Introduction

Many older people in Australia and elsewhere are retaining their teeth into old age, and growing numbers are entering residential aged care facilities (RACFs) where a shortage of care workers raises the question of whether there are adequate numbers to meet this demand (Chalmers 2003; Paley et al. 2004; Lindqvist et al. 2013). Older adults in RACFs are at greater risk of developing oral diseases (Chalmers 2003; Carter 2009; Moriarty 2000). Such constraints can affect the general health, behaviour and communication may be affected (Chalmers 2003; Carter et al. 2004; Miegel and Wachtel 2009). However, heavy staff workload, time restrictions, insufficient resources, caregiver attitudes, lack of oral health knowledge, policy constraints and poor documentation of residents’ records have been identified as barriers to effective oral care in RACFs (Hearn and Slack-Smith 2015).

Studies indicate the importance of good communication and its positive effect on quality of care at RACFs (McGilton et al. 2009; Moriarty et al. 2010). Yet, good communication can be inhibited by various factors including communication impairment in residents (Bryan et al. 2002) and carers’ communication styles (Caris-Verhallen et al. 2000). Such constraints can affect the delivery of oral health care to residents. Information and communication technology (ICT) may be an effective modality to help address this issue at an organisational level to meet the oral health needs of residents (Yu and Comensoli 2004).

Although ICT use has been limited at RACFs (Yu and Comensoli 2004; Yu et al. 2009), it could provide knowledge and clinical support to staff to make informed decisions regarding oral care (Loh et al. 2009). ICT takes many forms: print resources (Matear and Gudofsky 1999), video and visual materials (Caris-Verhallen et al. 2000; Chalmers et al. 2005) and the Internet (Issrani et al. 2012; Marinho 2015).

Telemedicine (Amart and Delesie 2001) and teledentistry (Kumar 2014) have been used to improve inter-sectoral communication between staff, residents and external stakeholders at RACFs (Lyuhe et al. 2012; Kumar 2014) and to promote care of people with chronic medical conditions (Jhaveri et al. 2015). Teledentistry uses health information and telecommunications (Fricton and Chen 2009) for oral care across a range of contexts including clinical consultations, education and to increase public awareness about improving oral health (Fricton and Chen 2009; Daniel and Kumar 2014). In Australia, a review of information technology use in the Australian aged care industry highlighted individual and institutional barriers to its adoption (Yu and Comensoli 2004). Other studies reported barriers to older adults using the Internet (Irizarry et al. 2002), including age-related cognitive change and rapid changes in technology (Docampo Rama et al. 2001; Irizarry et al. 2002). Although some older adults left the educational system and the workplace before the widespread introduction of ICT, they were unlikely to have been exposed to...
or used new technologies (Irizarry et al. 2002), whereas others may be more familiar with the Internet and other ICT modalities, and often had access to education, occupation and household income; this is commonly referred to as the digital divide (Australian Bureau of Statistics 2014).

Aims
This paper aims to: (1) review literature on ICT methods targeted at residents, staff and external providers in RACFs such as general practitioners, dental and allied health professionals to improve oral health of residents; (2) identify barriers and enablers to the use of ICT at RACFs; and (3) investigate evidence of effectiveness of these approaches in increasing oral health knowledge.

Methods
A narrative literature review approach was chosen, as it successfully synthesises different types of research evidence and can also identify gaps in the literature (Lucas et al. 2007). Online databases Medline, EMBASE, CINAHL, OVID and Psych Info were searched to identify published papers focusing on residential aged care, oral health promotion and ICT. Search terms included oral or dental health, oral health promotion, residents, carers, nursing staff, dental professionals, residential aged care, teledentistry, video and visual, ICT, workers, residents’ families. Relevant articles were also identified from other sources, including hand searches of journals and reference lists of individual articles. Criteria for article selection were: inclusion in English language peer-reviewed journals and studies conducted in healthcare settings that had used ICT methods to improve care delivery in developing countries such as Australia. The first author (BA) independently identified studies that fulfilled the selection criteria, discussed and agreed on article selection with the other authors. Key findings are presented under two main categories: (1) ICT methods for oral health promotion at RACFs; and (2) barriers in using ICT for promoting oral health at RACFs. The two categories were further divided into sub-themes.

Results
Fifty papers published from 1990 to 2014 were identified as potentially relevant. After careful review, 34 papers were included. Twenty-six papers focused on different ICT methods used at RACFs and eight papers highlighted barriers to using ICT at RACFs. Box 1 summarises the 26 papers on ICT methods and Box 2 details the eight papers on barriers to ICT methods at RACFs. This review highlighted studies on video communication ($n = 9$), Internet, television and radio ($n = 3$), teledentistry ($n = 9$) and print resources ($n = 5$) as available ICT methods at RACFs.

Box 1. Summary of research articles on information and communication technology (ICT) methods used at residential aged care facilities (RACFs)

- Enhanced social inclusion between residents and families.
- Facilitated communication between care provider and residents.
- Demonstrated successful outcomes in education and inter-professional training, especially in under-served populations.
- Improved residents’ verbal fluency and communication skills.

**Internet, television and radio** (Anderson et al. 2003 Walmsley et al. 2003 Harris and Chestnutt 2005)
- Internet provided easily accessible oral-health educational resources for residents and care providers.
- Internet facilitated capacity building and self-empowerment in residents.
- Multimedia technologies, such as radio and TV, have the potential ability to promote good oral health at RACFs because of their popularity in among the older adults.
- Little or no research studies in using social media, such as Facebook, YouTube, MySpace and Twitter, to promote oral health outcomes at RACFs.

- Early detection and timely treatment of oral diseases.
- Diagnostic, monitoring and education purposes for residents and care providers at different oral care settings.
- Allowed better and fairer access to specialist oral healthcare services.
- More research required for oral health promotion at RACFs.

**Print resources** – newsletters, booklets and paper stickers (Matear and Gudofsky 1999 Paley et al. 2004 American Dental Education Association 2006 Issrani et al. 2012)
- Facilitated dental geriatric education for dental professionals at a geriatric resource centre and database on geriatric topics in booklet and CD format.
- Presence of educational newsletters and materials on oral health at RACFs for residents and care-workers has potential capacity to promote oral health at RACFs.
- Using stickers with oral health messages to remind residents on oral hygiene practices may promote oral health.
- Providing information on dental geriatric in seniors’ magazines and newspapers can be a good source of promoting oral health in community stakeholders.
Commentaries or discussion in editorials, reflective pieces including recommendations for practice and opinion pieces, were also included, where relevant, for their possible effect on policy and practice.

Enablers to using ICT for promoting oral health in RACFs

Promoting oral health for residents using ICT at RACFs

This review identified literature regarding ICT in promoting oral health at RACFs. These included making print-based educational newsletters and materials on oral health available in RACFs’ reception rooms (Matear and Gudofsky 1999; Issrani et al. 2012), using stickers to remind residents to clean their teeth (Paley et al. 2004) and placing articles on geriatric dentistry in seniors’ magazines and newspapers to promote oral health at a population level (Matear and Gudofsky 1999). ICT such as television and radio are popular among older adults. As older adults frequently access these media sources, evidence suggests they could be used more effectively to disseminate knowledge of oral self-care including prevention (Arnaert and Delesie 2001; Issrani et al. 2012).

A Melbourne study evaluated the effectiveness of a web-based oral health promotion program targeting older adults living in community settings (Mariño 2015). It aimed to improve their oral health knowledge, attitudes, practices and self-efficacy. Although this program presumes a degree of computer literacy, findings nevertheless showed that web-based technology was effective in promoting oral health in older adults in this population. Furthermore, the program created an easily accessible oral health resource for both older adults and healthcare providers (Mariño 2015). Additionally, the project enhanced the capacity of older adults to be sufficiently empowered to access health information using ICT (Mariño 2015).

Studies identified how social media including YouTube, Facebook, MySpace and Twitter can encourage health improvement and behaviour change (Vance et al. 2009; Korda and Itani 2013). Whereas the 2010 Deloitte Survey of the US Health Care Consumers reported that older consumers, including seniors, baby boomers and those with chronic conditions, were more likely to participate in online wellness programs than the younger generation (Deloitte 2010), another study reported that younger adults were more likely to participate in social media (Chou et al. 2009). Nevertheless, there was a paucity of studies on the use of social media and the Internet to promote health, particularly oral health, in older adults at RACFs.

An Australian study demonstrated that media resources such as video and booklet materials were successfully used by staff in promoting oral health to residents in RACFs (Chalmers et al. 2005). Video telephony using a telephone or mobile phone with a video application such as FaceTime (Arnaert and Delesie 2001) has been effective in improving care in older adults living in the communities (Nakamura et al. 1999; Mochizuki-Kawai et al. 2008). A study conducted in Japan, in which 13 healthcare professionals from different disciplines provided care using video telephony for older adults in the community, reported improvement in overall care quality (Nakamura et al. 1999). This includes improvement in clients’ communication skills, personal care and social activities. This method also facilitated emotional support for the clients and their families. Furthermore, the safety of clients living alone in the community was ensured, and overall communications among multidisciplinary home healthcare professionals was enhanced through this method (Nakamura et al. 1999).

Also, a Swedish study found video–phone conversations using FaceTime could be effective as a communication resource (Sävenstedt et al. 2003) between family members, carers and the residents at RACFs. This method allowed the residents’ families to be involved in the caring process; therefore, partnerships with family members in caring was enhanced. This further minimised the loss of control, disempowerment and guilt families sometimes felt as a result of placing older adults in a RACF (Sävenstedt et al. 2003).

These examples suggest that video–phone communication has the potential to promote oral health in residents. However, there is limited literature on the use of video telephony in promoting oral care at RACFs.

Oral health education for health professionals using ICT

Healthcare providers’ applied knowledge of oral health and communication skills may contribute to oral health literacy (Lo and Tan 2014). Evidence suggests that healthcare professionals, such as dental professionals who engage with educational initiatives and geriatric dental education resources, will greatly enhance their ability to effectively treat and manage older patients (Issrani et al. 2012). In Australia, dental professionals include dentists, dental hygienists, dental therapists and, more recently, oral health therapists. Oral health therapists are trained throughout Australia and are required to successfully complete an accredited

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<th>Box 2. Barriers to using information and communication technologies (ICT) for promoting oral health at residential aged care facilities (RACFs)</th>
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<tr>
<td><strong>Residents</strong> (McClung et al. 1998; Irazzáry et al. 2002; Xie 2003; Loh et al. 2009)</td>
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<tr>
<td>* Limited expertise and inability to use technology because of their age.</td>
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<td>* Impaired cognitive function, physiological changes in perception, movement and psychosocial functioning.</td>
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<td><strong>Management</strong> (Yu and Comensoli 2004 Pitsikali 2014)</td>
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<tr>
<td>* Cost of acquisition, implementation and maintenance of ICT equipment.</td>
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<td>* Technical issues leading to malfunction of technology devices.</td>
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<td>* Cultural resistance towards ICT adoption.</td>
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<td>* Complex decision-making because of multiple stakeholder involvement at RACFs.</td>
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<td>* Attitudes of RACF staff towards using ICT.</td>
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<td>* Capacity of healthcare practitioners to manage changes because of ageing workforce at RACFs.</td>
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<tr>
<td>* Professional liability, time, accountability, privacy and confidentiality of residents’ electronic health records.</td>
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<td>* Limited training for the RACF staff on how to use ICT equipment.</td>
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3-year bachelor degree in the dual streams of dental hygiene and dental therapy (Dental Board of Australia 2012).

One suggestion was to create a geriatric resource centre or database on relevant topics, available to all dental practitioners (Matear and Gudofsky 1999). Also, a resource guide was compiled by the American Dental Education Association and funded by GlaxoSmithKline, which was published as a booklet and a CD-ROM, about geriatric dental education for dental professionals (American Dental Education Association 2006).

The Internet can be used as a powerful tool for both improving communication and expanding knowledge (Walmsley et al. 2003). Benefits for dentistry include patient and dentist education, communication between dental practitioners, up-to-date knowledge of new developments and products for dental practice (Walmsley et al. 2003). Although there is a dearth of literature on web-based training resources on oral health for RACF staff, web-based training resources on oral health are available to facilitate oral health education and training as part of staff development for carers at RACFs and for students undertaking aged care or nursing qualifications (The Government of South Australia 2008). The post-evaluation results indicated that healthcare professionals such as GPs and nurses had significantly improved their assessment of residents’ oral health conditions for diagnosis and care purposes (The Government of South Australia 2008).

Furthermore, a UK study suggested the Internet as a future source of oral health education material, which dental professionals underutilised, as an educational resource for their patients (Harris and Chestnutt 2005). However, another study reported that the use of the Internet could lead to disagreements on treatment, resulting in tension between practitioner and patient (Anderson et al. 2003).

Teledentistry uses electronic health records, telecommunications technology, digital imaging and the Internet to provide teleconsultation and information in oral healthcare settings (Fricton and Chen 2009). Research indicates the potential of teledentistry to reduce healthcare inequalities by providing dental professionals with greater access and timely oral care for underserved populations such as those in rural or remote settings (Fricton and Chen 2009). Digital imaging is a type of teledentistry used for diagnosing oral conditions for referral, treatment and consultation among specialists and primary oral healthcare providers (Kopycka-Kedziewaraki and Billings 2006). The benefits of digital images are greater accuracy and improved diagnosis, as images can be stored in a computer and accessed when needed (Kopycka-Kedziewaraki and Billings 2006). An experimental study using digital imaging conducted at three different RACFs with 50 residents in Melbourne, Australia, reported that participants viewed teledentistry as relevant to the scope of oral health care at RACFs (Kumar 2014).

Further studies on oral health promotion are required to identify the effectiveness of digital imaging in promoting oral health in RACFs. Tablets, smart phones and mobile electronic health records (referred to as m-health) have also been reported as effective for diagnostic, monitoring and education purposes in different clinical dental settings (Daniel and Kumar 2014). A USA study reported that smart phone camera technology was used to obtain and transmit images for dental caries screening in school children (Daniel 2013). However, findings from the study showed that this was less definitive than clinical examination by an on-site dental professional. The smart phone’s limitations, including its inability to capture several teeth in different quadrants (Daniel 2013; Daniel and Kumar 2014), were offset by its advantages such as smaller size, availability, popularity and reduced likelihood of intimidating patients (Daniel and Kumar 2014). This suggests that m-health could be useful for interdisciplinary collaborative healthcare settings such as RACFs.

Video conferencing has been successful in education and professional development at RACFs (Kumar 2014). A Netherlands study on improving communication techniques to enhance nurse–resident relationships at RACFs found that using video interaction analysis for trained nurses at RACFs was effective (Caris-Verhallen et al. 2000). Swedish research reported the successful outcome of video conferencing in educating staff and improving the quality of care at RACFs (Helgesson et al. 2005). Most literature reported the effectiveness of video conferencing in training dental students (Reynolds and Mason 2002) in diagnosing oral conditions (Kumar 2014) and for inter-professional communication (Bauer and Brown 2001) between different sites, particularly for those in rural and remote areas (Fricton and Chen 2009).

Barriers to using ICT for promoting oral health in RACFs

Barriers to adopting ICT at Australian RACFs occurred at individual and organisational levels (Yu and Comensoli 2004). These included lack of management and stakeholder support, cultural resistance towards ICT adoption, cost, staffing issues, work practice and the capacity to manage change (Yu and Comensoli 2004; Loh et al. 2009).

Barriers to residents

Some studies identified age as a major barrier to using ICT to promote oral health care at RACFs (Xie 2003; Eley et al. 2009). Research indicated age-related changes in visual, perceptual, motor and cognitive abilities made it more difficult for older adults to learn and use new technologies (Xie 2003; Wood et al. 2005). However, a comparison study between older and younger adults concluded that experience and consistency rather than age were important factors in older adults becoming familiar and comfortable with using computers (Wood et al. 2005). Nevertheless, the limited expertise and inability of residents to use technology may lead to inappropriate application and utilisation of health information, which may further complicate their medical conditions (Crocco et al. 2002). Although evidence suggests multimedia, such as the Internet and print resources, are effective in promoting oral health at RACFs (Issrani et al. 2012), older adults with a language barrier, especially those from culturally and linguistic diverse (CALD) backgrounds, face additional challenges learning a new computer language (Irizarry et al. 2002).

Barriers to allied health and dental professionals

Barriers identified by allied health and dental professionals to adopting teledentistry in oral care settings included time, accountability, privacy and confidentiality of residents’ electronic
health records (Sanjeev and Shushant 2011; Daniel and Kumar 2014; Kumar 2014).

The attitude of RACF staff was another barrier to adopting ICT as a tool to promote oral health (Loh et al. 2009). Participants in some studies explained that providing care using ICT in healthcare settings might have serious psychological implications for clients who miss out on physical contact with healthcare professionals (Eley et al. 2009; Loh et al. 2009; Pitsikali 2014). Other participants considered ICT a waste of time and felt that the equipment was not user-friendly (Loh et al. 2009). Nevertheless, an Australian study reported that the age of nurses may affect the adoption of ICT, with older nurses more likely than the younger nurses to perceive ICT as a barrier (Eley et al. 2009). However, the study further recommended training for older nurses with limited ICT skills (Eley et al. 2009).

**Management barriers**

The cost of acquisition, implementation and maintenance of some forms of ICT equipment is a major barrier (Yu and Comensoli 2004). Technical issues are inevitable, visual or audio difficulties, and Internet network breakdowns may also occur during usage (Pitsikali 2014). Furthermore, the quality of health information available on the Internet may be inaccurate and misleading (McClung et al. 1998).

Multiple stakeholders in the aged care sector provide another barrier to adopting ICT to promote oral health at RACFs (Yu and Comensoli 2004). Stakeholders include residents and their family, staff, management, dental practitioners, general practitioners, allied health professionals and government. Decisions on implementing ICT may take a long time or may never be implemented (Yu and Comensoli 2004) because of a long negotiation process between multiple stakeholders.

**Discussion and conclusion**

This review identified literature regarding how ICT has been used to promote oral health in residential aged care facilities and highlighted the benefits of and barriers to its use. A key gap in several studies was the lack of attention to the needs of CALD populations when using ICT to promote oral health. For instance, oral health messages for older adults from CALD populations need to reflect background and level of acculturation (Lo and Tan 2014). Considering the current relevance of ICT, especially computers and their benefits, designing ICT to meet the capabilities of older adults to use technology devices is important (Chen and Chan 2011), particularly given the physiological changes they face in perception, cognition, movement and psychosocial functioning (Charness et al. 2001). Providing opportunities for older adults to comfortably engage with technology, age-appropriate training and strategies for using ICT (Wood et al. 2005) is important. ICT methods such as the Internet can be of great value to CALD populations for accessing dental practitioners who speak their languages (Pitsikali 2014). Although some studies have highlighted the benefits of teledentistry in promoting health equality in vulnerable populations (Fricton and Chen 2009; Bradley et al. 2010), little work has been conducted in the area of oral health promotion using teledentistry in RACFs.

The Internet offers a dynamic means of promoting oral health at RACFs through its potential to disseminate information, enhance communication and facilitate interactions between residents and care providers. It has been shown to be effective in promoting lifestyle changes in diet (Brug et al. 2003) and smoking cessation (Takahashi et al. 1999). However, the immense amount of health information on the Internet is not always reliable. A study investigated the nature and quality of periodontal-related patient information on the Internet and reported variations and inaccurate information on some websites (Chestnutt 2002). This suggests patients may experience difficulty discerning and locating the most accurate health information on Internet sites (Chestnutt 2002). Evidence suggests that healthcare professionals should direct interested patients to the most relevant material or credible health information websites (Chestnutt 2002).

There is less clarity in the literature about cost being a barrier to using ICT at RACFs. Whereas some studies identified implementation and operation costs of ICT equipment as a barrier (Yu and Comensoli 2004; Eley et al. 2009), others viewed ICT methods such as teledentistry as reducing cost for residents, RACF management and the government (Daniel and Kumar 2014). Facilitating early diagnosis of oral conditions using ICT may allow timely interventions for oral conditions, prevent hospitalisation, decrease morbidity and mortality and reduce long waiting times for the clients, thereby reducing the patients’ costs (Daniel and Kumar 2014).

Dental professionals on site in RACFs may facilitate effective use of the Internet in promoting oral health. A UK survey investigated patients’ use of the Internet to access oral health-related information while attending a dental hygiene clinic. Results showed that participants wanted direction to an appropriate educational resource by their dental professional (Harris and Chestnutt 2005). Partnering with internal oral health champions who know the context and culture of the organisation and want to advocate for oral health, is essential in translating health promotion efforts to sustainable oral healthcare change (Thorne et al. 2001). Studies have identified dental professionals including hygienists as potentially championing oral health care at RACFs (Miegel and Wachtel 2009; Yakiwchuk 2013) by promoting oral health through ICT and demonstrating effective oral healthcare practices to residents by showing videos, providing information on oral health in the facility newsletters and providing oral health education and training to RACF staff (Yakiwchuk 2013).

ICT affects activities in daily life including human interaction, communication, information and learning (Glick et al. 2012). However, physical contact between residents and staff members is also important. This raises the questions of ICT being used to complement face-to-face communication to promote oral health in RACFs (Glick et al. 2012). ICT services need to be designed to enhance routine care delivery and human contact for residents (Loh et al. 2009). However, more evidence is needed, not only on how organisations, health professionals and residents can effectively address these challenges, but also on evaluating the role ICT plays in improving oral health outcomes in this context.
Study limitations
This review highlights key barriers and facilitators to its use in this context, but it is not a conclusive analysis of the current usage of ICT in RACFs, because of rapid changes and developments in ICT.

Conflicts of interest
The authors declare that they have no conflicts of interest.

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