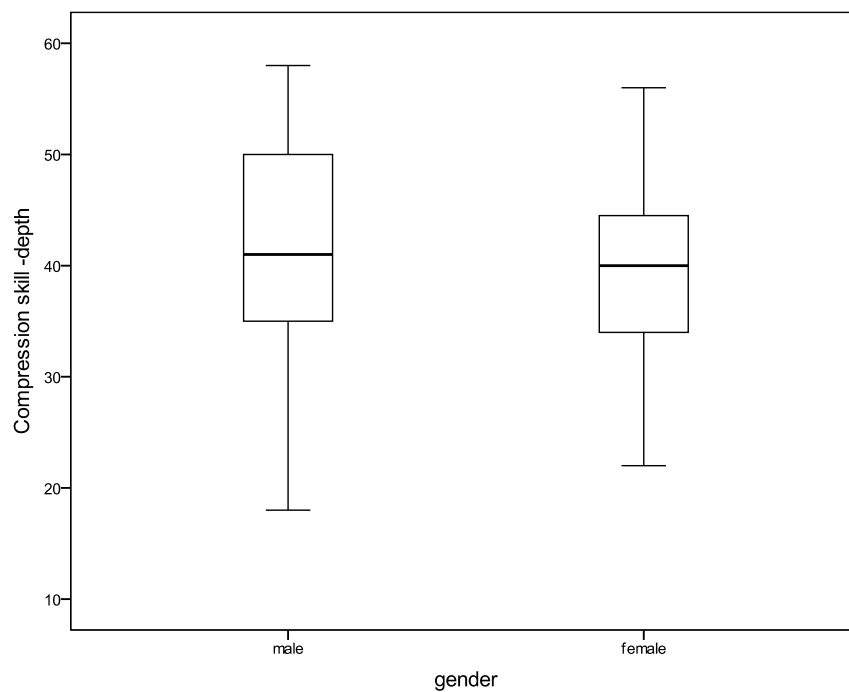
In terms of technical errors when using the manikin, some lifeguards performed incomplete releases (3.8%), placed their hands too low (8.8%), or compressed the chest too deeply (17.9%). One quarter (25.2%) of lifeguards at some stage compressed the chest with the wrong hand position, and one third (34.9%) were too shallow with some compressions during the 2 minutes test duration.

**Figure 3. Comparison of average compression depth by gender**



No significant differences were found when compression skills were analysed by age group, length of lifeguard experience, and gender, although Figures 3 and 4 show male lifeguards in the study tended to compress to a greater depth and slightly faster than female lifeguards.

**Figure 4. Comparison of average compression rates by gender**



#### 4.4.3 Ventilation Skills

Table 6 shows the ventilation skills that were electronically recorded via the Resusci®Anne SkillReporter™ manikins (see Illustration 1). The data shows that lifeguards provide slightly less number of ventilations ( $M = 8.91 \pm 2.401$ , range 2-19) than the recommended 10 in 2 minutes of manikin practice (NZRC, 2011) and at a slightly lower rate per minute ( $M = 3.98 \pm 0.960$ , range 1-6). In terms of technical errors recorded by the SkillReporter™ during 2 minutes of lifeguard resuscitation on the manikin, one quarter (27%) of the ventilations were too little, and almost two thirds (62.6%) were delivered too rapidly.

Table 6 also shows that lifeguards tended to over-ventilate the lungs on each rescue breath ( $M = 935.55 \text{ ml} \pm 292.907$ , range 400-1790 ml), resulting in an elevated minute volume ( $M = 3709.76 \text{ ml} \pm 1481.886$ , range 500-8950 ml). Similarly, excessive ventilation volumes were also reported for both rested (1174ml  $\pm$  324ml) and exercised surf lifeguards (1203ml  $\pm$  377ml) after 8 minutes of CPR by Claesson and colleagues (2011).

**Table 6. Ventilation skills of lifeguards**

<b>Ventilation skills</b>	<i>Mean</i>	<i>S.D.</i>	<i>Range</i>
Average number of ventilations p.m.	3.98	0.960	2-9
Average volume of ventilations (500-600ml)	935.55	292.907	400-1790
Minute volume ventilations in 2 minutes (2500-3000ml in 5 cycles of CPR)	3709.76	1481.886	500-8950
Total number of ventilation (10 ventilations recommended in 2 min)	8.83	2.577	2-19
% correct ventilations	8.81	14.182	0-100
<b>Technical errors</b>			
Number of too fast ventilations in 2 minutes	5.58	3.719	0-16
Number of too little ventilations in 2 minutes	2.41	2.858	0-19
Number of too much ventilations in 2 minutes	3.65	3.729	0-16

This is potentially problematic since hyperventilation is harmful because it increases intra-thoracic pressure, which decreases venous return to the heart and reduces cardiac

output (European Resuscitation Council (ERC), 2005). Wenzel, Idris, Banner, Kubilis and Williams (1998) suggest that, when the airway is unprotected (as in an unconscious person), a tidal volume of 1000 ml produces significantly more gastric distension than a tidal volume of 500 ml. Low minute-ventilation (lower than normal tidal volume and respiratory rate) can maintain effective oxygenation and ventilation during CPR. During adult CPR, tidal volumes of approximately 500–600 ml (6–7 ml kg<sup>-1</sup>) are recommended (ERC, 2005). The current recommendations are for rescuers to give each rescue breath over about 1 second, with enough volume to make the victim’s chest rise, but to avoid rapid or forceful breaths (NZRC, 2011). Figure 5 illustrates the extent of the over-ventilation when lifeguards used expired air resuscitation during the manikin test.

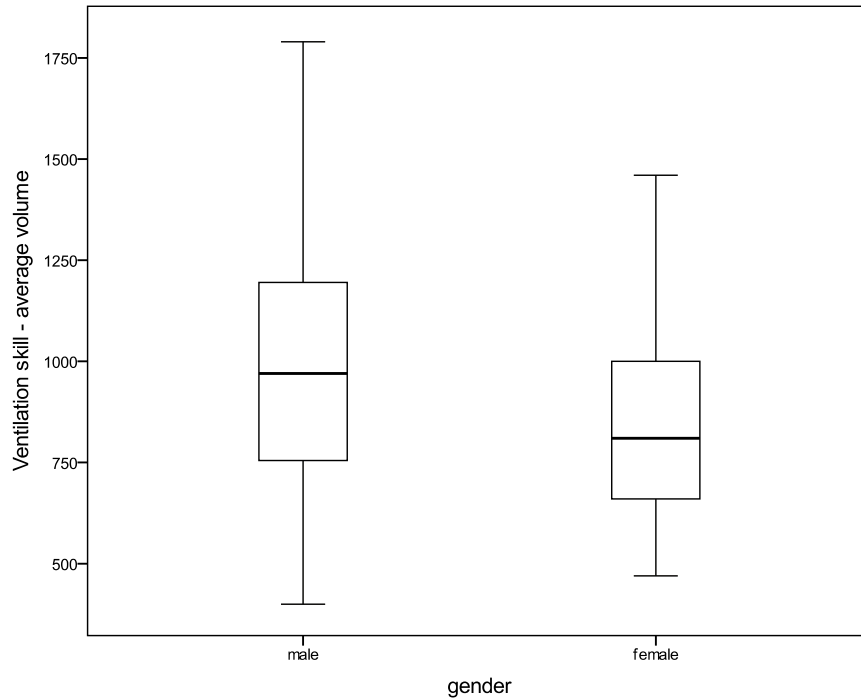
No significant differences were found when ventilation skills were analysed by age group, length of lifeguard experience, and gender with the exception that male lifeguards were significantly more likely than female lifeguards to record over-inflation of the lungs during testing on the manikin ( $\chi^2 = 28.965$ ,  $df = 14$ ,  $p = 0.011$ ).

**Figure 5. Over-ventilation of manikin in lifeguard rescue breathing**  
(n = 245)

n = 7 (2.9%)	n = 21 (8.6%)	n = 141 (57.6%)	n = 76 (31.0%)
<b>&lt; 500ml</b>	<b>500-600ml</b>	<b>600-1000ml</b>	<b>&gt; 1000ml</b>
<b>Too little</b>	<b>Normal range</b>	<b>Too much</b>	<b>May worsen gastric distension</b>

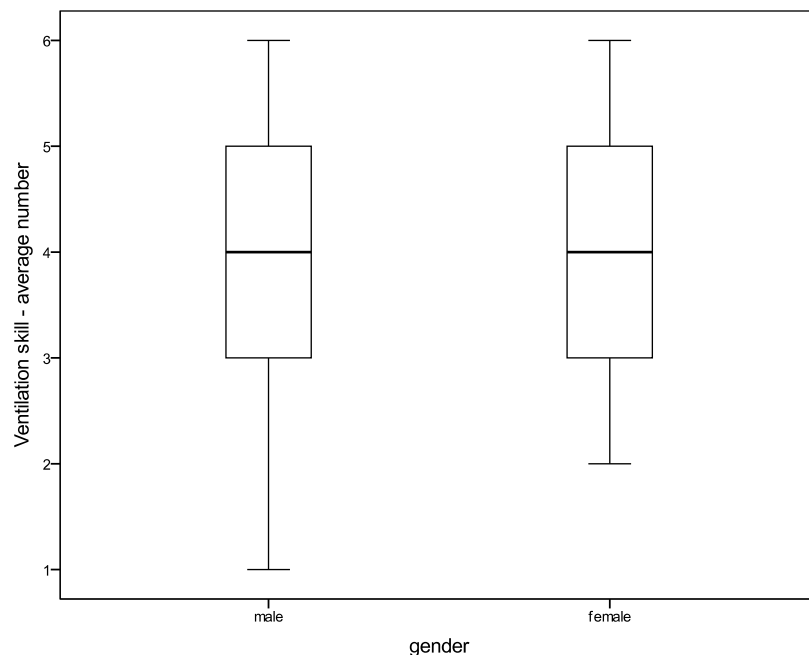
The reasons for these errors in ventilation technique are unknown. One possible explanation is that the volunteer surf lifeguards in this study were predominantly young, and presumably fit (since they are required to perform swimming-related performance tests during their training/retraining). They may have thus had healthy lung capacities and strong forced respiratory muscles that may have caused over-inflation of the manikin lungs but further research is required to corroborate or refute this speculation. Another possible explanation is that lifeguards may simply not have been exposed to the accurate recording of ventilation volumes during simulated practice since many may have learned CPR on the more basic manikins either in their initial training or annual re-training. Claesson and colleague (2011) speculate that, in the case of drowning, increased ventilation volumes in the first initial minute may perhaps be of use in clearing the airways and lungs of water.

**Figure 6. Comparison of average ventilation volumes by gender**



Further work is required to determine if this is the case, but, given the extent of over-ventilation reported here, it is recommended that clubs and instructors emphasise caution when practising expired air breathing, especially among male lifeguards. It is also recommended that manikins that can accurately record over-ventilation (such as the SkillReporters™ used in this study) be a part of normal training/retraining practice.

**Figure 7. Comparison of average number of ventilations by gender**



#### **4.5 Limitations of the study**

While the written survey responses and technical evidence of CPR capabilities of volunteer surf lifeguards participating in this study offer sound evidence to guide future training and use of CPR in drowning prevention, several limitations should be borne in mind:

1. The study was limited to study of CPR using manikins rather than real-life situations,
2. The study was confined to volunteer surf lifeguards patrolling the greater Auckland region,
3. The study was confined to volunteer surf lifeguards on patrol at the beginning of the summer season, so the influence of recent training and higher skill retention may favourably bias the results,
4. The study included only qualified volunteer surf lifeguards so generalization of the results to others such as the professional guards or the general public is not warranted,
5. All subjects were rested so the effect of fatigue associated with rescue prior to the accurate performance of CPR is not known,
6. Participants only completed a primary survey (DRSABC) and 2 minutes of CPR in the practical test so the influence of fatigue of performing CPR was not tested. Recent consensus recommendations from the United States Lifeguards Standards Coalition (2011) suggest that lifeguard should be routinely assessed for a period of 9 minutes of CPR use, the average US emergency medical services response time,
7. The practical skill test confined all respondents to a non-drowning related, adult cardiac arrest scenario requiring single person response whereas most rescue and drowning emergencies are conducted by teams of lifeguards, and
8. Written responses on CPR training, its use in an emergency, and estimates of competency were self-estimates and are thus may not provides a valid measure of actual competency and/or actual experience.

## Conclusions

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On the basis of the results of the written questionnaire and the practical test of CPR skills on a simulated exercise using a CPR manikin, the following conclusions are drawn:

### **1) Theoretical knowledge and perception of competency**

The relative recency of CPR training among lifeguards that took part in the study (77% had received training less than 6 months prior to completing the survey) and their high level of theoretical knowledge (Tables 3 and 4) was generally very encouraging. Almost all lifeguards (83%) were willing to perform CPR although 17% reported that they were hesitant about performing CPR. Lifeguards have a duty of care to respond in an effective and timely manner when called upon to perform CPR. Resuscitation is a core not optional skill of any lifeguard. That almost one fifth of those surveyed were hesitant about performing CPR is a concern and warrants further investigation. More research is required to determine if this hesitance relates to inadequate training (a concern that they won't know what to do) or a perception/belief that can be altered through education. Many of the mantras used by resuscitation councils in teaching health professionals e.g. "Push hard and fast" and "Any attempt at resuscitation is better than none" may not currently be incorporated into lifeguard training when these messages are just as important for first responders as they are for health professionals. Resuscitation training should focus on empowering lifeguards to act, rather than worry about making a mistake.

Almost one half (48%) believed that the chances of obtaining ROSC through CPR were 25% or less. Whilst this perception mirrors reality, it is important senior lifeguards and patrol captains who may be in charge of a resuscitation scene remember that the only person who can certify a patient as deceased is a doctor or paramedic. Therefore if the patient is found within 60 minutes of being reported missing resuscitation should commence (USLA, 2003) and continue until the patient recovers or professional help arrives no matter how poor the prognosis may seem; the rationale for this is that the exact time of submersion is not known. Furthermore, lifeguards should be encouraged to go in to a resuscitation attempt with a positive attitude as evidenced by the occurrence of four drowning incidents this season in the Auckland region where CPR was applied by lifeguards and a positive outcome was achieved in two cases.

Just over one quarter of lifeguards (29%) surveyed did not know that if alone, they needed to go for help. The basis for doing this is to ensure a defibrillator is en route to the scene and ambulance personnel are summoned. Whilst on-duty it would be unlikely for a

lifeguard to be alone with a collapsed patient, however resuscitation skills may be called upon off-duty, at home or at work etc. Therefore it is important lifeguards know they cannot manage a cardiac arrest situation on their own and should know when it is appropriate to leave the patient to call for help.

Nearly one third (31%) of lifeguards surveyed did not check if it was safe to approach the scene or don personal protective equipment (PPE) when it was made available to them. Clearly the rationale for ensuring that a lifeguard does not injure themselves whilst attending to a casualty or risk contracting an infectious disease is self-explanatory, but requires reinforcement during training/retraining.

One third of lifeguards (34%) surveyed did not know that the minimum time they should take to deliver each rescue breath was 1 second. The rationale for taking at least one second is to minimise excessive inflation pressures and reduce the risk of gastric insufflation (air in the stomach). As will be discussed in the recommendations from the manikin data, this may explain why so many ventilation volumes were excessive and deemed by the manikin to probably have entered the stomach. The use of manikins that can give real-time feedback in training may help that lifeguards know when they are delivering a breath too fast or too forcefully.

Nearly half (49%) of those surveyed thought the AED (defibrillator) would advise a shock for all patient's in cardiac arrest. This perception suggests that some lifeguards have limited knowledge of the aetiology of cardiac arrest, which can be due to primary (cardiac) or secondary (non-cardiac) causes. Patients who benefit most from defibrillation are those who have a cardiac arrest due to *cardiac* problems e.g. heart attack as opposed to those whose heart has stopped due to drowning, trauma etc.

Of those surveyed, less than half (44%) knew that the current SLSNZ recommendation (as per the Surf Lifeguard Award Training Manual) for victims of drowning was to commence CPR with 5 initial breaths. As there is no clinical evidence to show that initial breaths vs. chest compressions first does anything to improve patient outcomes it is suggested that SLSNZ adopt one common approach (i.e. breaths first or compressions first) for all patients in cardiac arrest. It authors' view that asking volunteer first responders to adopt a different DRSABC approach for victims of drowning vs. non-drowning will only confuse lifeguards and may delay starting CPR and should not therefore be taught.

## **2) Practical skills**

### **a) Compression Skills**

The mean compression rate as measured by the manikin exceeded the 2005 NZRC Guideline recommendation of 100/min. At the time the study commenced, new resuscitation guidelines had just been published (ARC/NZRC 2010). The new guidelines also recommend 100 compressions per minute but in order to provide some guidance on the upper rate state that compressions should not exceed 120/min. This is based on expert opinion that there is no benefit from higher compression rates and from a basic understanding of the physiology of the heart, where excessively fast/slow rates reduce cardiac output. Overseas resuscitation councils have recommended “at least 100 compressions per minute” (ERC/AHA 2010) and also state that compressions should not exceed 120/min.

The manikins currently used by Clubs and first aid training providers do not measure the compression rate, therefore lifeguards being instructed/refreshed in CPR and instructors cannot objectively measure and obtain feedback on their compression rate. Similarly other ‘errors’ that the manikin detected in the study (such as incomplete release, compressing too shallow/too deep, and incorrect hand placement) currently rely on an instructor observing and correcting each individual lifeguard, rather than using a manikin to detect errors during training. Instructor-led feedback is subjective and may not even be provided in a classroom environment where the instructor is trying to observe multiple students.

The new guidelines continue to emphasise that effective chest compressions are the foundation of any resuscitation attempt and that the likelihood of a successful outcome and worth of advanced life support interventions is severely diminished if CPR is ineffective. With a quarter of chest compressions delivered in the wrong location, and a third too shallow findings from this study implies that lifeguards could further improve their technical performance of CPR, thereby enhancing the possibility of a positive patient outcome from a drowning incident.

### **b) Ventilation Skills**

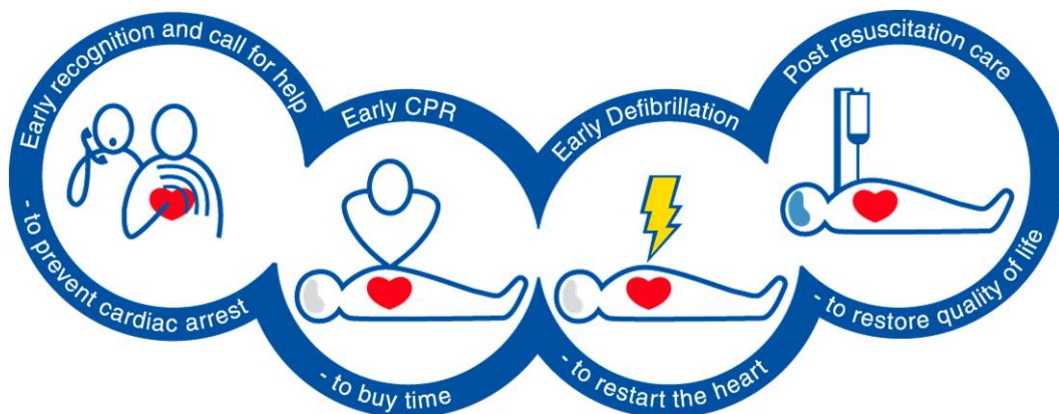
The finding of greatest concern from the manikin data was the excessive volumes of air delivered by lifeguards; one third to the point where they may have caused gastric distension and the high inspiratory pressures detected by the manikin as a result of two thirds of ventilations being delivered in less than one second, which could also exacerbate this problem. Only 8.6% of ventilations were delivered within the recommended range of 500-600mL. As victims of drowning often present with significant gastric detention, excessive tidal volumes/inspiratory pressures could contribute to gastric distension promoting

regurgitation and making delivery of rescue breaths/bag-mask ventilations more difficult. To address this, remedial training of existing lifeguards using manikins equipped to measure tidal volumes and inspiratory times appears warranted. As most clubs do not have these manikins, in the interim, two key messages are suggested to incorporate into training to slow down the delivery-time of each breath and to limit the volume:

- Each rescue breath should be delivered over a full second. Practice exhaling for the correct time by counting “one-one-thousand” as each breath is delivered.
- When delivering a rescue breath, as soon as you see the chest start to move, do not deliver any more air.

### Illustration 3. Chain of Survival

Source: European Resuscitation Council



## Recommendations

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To address issues of lifeguard knowledge and perceptions reported in the survey, the authors recommend:

- Additional training on when to leave a patient and go for help.
- More training to address failures in observing safety precautions at the scene of an emergency. The routine requirement of donning gloves during training/retraining sessions may make this required action more automatic in an emergency.
- In training lifeguards in the use of AED, that the following key messages are emphasised:
  - Commence high-quality CPR as soon as the patient is recovered from the water. High-quality CPR improves survival and the likelihood that defibrillation will be successful
  - Attach the AED as soon as possible without stopping chest compressions as the pads are being applied
  - When the AED is attached it may or may not advise a shock. Not all patients in cardiac arrest require defibrillation so if no shock is advised, resume CPR immediately and continue until help arrives or the patient recovers.

To address issues of technical competency of lifeguards in this study, the authors recommend:

- Non-feedback manikins be replaced/upgraded (as funding allows) to manikins with a feedback/prompt mechanism eg. Laerdal SkillReporter™/ SkillGuide™. Furthermore, manikins equipped with a feedback mechanism should be used in all facets of lifeguard training (initial training, refresher training, and on first aid courses).
- For advanced resuscitation courses, it should be a requirement that these manikins are used. Whilst improving instructor-based supervision of individual candidates could address some of these issues, the only practical means by which these issues can be identified is by using a recording/reporting manikin.
- Every patrol should have at least one lifeguard trained in advanced resuscitation/CPR instruction to facilitate the training/re-training process and who, during an actual resuscitation is trained to observe the quality of chest-compressions (rate/depth),

ensure rescue breaths/bag-mask ventilations are delivered at low pressures with appropriate volumes and give corrective feedback as required.

- The authors are aware that some AEDs can give real-time feedback during resuscitation on compression rates/depth and ventilations; some pre-hospital agencies in New Zealand already have this technology on their defibrillators (eg. St John Ambulance). Given the infrequent use of AEDs by lifeguards the cost/benefit of purchasing these types of AEDs over standard AEDs has not been determined.

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## APPENDICES

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1. **Are you?**  
 Male  Female
2. **How old are you?**  
 14-19 years  
 20-29 years  
 30-44 years  
 45+ years
3. **How long have you been a lifeguard?**  
 1 year (or less)  
 2-5 years  
 6-10 years  
 11-19 years  
 More than 20 years
4. **When did you last undertake lifeguard CPR training/re-training?**  
 Less than 1 month  
 1-3 months  
 4-6 months  
 7-12 months  
 1-2 years  
 3-5 years  
 More than 5 years ago
5. **Do you think that your training was:**  
 Highly effective  
 Effective  
 Satisfactory  
 Fair  
 Poor  
 Don't know
6. **Have you ever had to use CPR on duty?**  
 Yes  No  No, but my patrol has  
 If yes, how many times \_\_\_ (you) \_\_\_ (your patrol)  
 How many times was it successful? \_\_\_ \_\_\_
7. **Have you other current First Aid qualifications?**  
 Yes  No  
 If yes, at what level? (eg St Johns, SLSNZ 1,2,3)  
 \_\_\_\_\_
8. **How would you rate your ability to do CPR?**  
 Highly effective  
 Effective  
 Satisfactory  
 Fair  
 Poor  
 Don't know
9. **How willing are you to attempt CPR?**  
 Definite  Fairly certain  Hesitant  Would not do
10. **How often do you think CPR is successful in out of hospital cardiac arrest? (OHCA)? (use%)**  
 \_\_\_\_\_%
11. **How often do you think *the public* would expect CPR to be successful in OHCA? (use%)**  
 \_\_\_\_\_%
12. **What is the correct rate for cardiac compressions?**  
 60 compressions per minute  
 80 compressions per minute  
 100 compressions per minute  
 120 compressions per minute  
 Don't know
13. **Are the following statements true (T) or False(F):**  
 T  F  Each rescue breath should be given over 1 second  
 T  F  If alone with an adult patient, go for help before starting CPR  
 T  F  Stop CPR if the patient has not recovered after 15-20 minutes of resuscitation  
 T  F  The automated external defibrillator (AED) will advise a shock for all victims of cardiac arrest  
 T  F  Take no longer than 10 seconds to check for breathing  
 T  F  Reassess the victim after every 4 cycles of CPR to see if they have recovered  
 T  F  Give all victims of drowning 5 initial rescue breaths before starting chest compressions  
 T  F  The first step at the scene of a medical emergency is to check victim responsiveness  
 T  F  If the airway is blocked by foreign objects or vomit, start CPR first before clearing  
 T  F  The recommended compression depth for adults is 4-5cm
14. **Finally, rank the following skills from 1-5, with 1 being the most important, 5 the least important:**  
 **Swimming skills**  
 **IRB driving or crewing skills**  
 **CPR skills**  
 **Tube rescue skills**  
 **First aid skills**

## Appendix 2 - Practical Test Recording



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### Surf Lifeguard CPR Survey 2010 Practical Skills test

Participant number: \_\_\_\_\_ Club: \_\_\_\_\_

Tester: \_\_\_\_\_ Date: \_\_\_\_\_

Item No.	Description	Pass(1)/Fail(2)
<b>Observed Skills</b>		
1	<b>Danger</b> (checks safe to approach, dons gloves)	
2	<b>Responsiveness</b> (checks using voice and touch)	
3	<b>Send for help</b> (calls 111/summons assistance)	
4	<b>Airway</b> (opens airway using head-tilt/chin-lift)	
5	<b>Breathing</b> (checks breathing ≤ 10 seconds)	
6	Upon being told "not breathing" goes for help (or indicates they would do so)	
7	<b>Chest compressions</b> (commences CPR)	
8	Correct ratio (30:2)	
9	Maintains airway between sets of compressions	
10	Correct sequence (DRSABC)	
<b>Chest compression skills</b>		<b>Number/ %</b>
1	Average compression rate	
2	Average compression depth	
3	Average number of compressions per min	
4	Percentage of correct chest compressions	
5	Number of too deep chest compressions	
6	Number of too shallow chest compressions	
7	Number of too low hand positions	
8	Total number of compressions	
9	Number of wrong hand positions	
10	Number of incomplete releases	
<b>Ventilation skills</b>		
1	Average number of ventilations	
2	Average volume of ventilations	
3	Minute volume ventilations	
4	Number of too fast ventilations	
5	Number of too little ventilations	
6	Number of too much ventilations	
7	Total number of ventilations	
8	Percentage of correct ventilations	

**Appendix 3 - Resusci®Anne SkillReporter™**

Student name: \_\_\_\_\_

Instructor name: \_\_\_\_\_

Duration of the session: (min : sec) \_\_\_\_\_

**Ventilations:**

Average volume (ml) \_\_\_\_\_

Average number per min. (#/min) \_\_\_\_\_

Minute volume (ml/min) \_\_\_\_\_

Total number (#) \_\_\_\_\_

Number correct (#) \_\_\_\_\_

Percent correct (%) \_\_\_\_\_

Too much (#) \_\_\_\_\_

Too little (#) \_\_\_\_\_

Too fast (#) \_\_\_\_\_

Compression/Ventilation ratio \_\_\_\_\_

**Compressions**

Average depth (mm) \_\_\_\_\_

Average number per min. (#/min) \_\_\_\_\_

Average compression rate (#/min) \_\_\_\_\_

Total number (#) \_\_\_\_\_

Number correct (#) \_\_\_\_\_

Percent correct (%) \_\_\_\_\_

Too deep (#) \_\_\_\_\_

Too shallow (#) \_\_\_\_\_

Wrong hand position (#) \_\_\_\_\_

Hand position too low (#) \_\_\_\_\_

Incomplete release (#) \_\_\_\_\_

**Defibrillation (CPR-D models only)**

Time from scenario start

to first shock (min : sec) \_\_\_\_\_

Time from call for help

to first shock (min : sec) \_\_\_\_\_

Time from arrival of defibrillator

to first shock (min : sec) \_\_\_\_\_

## Appendix 4 - Data gathering procedures at the beach



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### Surf Lifeguard CPR Survey 2010

#### DATA GATHERING PROCEDURES AT THE BEACH

##### Prior to introducing yourself to the Patrol

1. Write candidate number on survey and practical assessment sheets
  2. Set manikin and table up with 2 chairs in an area of the club where you will not be interrupted during the testing
  3. Check manikin (perform daily test at each location). Turn SkillReporter on and check LED light is not flashing (= low battery). Change batteries if necessary. Turn OFF until needed
- Check in with Patrol Captain**

1. Introduce yourself to the Patrol Captain and find out how many patrol members are available (need to record number on patrol/how many took part for response rate)
2. Introduce yourself to the patrol members and explain your purpose.  
**“We’re doing on at study on volunteer lifeguard CPR skills and what you think about CPR, we would be grateful if you would take part in a brief short answer survey first and then have a go on our latest manikin set up in the Clubhouse/Patrol tower**

**I’ll now give you out a survey and pen, please do not discuss this with others and be honest in your responses**

**Please do not put your name on it as this is an anonymous survey but remember the number on top of the survey when you come to do the manikin stuff**

**Any questions, okay, let’s do the survey first**

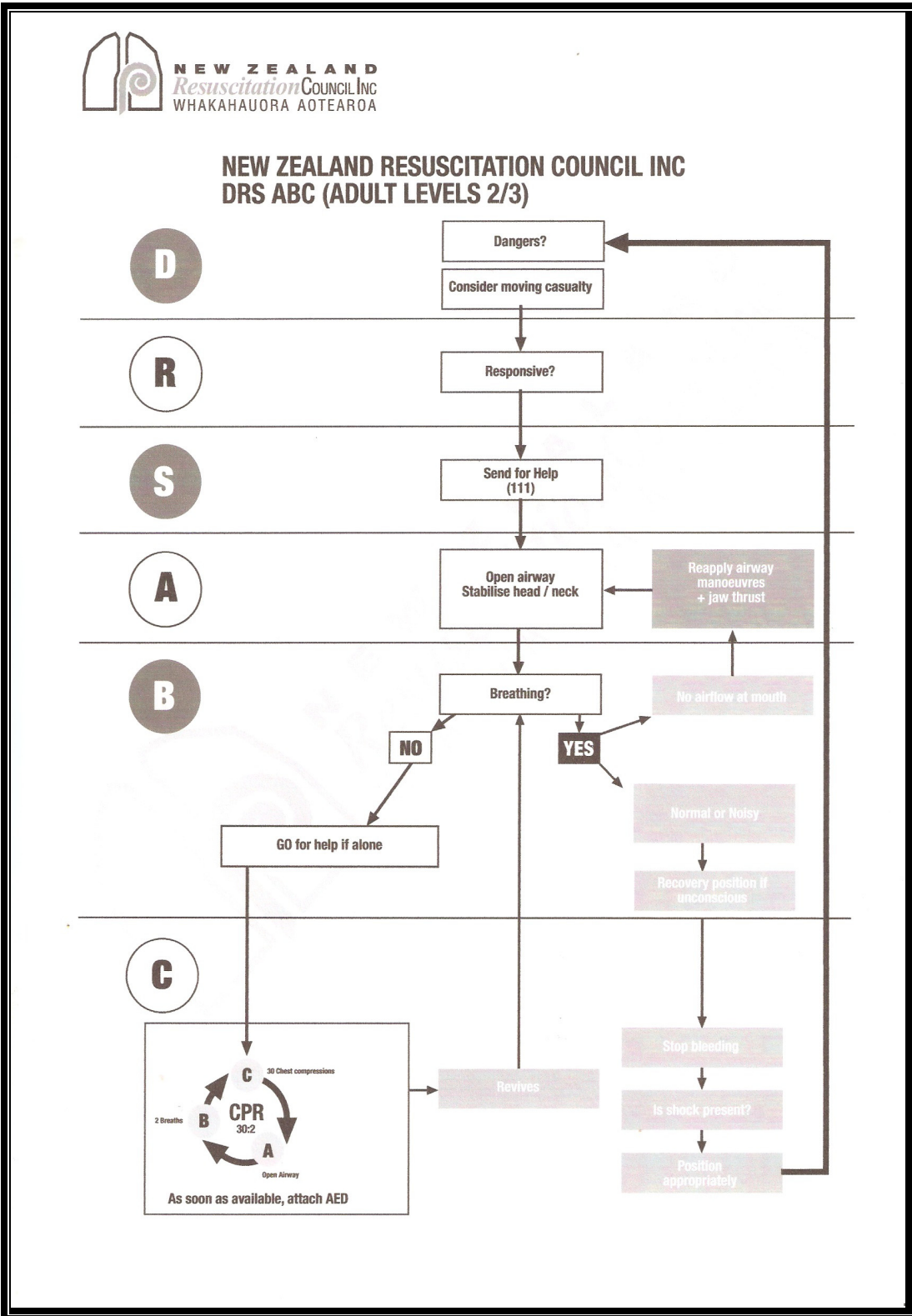
##### After completing the survey

3. Bring candidate into room; ask them to be seated
4. Brief candidate on practical assessment
5. Hand candidate “first aid kit” and inform them they can use all or some of the equipment, but that the face shield must be used
6. Ensure SkillReporter is positioned on the assessor’s side of the manikin with the display facing away from the candidate.
7. Turn ON the SkillReporter and press the log button
8. Read preamble
9. Assess candidate using the observed skills section of assessment sheet
10. Start stopwatch when chest compressions commence
11. After 2 mins of CPR ask the candidate to stop; press the short report button on the SkillReporter
12. Do not discuss the results with the candidate. Thank them for their participation
13. Remove the printout from the SkillReporter, **write the candidate number** on the strip and staple it to the skills assessment sheet
14. Clean the manikin with an alcohol wipe, re-set the room and first aid kit

##### After completing data gathering

1. Go back to Patrol Captain and patrol members
2. Thank them for taking part, explain that the results of the study will be available in 6 months time
3. Check equipment is sanitised (see page 11), secure, check data is secure and numbers all match and correspond with number of participants
4. Make a note on the main Data Sheet of the day, date, location, patrol number, time, and number of participants for future reference

# Appendix 5 – NZRC Resuscitation Algorithm



## Appendix 6 – SLSNZ Resuscitation Checklist

(Surf Lifeguard Refresher Manual, 2009, p.9)



Surf Lifeguard Refresher Manual  
August 2009

### Resuscitation Checklist

SLSNZ are assessing Surf Lifeguards on their knowledge of The New Zealand Resuscitation Council Level 2 Adult Resuscitation

#### Adult CPR (8 Years+)

##### Danger

- Check if scene is safe
- Approach patient without undue delay

##### Response

- Check for response using voice and touch

##### Send for help

- Summon/Call for help (111)

##### Airway

- Check in mouth
- Open the airway (head tilt, chin lift)\*

##### Breathing

- Look, listen and feel for breathing\*
- Go for help in alone

##### Circulation

- Locate correct hand position
- 30 chest compressions at correct speed (100 per min)\***
- Compress chest to correct depth 4–5cm
- Two rescue breaths (delivered over one second – airway should be reopened to ensure effective ventilations)
- Continue with compression to breath ratio of 30:2
- Continue until advanced help arrives, the patient is revived (shows signs of life) or you can no longer continue

\*The 3 bolded assessment criteria must be mastered to pass this section.

In it for life.